INTERNATIONAL JOURNAL OF INDUSTRIAL MANAGEMENT
ISSN: 2289-9286 E-ISSN: 0127-564X
VOLUME 18, NO. 2, 2024, 118 – 131
DOI: https://doi.org/10.15282/ijim.18.2.2024.10836

RESEARCH ARTICLE

ENHANCING LIFELONG LEARNING: A DATA-DRIVEN DASHBOARD APPROACH FOR STRATEGIC DECISION-MAKING AT UNIVERSITI MALAYSIA PAHANG AL-SULTAN ABDULLAH

Rosilavi Mat Jusoh[1]*, Zetty Ain Kamaruzzaman[1], Galuh Tresna Murti[2]

[1]Faculty of Industrial Management, Universiti Malaysia Pahang Al-Sultan Abdullah, 26600 Pahang, Malaysia
[2]School of Economics and Business, Telkom University, Bandung, West Java, Indonesia

ABSTRACT - The purpose of this study was to develop a dashboard with information visualisation for the lifelong learning (LLL) programs at Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA) and provide recommendations for UMPSA to improve the strategies and decision-making for future LLL program offerings. This study used the Cross Industry Standard Process for Data Mining (CRISP-DM) model created by the International Business Machines Corporation (IBM) and dashboard development using Microsoft Power BI. The updated database was created by obtaining data from the Institute of Graduate Studies (IPS), UMPSA. Such data was then prepared through the process of selecting, cleaning, constructing, integrating, and formatting data. The dashboard was developed using a database for data visualisation and information in the form of reports. Such information can ensure a better decision-making process and the UMPSA management's readiness in planning the admission process for future students. However, the data management and data quality at UMPSA must be improved. Future research can expand the present investigation by including data from all categories of LLL students at UMPSA to facilitate a more comprehensive analysis. It will also enable the university management to make accurate decisions about program offerings in the future.

ARTICLE HISTORY
Received : 04-12-2023
Revised : 14-01-2024
Accepted : 14-02-2024
Published : 25-06-2024

KEYWORDS
Cross Industry Standard Process for Data Mining (CRISP-DM)
Microsoft Power BI
Lifelong learning
Data-driven decision making

1.0 INTRODUCTION

Lifelong learning (LLL) aims to not only produce graduates who are highly skilled in their respective fields but also facilitate the development of a country's future assets. These highly skilled workers are crucial to help develop the human capital of a country and assist in economic development (Hamat & Che Nordin, 2012). The transformation of national education has positioned Higher Education Institutions (HEIs) as the main platform for producing a skilled workforce whether through full-time or part-time studies (Naemat et al., 2017). The primary plan for national growth is the regular and continuous improvement of skills to meet the ever-changing global environment. Therefore, LLL programs ensure that every worker has the chance to pursue education for personal as well as career growth.

In Malaysia, the prominence of LLL has been highlighted in the Malaysia Education Blueprint 2015–2025 (Higher Education) to support the government's effort to better educate the people in facing the challenges of sustainable development (MOHE, 2015). The Ministry of Higher Education (MOHE) describes LLL as a strategy for democratising education that involves acquiring knowledge, abilities, and competencies in formal, informal, or non-formal settings based on real-world experience or training. Unlike the conventional method of studying by enrolling full-time into academic programs, LLL programs allow individuals aged 15 years old and older to earn academic or skill credentials through online learning, workplace learning, and part-time or remote learning.

According to the Malaysia Education Blueprint 2015-2025, LLL is the third pillar of the nation's human capital program that offers higher-level learning options and opportunities aiming to develop fundamental skills. LLL helps to develop all-around talent, which ultimately benefits the citizens. Malaysia must create an inclusive knowledge society that gives people the chance to participate in the nation's socioeconomic transformation. Changes in the global employment market necessitate ongoing learning and growth. Throughout their careers, people can anticipate switching occupations about ten times. The recent data also denotes that 65% of elementary school pupils are anticipated to work in jobs that are yet to exist. Therefore, Malaysia must improve the abilities of workers across all levels to boost the labour market. LLL is believed to have the capability of maximising people's potential by providing the opportunity for skill development, including those who are unemployed or have left the education system.

A number of major LLL projects have been established by MOHE, including the Blueprint on Enculturation of Lifelong Learning for Malaysia 2011-2020 (LLL Enculturation Blueprint). The Blueprint categorises the Malaysian LLL programs into three categories: formal, non-formal, and informal (MOHE, 2011). Formal LLL encompasses learning that takes place in formal learning institutions and can lead to academic credentials or recognised forms of learning. These

*CORRESPONDING AUTHOR | R. Mat Jusoh | ✉ rosilavi@umpsa.edu.my

programs often have well-organised and well-structured learning objectives and outputs. Among the examples include executive diplomas, certificates, and diplomas from polytechnics and community colleges, undergraduate and graduate degrees granted by public and private universities, and certificates and diplomas from community colleges (MOHE, 2011). Non-formal LLL, on the other hand, refers to learning that occurs away from a formal institutional setting. These applications usually include excellent organisation and design. However, the issuance of specific academic certificates may not always follow the participation in non-formal LLL. Furthermore, non-formal LLL is utilised frequently by in-service employees with the aim of enhancing and developing professional skills (MOHE, 2011). Finally, informal LLL is often conducted to raise students' quality of life. Informal LLL completion does not lead to academic credentials but rather happens as a result of a person's interest or initiative in self-improvement and personal growth. This may include community-based initiatives designed to solve current skill shortages, societal issues, or community needs (MOHE, 2011)

This study aims to achieve the following research objectives: (1) To develop a dashboard with information visualisation for the LLL programs at UMPSA and (2) To recommend UMPSA in improving the strategies and decision-making for LLL program offerings in the future. The findings will have an impact on the society, academia, government, industry, and the environment based on the Quintuple Helix model. The interaction between university, industry, and government is the centre of the Triple Helix innovation paradigm. The Quadruple Helix embeds the Triple Helix by including a fourth helix, namely public society based on media and culture as well as civil society. Contextualising the Quadruple Helix and including the natural environmental helix of society resulted in a bigger and more thorough Quintuple Helix innovation model (Carayannis et al., 2012).

Higher education is unquestionably essential for innovation. The economy must strongly emphasise knowledge generation and innovation for it to be compatible with the knowledge economy. In terms of knowledge creation and innovation, this study can promote the ideas of a knowledge society and a knowledge democracy. The knowledge economy must change socio-ecologically to fit into the current economy and society, co-evolving with the information society (MOHE, 2011). The economy, society, and environment will work together more effectively as a result of knowledge and innovation. The primary benefit that most people who utilise electronic systems solely consider is convenience. Additionally, the use of the latest technology, such as a dashboard, also helps the environment (MOHE, 2011). By reducing paper usage, UMPSA management can see the analysis of a report through a dashboard while reducing its impact on the environment and can highlight the paperless UMPSA's concern for the environment.

This study can also assist the UMPSA management in making decisions to offer formal LLL programs in the future. The findings hope to provide a better understanding about adult challenges for UMPSA to deliver improved services to students in the future. This research is crucial to obtain accurate data from the dashboard display regarding the official LLL programs offered at UMPSA. With the aid of this dashboard display, UMPSA will be able to conduct an analysis and propose appropriate improvements to the services offered to new students in the future. The findings of this study can also be included as part of the marketing plans for official LLL programs in catering for the intended audience.

Furthermore, the present study stands as an initiative under the UMPSA Strategic Plan 2021-2025. It particularly addresses Core 1B (1): Academics Together with the Community: Industry Students, aiming to increase targeted students from the industry. For premier and executive programs, students from the industry refer to those who are employed by the industry while also enrolled as students in an academic or learning program. It seeks to acquire information and abilities for both career and personal growth. The presence of students from the industry not only improves learning opportunities but also exposes them to the work culture and perspectives of seasoned professionals. The inclusion of industrial workers in the academic programs at UMPSA also demonstrates the working group's endorsement regarding its adequacy (Universiti Malaysia Pahang, 2021).

This paper is organised as follows: Section 2 presents the literature review, Section 3 explains the research methodology, Section 4 discusses the results, and Section 5 presents a conclusion of the paper.

2.0 METHODS AND MATERIAL

2.1 Lifelong Learning in Malaysia

Each person needs to be endowed with dynamic knowledge and constantly improve their quality of life as part of the efforts to develop individuals who think logically, ingeniously, and artistically. Therefore, it is important for every level of the society to understand the goals and principles of LLL. Many students have cited self-satisfaction and self-improvement as the motivating factors for learning. Lifelong learning refers to all learning events, whether formal, informal, or non-formal, that contribute to the development of knowledge, skills, abilities, experience, and values over the course of a person's lifetime (Abdullah et al., 2005). An individual interested in learning, whether formally or informally, will (i) acquire a high level of self-assurance, notably when learning about the education and training system; (ii) be ready in terms of their drive to study; and (iii) demonstrate particular learning practices and skills, including proficiency in reading, writing, and mathematics.

The LLL effort has been enthusiastically embraced in Malaysia, especially by people who work in the manufacturing industry. This tendency has been observed across many industrialised nations due to the importance of lifelong learning in the knowledge-based economy (Ting et al., 2015). Any nation that wants to be considered completely developed must have a population of educated inhabitants that can satisfy the demands and needs of the day. Conversely, LLL maximises

the potential of persons who are currently unemployed by providing possibilities for reskilling and upskilling. It also assists Malaysians in meeting the changing skill requirements of a high-income economy. Additionally, LLL promotes the development of individual goals and talents for a fuller life. Malaysia aspires to move away from a society in which education is viewed as something that exclusively happens to children towards one in which citizens of all ages actively seek out educational opportunities to further their own development (MOHE, 2015). According to Edwards (2019), the benefits of LLL include the complete development of innate skills as well as the production and expansion of inquisitive, ravenous intellects, helping individuals to grow in wisdom. It also facilitates individuals to adjust to changes and encourages them to participate responsibly in society in order to discover their intended purpose in life. Ultimately, LLL enables the formation of meaningful connections and meeting new acquaintances, resulting in an enriching life of self-fulfilment.

2.2 Cross-Industry Standard Process for Data Mining (CRISP-DM)

Cross Industry Standard Process for Data Mining, or CRISP-DM, is a framework widely used to conduct data science projects. It gives a realistic account of the data science life cycle, also known as the workflow in data-focused projects (Hotz, 2024). According to Chapman (2000), CRISP-DM was published in late 1996 by three "veterans" of the young and immature data mining market. Daimler Chrysler (previously Daimler-Benz) had experience with data mining in its business operations before most industrial and commercial organisations. Data mining services have been provided by SPSS (previously ISL) since 1990, and in 1994, the company published Clementine, the first commercial data mining workstation. The purpose of TTo was to better serve its clients and offer added value to Teradata data warehouse users. Additionally, NCR assembled teams of data mining consultants and technical experts. According to Schröer et al. (2021), CRISP-DM offers a common data mining process as a generic approach to problem-solving from a business or research organisation. CRISP-DM divides the life cycle of a data mining project into six stages, with the subsequent stages in the sequence are determined by the outcomes of the prerequisite step. These procedures aim to process the data after the CRISP-DM approach has been used to analyse the need for a dataset.

Data generally refers to unprocessed letters, numbers, or symbols. Information is created when raw data is turned into something useful or significant (Berwind et al., 2017). The information is broken down into who, what, when, and where. Some experts define data as discrete facts, statistics, or pieces of knowledge that frequently take the shape of numbers forming a collection of qualitative or quantitative values related to one or more individuals or objects (Berwind et al., 2017).

Today, data science and analytics are employed by enterprises all over the world in enabling them to make the most profitable decisions. Firms use a variety of models for organising business data (Parate, 2020) through a methodical presentation of information, such as facts, concepts, or instructions, that is suitable for machine or human interpretation, processing, or transmission (Bag, 2017). Additionally, big data requires data processing and storage solutions. These systems play a key role in many data management frameworks by frequently working along with platforms and technologies for big data analytics.

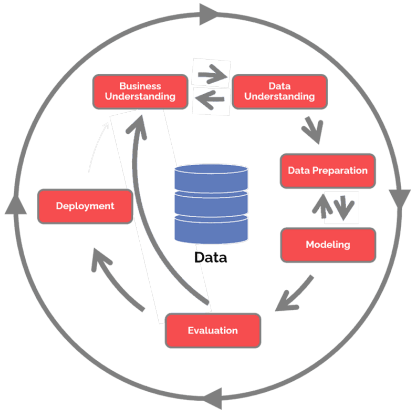

Figure 1. CRISP-DM method for data mining (Parate, 2020)

CRISP-DM consists of six iterative, partially affiliated steps, as shown in Figure 1. The foundation of the entire process is formed by the phases of Business Understanding, Data Understanding, Data Preparation, Data Modeling, Evaluation, and Deployment, which define a project's needs and objectives. These phases are also responsible for modelling, evaluating, and deploying a data mining process (Berwind et al., 2017).

i) The Business Understanding phase oversees the project's objectives and needs from a business perspective and creates an overall project solution process, including a project plan.

ii) Data understanding begins with the gathering of data and initial ad-hoc analysis to familiarise oneself with the data, identify issues (such as poor data quality), and develop initial insights into the data.

iii) Based on the raw data gathered in the Data Understanding phase, the Data Preparation phase coordinates all necessary tasks to produce a final dataset. Data preparation procedures can be conducted several times and in different sequences to load, process, or clean data.

iv) Modelling is the process of using different modelling and data mining techniques to gain fresh insights based on mathematical and statistical models. When using different modelling or data mining approaches, it may be essential to adapt the initial dataset depending on the data preparation process.

v) The Evaluation phase examines the constructed model to guarantee the accuracy of the analysis. The findings will be contrasted with the project and business goals established during the Business Understanding phase.

vi) The model's "go live" occurs during the Deployment phase. However, it is essential to structure and display this model so that a client or user can use its output to enhance decision-making.

2.3 Data Analytics

Business analytics, also referred to as analytics, is the use of data, information technology (IT), statistical analysis, quantitative methods, and mathematical or computer-based models to better understand business operations and make informed decisions. It describes the process of transforming data into actions through analysis and insights in the context of organisational decision-making and problem-solving. A variety of tools can assist business analytics, including Microsoft Excel and numerous Excel add-ins, paid statistical software programs like SAS or Minitab, and sophisticated business intelligence suites that connect data with analytical software (Evens, 2021). Large datasets can now be used for statistical and quantitative analysis, predictive modelling, optimisation, and simulation owing to the technology that is now accessible to businesses. In other words, the same quantitative tools that have been available for years have now become more successful by employing big data and the associated technologies (Albright & Winston, 2020).

According to Evens (2021), data collection, organisation, and manipulation are the first steps in business analytics. Depending on the extent of the data analytics maturity curve, the term "data analytics" is broad and can indicate many different things; nonetheless, data without analytics is not particularly valuable (Ramaswami et al., 2022). All four pillars of the contemporary analytics approach are collectively referred to as "analytics". Each pillar is crucial to assist a better understanding of the information given by the data and how these insights can be used to advance corporate objectives.

2.4 Data Visualisations

Data visualisation describes the process of visualising a dataset that is done after data correction, enabling users to comprehend the significance of the data through a visual context. These days, visualisation is more helpful in business intelligence and analytics across all industries. There are various approaches for visualising datasets, which can be interactive or dynamic in nature and can be displayed in a variety of visual insights (Bhargava et al., 2018).

One of the engaging techniques that promotes fresh invention and discovery is data visualisation. It is a dynamic instrument that aids in the scientific method. Every day, a significant amount of data is produced due to the widespread use of the internet, necessitating large and complex datasets to be understood. This can be achieved by processing the data using different data processing techniques and presented using various approaches and methodologies. Data visualisation is essential for any business to succeed because it enables them to manage data effectively and use it to their advantage (Anouncia et al., 2020).

The success of data visualisation depends on the speaker's ability to effectively convey information to the audience. Data visualisation is a method of transforming data or information into a visual object, such as points, lines, or graphic figures. Analogies between the past and present have been used to visualise data as a storage strategy, transforming it into clear information.

2.5 Dashboard Development Using Microsoft Power BI

According to Widjaja and Mauritsius (2019), Power BI is an analytical tool used in business for data analysis and information sharing. Power BI's cloud connectivity offers several data warehouse services, including data preparation, data discovery, and interactive dashboards. It has the capability to merge numerous databases, files, and web services to swiftly make changes or automatically fix data and issues. Power BI also automatically updates data while maintaining anonymity when sharing internal reports. Microsoft's Power BI is perceived as a Software as a Service (SaaS) product that enables users to create dashboards, reports, datasets, and visualisations for business intelligence. The tool can establish connections to a variety of different data sources, aggregate and shape the data obtained through those connections, and produce reports and dashboards that can be shared with others (Cybersecurity and Infrastructure Security Agency, 2022).

According to Biswal (2020), Power BI stands as one of the useful tools for data visualisation and business intelligence. It is helpful for converting data from many sources into interactive dashboards and BI reports. Power BI is available in many different versions, including desktop, service-based (SaaS), and mobile apps. One of the most important authoring and publishing tools is Power BI Desktop, which is mostly used by users and developers to produce new brand models and reports. This free program enables users to connect to a variety of data sources in order to create collections and visualisations as well as share reports with other employees. Most customers utilise BI desktop to produce and share reports with other users.

3.0 METHODOLOGY

Data mining can be conducted using the CRISP-DM standard process model to investigate databases for patterns, trends, and correlations. It outlines six distinct steps that must be completed once or a few times (Berwind et al., 2017). Figure 2 shows the flow of the research design. This study sought to enhance the manner in which pay data is provided to UMPSA management and to incorporate data analysis into dashboards for enhancing decision-making.

Past evidence suggests that analysing and deploying big data analytics often results in a greater impact on decision-making, making it more transparent, accurate, efficient, and faster (Björkman et al., 2017).

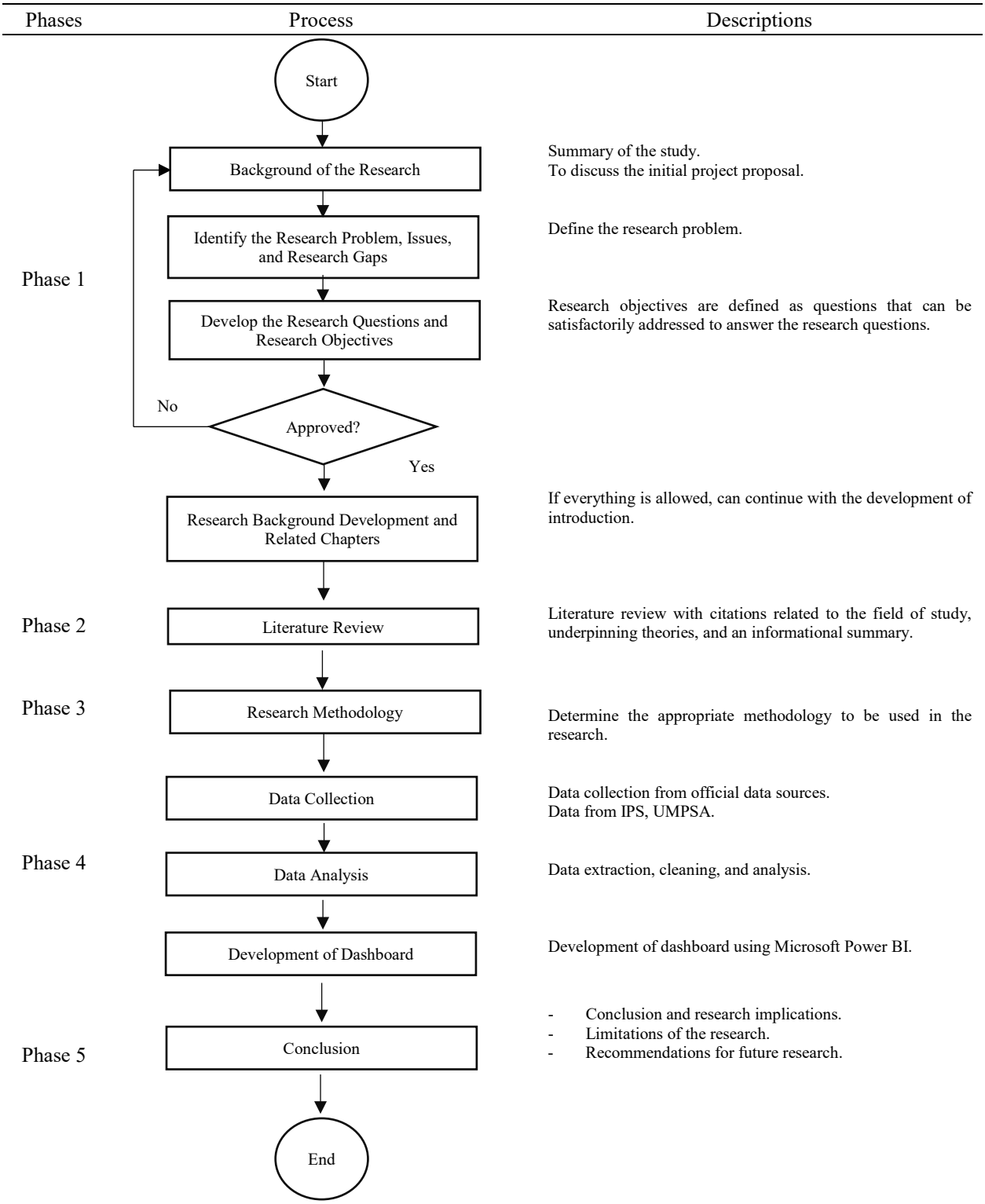

Figure 2. Flow of research

3.2 Developing a Dashboard Using Microsoft Power BI

Microsoft Power BI is a data visualisation and business intelligence tool that can assist in converting data from many sources into interactive dashboards and BI reports (Biswal, 2020). CRISP-DM comprises six iterative, sporadically connected phases, namely Business Understanding, Data Understanding, Data Preparation, Data Modeling, Evaluation and Deployment, along with the Modeling, Evaluation, and Deployment of the Data Mining Process. These phases serve as the foundation for the entire process and direct the goals and objectives of the project (Berwind et al., 2017). The following section explains the six steps involved in creating a dashboard.

Step 1: Business Understanding

Understand the organisation's goals and identify elements that may affect a decision. The result is useful to develop a visualisation of the implementation planning of the LLL program dashboard at UMPSA.

Step 2: Data Understanding

Focuses on data collection and ensures accuracy to avoid errors or missing numbers while gaining a basic understanding of the data. At this stage, the data was gathered in the Microsoft Excel format from the Institute of Graduate Studies (IPS), UMPSA. The data obtained was raw and further processing was required to obtain actual research data.

Step 3: Data Preparation

Following the raw data gathered in the Data Understanding phase, the Data Preparation phase coordinates all necessary tasks to produce a final dataset. Data preparation involves the process of loading, processing, and cleaning the data, which can be conducted several times and in different sequences. The benefits of data preparation include the ability to spot problems or errors before processing begins, which may lead to the production of higher-quality data. This produces better insights that are useful for organisations to make better decisions.

Step 4: Data Modelling

Data modelling involves applying various modelling and data mining techniques to gain fresh insights based on mathematical and statistical models. The modelling technique should be appropriately evaluated and utilised. In this step, the clean data that was processed in Phase 3 was uploaded into Microsoft Power BI in Microsoft Excel format. The potential graphics that might be displayed in response to the processed data were thoroughly evaluated using a prototype dashboard.

Step 5: Data Visualisation

Data visualisation is an integrated view and collection of reports from several databases. Users can view an organisation's performance in real-time by using dashboards, which can collect, arrange, and show data from various sources. Dashboards can also improve decision-making by enabling understanding and leveraging human perception.

Step 6: Data Synchronise and Update

Before any decisions can be made, it is important to have up-to-date dashboards and reports. The development of an interactive dashboard to compile all important performance indicators for LLL programs' student data at UMPSA will take place in this phase.

4.0 RESULT AND DISCUSSION

4.1 Business Understanding

The first stage aims to gain an in-depth understanding about the company's objectives by making the problem, goals, and resources clear. Among the tasks that must be completed during this phase include clear business objectives, situation analysis, project goal formulation, and project planning. An interview with the IPS administration was held to obtain background information regarding the current state of managing the admission of LLL students. The success of data mining depends on the information acquired in this step.

4.2 Data Understanding

The second stage of CRISP-DM examines the necessary data in greater detail by examining the accessible data. This can be achieved by performing the activities in this phase, including gathering preliminary data, describing the data, studying the data, and confirming the data's quality. Among the knowledge gained from business understanding includes the data pertaining to program offerings, gender, current address, and income. This can be used as a basis for UMPSA to enhance strategies and decision-making for future LLL program offerings. Data owners were identified and contacted, and their data was gathered since the primary aim of this phase was to collect initial data. For this investigation, IPS UMPSA provided the datasets and data owners.

Since the data was provided in the requested format and was based on their database, there were no issues with data acquisition. After the subsequent assignment, each dataset was described in terms of general information, investigated to find connections between data, and verified for data quality, along with potential fixes in the occurrence of any issues.

In collecting the student datasets, the available columns encompassed name, student ID, status, level description, program code, program description, entry qualification, entry CGPA, country, gender, income, birthplace, address, city, state, study mode, type of mode, race, and religion. The main source for acquiring and matching other additional information in the future was the student ID. The current address is the most interesting and useful set of information among all the accessible columns. Although the students must manually enter the current address, other address-related columns with drop-down menus, like city and state, are crucial. Overall, the data acquired was appropriate for this study.

4.3 Data Preparation

The third stage of CRISP-DM is data preparation with the goal to prepare and produce a set of data that would be used in this study. This phase is crucial because it allows the search for problems or errors before the processing begins, which can lead to better data. Processing often involves six tasks, namely gather, discover, cleanse, transform, enrich, and store data. Better insights come from processing high-quality data and help organisations to make better decisions.

4.4 Data Modelling

Data modelling is the process of using various modelling and data mining techniques to obtain new insights based on mathematical and statistical models. It is important to evaluate and use modelling techniques correctly. In this step, the data that was processed and cleaned in Phase 3 was uploaded to Microsoft Power BI in the form of Microsoft Excel. The prototype dashboard was used to thoroughly evaluate the graphics that were displayed in response to the processed data using the following methods:

i) Choosing the best modelling technique
ii) Implement or adopt to develop a model
iii) Develop the dashboard prototype

Figure 3 illustrates the first stage of uploading the data onto Microsoft Power BI using the Microsoft Excel format.

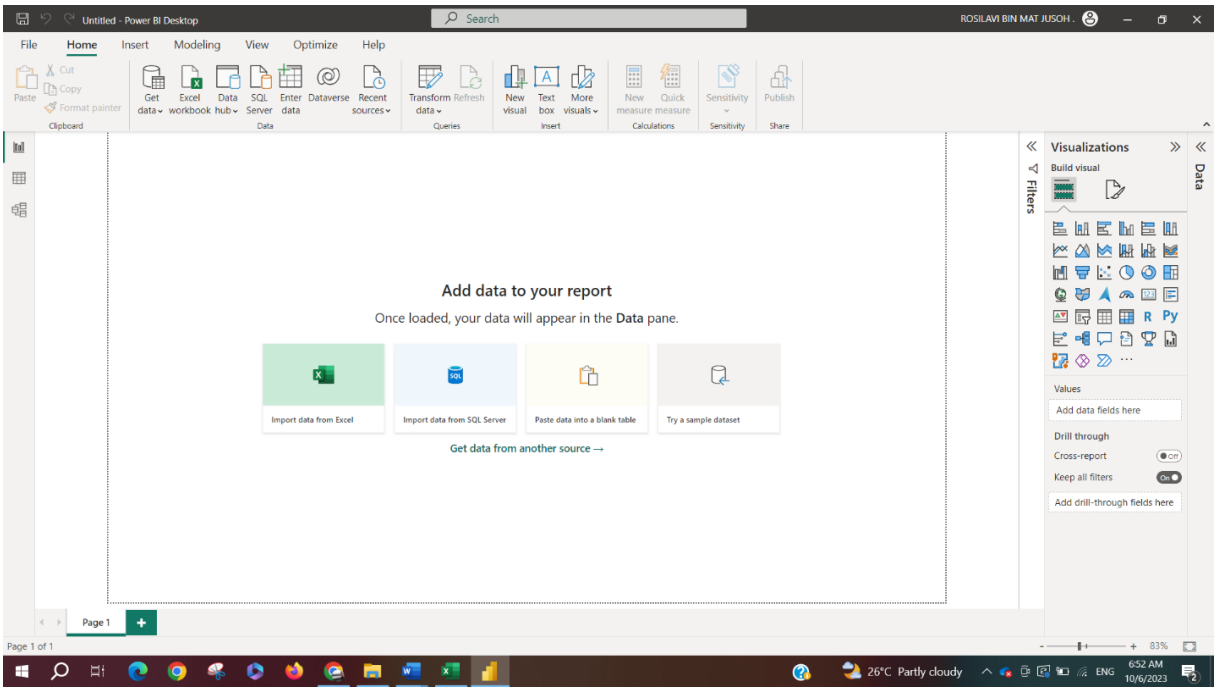

Figure 3. Visualisation of data uploading

4.5 Data Visualisation

Data visualisation is the process of carefully creating graphics that depict the data in a way that facilitates understanding, speeds up the identification of patterns, trends, or anomalies, and encourages lively debate (Moore, 2017). It involves the use of visual elements such as charts, graphs, and maps to present complex patterns or datasets in a way that allows users to see clearly, find trends, and make informed decisions.

4.5.1 Design and Build a Dashboard

The most important phase in this study is the designing and building of a dashboard. The design of the dashboard can vary depending on the specific needs and goals of the project. Dashboards allow users to view and analyse data in real-time as it provides an overview of key metrics or data points. The target audience and purpose of the visualisation are important when creating data visualisation. There are many important things to consider for effective data visualisation, such as choosing the right type of visualisation, appropriate colours, labels, and titles, and ensuring that the visual representation is accurate and easy to interpret. Table 1 shows the dashboard page and purposes.

Table 1. Dashboard page and purposes

Dashboard Page	Purposes
Main Page	To highlight an overview of the student enrolment dashboard for the master's by coursework programs at UMPSA.
Demographics Page	To highlight the student enrolment dashboard for the master's by coursework programs at UMPSA by demographics.
Academic Affairs Page	To highlight the student enrolment dashboard for the master's by coursework programs at UMPSA by academic affairs.
Income Classification by Household Page	To highlight the student enrolment dashboard for the master's by coursework programs at UMPSA by income classification by household.
Race & Religion Page	To highlight the student enrolment dashboard for the master's by coursework programs at UMPSA by race and religion.

4.5.2 Overview of Student Enrolment Dashboard for Master's Course Work Programs at UMPSA

The Student Enrolment Dashboard for the Master's by Coursework Programs at UMPSA provides an overview of student enrolment data for the master's programs, which is organised by coursework structure from 2018 to 2022 (see Figure 4). This dashboard provides important data and information about the student population, helping the UMPSA management to make decisions and monitor the programs' progress. An overview of the functionality of this dashboard is as follows:

i) Total Enrolment: The number of students enrolled in the UMPSA master's by coursework programs can be seen on the dashboard. This gives a general picture of the student population.

ii) Program Breakdown: It shows the breakdown of students based on the programs offered by UMPSA. This allows for a comprehensive analysis of enrolment distribution across different fields of study.

iii) Annual Enrolment Trends: The dashboard presents data for each academic year and shows the enrolment trends over time. It enables the UMPSA management to look for patterns, monitor changes, and predict future enrolments.

iv) Student Enrolment by Gender: It displays the percentage of student admissions by gender and by program.

v) Student Enrolment by Type of Student: It displays the admission of local and international students. This is important for the UMPSA management to identify the number of international student admissions.

vi) Student Enrolment of Age Range: It displays the admission of students by age range as a whole and by study program. This is important for UMPSA management to set future marketing targets and strategies.

vii) Student Enrolment of Age Range by Generation: It displays the student enrolment according to age range by generation (see Table 2). This study used expert opinion and evaluation of historical events to make a classification, although many different classifications are likely to be found when studying international and national literature (Berkup, 2014).

viii) The design and features of the Student Enrolment Dashboard for the Master's by Coursework Programs at UMPSA may vary depending on institutional requirements, data availability, and stakeholder requirements. It is a useful tool to monitor, analyse, and optimise the management of UMPSA's master's by coursework programs.

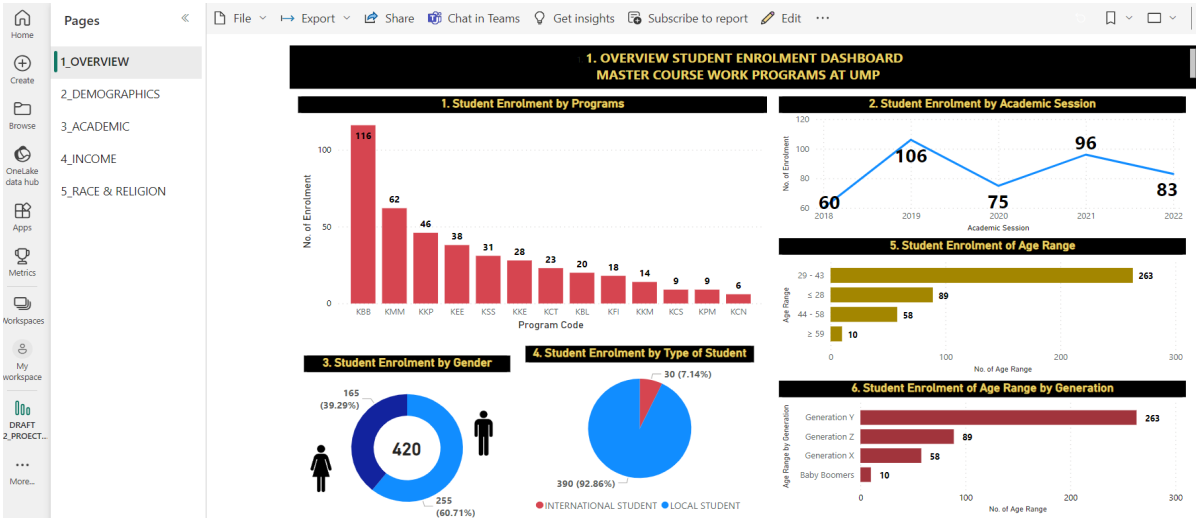

Figure 4. Example of dashboard – overview of the student enrolment dashboard for the Master's by Coursework Programs at UMPSA

Table 2. Chronological generation classification used in this study

Generation Name	Chronological Generation Classification
Baby Boomers	1946 – 1964 (≥ 59 years)
Generation X	1965 – 1979 (44 – 58 years)
Generation Y	1980 – 1994 (29 – 43 years)
Generation Z	1995 - …. (≤ 28 years)

4.5.3 Student Enrolment Dashboard for the Master's by Coursework Programs at UMPSA by Demographics

The Student Registration Dashboard for the Master's by Coursework Programs at UMPSA may use various demographic factors to determine the number of students accepted to enrol into the program. Some of the demographics included in the dashboard are:

i) Citizenship: It can show the distribution of students by country of origin or their citizenship status. The diversity of the student body is better identified with this data, especially at the international level.

ii) Geographic Location: Data about a student's geographic location, such as state or region, can be entered into the dashboard. This provides information on the distribution of student enrolment at the regional level.

Both UMPSA management and stakeholders can gain a better understanding about the demography of students enrolled in the master's by coursework programs by entering demographic information into the Student Enrolment Dashboard (see Figure 5). Such data can aid the decision-making process, support efforts for diversity and inclusion, and find specific needs or problems faced by certain demographic groups.

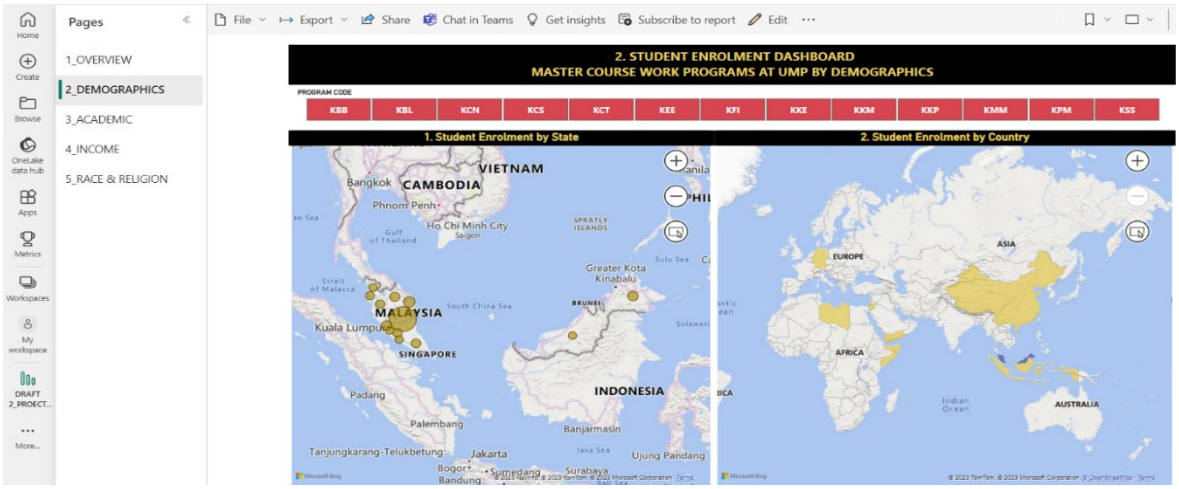

Figure 5. Example of dashboard – student enrolment dashboard for the Master's by Coursework Programs at UMPSA by demographics

4.5.4 Student Enrolment Dashboard for the Master's by Coursework Programs at UMPSA by Academic Affairs

The Student Enrolment Dashboard for the Master's by Coursework Programs at UMPSA can provide insights into the students' enrolment based on various factors related to academic affairs. Among the examples include:

i) Breakdown by Program: The dashboard can display the number of students enrolled for each master's program offered by UMPSA. This helps the management to understand the distribution of students across various fields of study.

ii) Academic Status: The dashboard can monitor the students' academic status. This allows the monitoring of students' achievement and identifies areas where additional support may be needed.

iii) Mode of Study: The dashboard was created to determine the mode of study, which informs UMPSA management about the number of students enrolled in full-time or part-time mode. Such information is important to prepare the teaching and learning platform as well as physical infrastructure.

iv) Enrolment by CGPA: It refers to the student admission process based on their Cumulative Grade Point Average (CGPA). CGPA is a numerical representation of a student's academic performance, which is calculated by averaging the grade points earned in all completed courses. In general, HEIs set minimum CGPA requirements for admission to various programs. This ensures that students admitted to a particular program demonstrate a certain level of academic ability and preparation. Finally, the registration process by CGPA serves as a criterion for evaluating students' academic performance and determining their eligibility for admission to a particular program.

By entering information related to academic affairs in the dashboard for student admissions (Figure 6), UMPSA management can gain insight into various aspects of the master's by coursework programs. Such data can facilitate informed decision-making, curriculum planning, and student support initiatives to improve the overall academic experience and students' success.

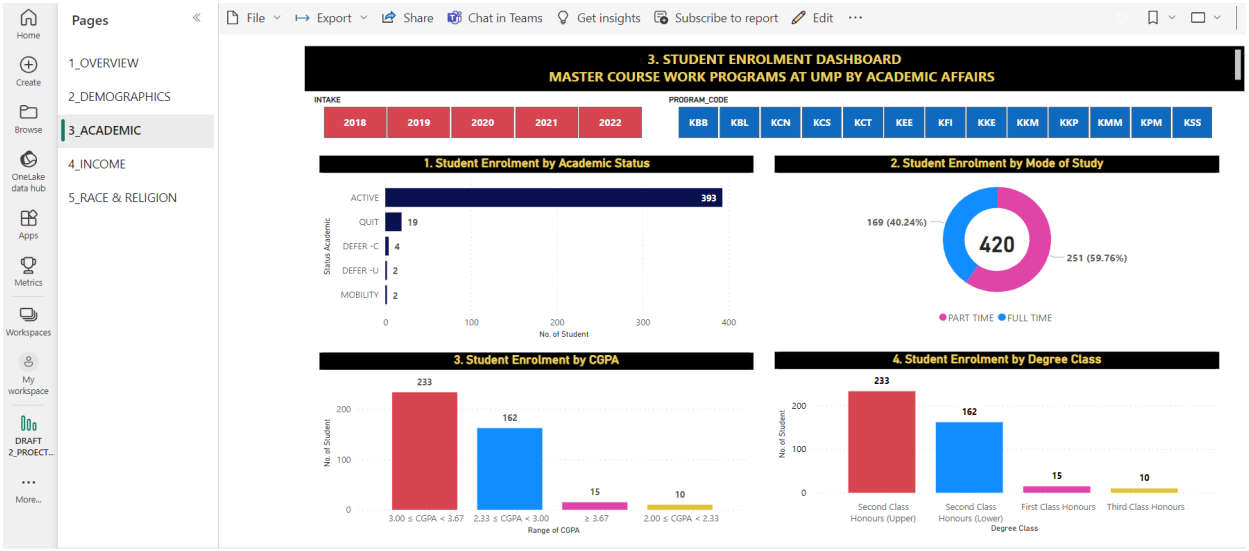

Figure 6. Example of dashboard – student enrolment dashboard for the Master's by Coursework Programs at UMPSA by academic affairs

4.5.5 Student Enrolment Dashboard for the Master's by Coursework Programs at UMPSA by Income Classification by Household

The master's by coursework programs at UMPSA can benefit from a student registration dashboard that is developed based on household income classification to gain more information about the students' socioeconomic background (Figure 7). It is crucial to remember that information about income classification may be delicate and subject to privacy restrictions. The following elements are included in the dashboard:

i) Income Category: The dashboard categorises students based on income classification (i.e., low income, middle income, and high income). This classification can be determined by household income or any other relevant criteria.

ii) Enrolment by Income Category: It shows the percentage of students in each income category who enrolled in the master's by coursework programs at UMPSA. It facilitates the understanding about the socioeconomic diversity of the student body.

The information gathered will allow UMPSA management to assist students with scholarship and financial planning. The number of students who receive scholarships, grants, or financial assistance in each income category can be included as part of the data in this dashboard. This facilitates the evaluation of financial assistance programs' efficacy and outreach. It is important to ensure the privacy and confidentiality of information related to student income while implementing the dashboards. To protect the privacy of individual student data, all data must be anonymous and aggregated. It is also important to adhere to institutional norms and data protection laws when handling sensitive information.

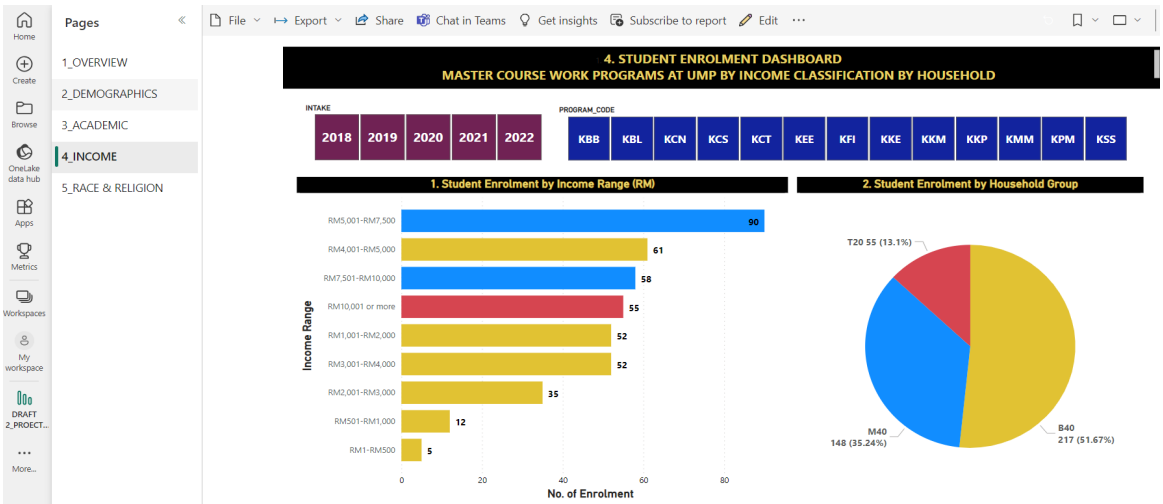

Figure 7. Example of dashboard – student enrolment dashboard for the Master's by Coursework Programs at UMPSA by income classification by household

4.5.6 Student Enrolment Dashboard for the Master's by Coursework Programs at UMPSA by Race and Religion

Developing a student admission dashboard based on race and religion can offer information concerning the diversity of the student body (see Figure 8). However, it is important to handle such demographic information carefully and ensure that institutional and privacy policies are adhered. The developed dashboard comprises the following components:

i) Racial/Ethnic Categories: The dashboard can classify students into different categories based on various racial or ethnic groups, such as Malay, Chinese, Indian, and other groups.

ii) Enrolment by Race/Ethnicity: It displays the percentage of students enrolled in the master's by coursework programs at UMPSA based on their respective race/ethnicity. This helps to explain the diversity and representation among various racial or ethnic groups.

iii) Religion Category: The dashboard displays sections for various religions, including those associated with Islam, Christianity, Buddhism, Hinduism, and others.

iv) Enrolment by Religion: It shows the ratio of students enrolled in UMPSA's master's by coursework programs based on religion. This provides an insight into the religious diversity of the student population.

v) Representation Ratios: The dashboard calculates and displays representation ratios to compare the enrolment of students into the master's by coursework programs across different racial or religious groups. It serves as their respective representation across a broader population or specific demographic benchmarks.

vi) Support and Inclusion Initiatives: The dashboard displays any inclusion or support programs that are geared towards specific racial or religious subgroups among students. It measures the impact of these aspects in promoting diversity and creating an inclusive atmosphere.

The ethical handling of racial and religious data is important and such sensitive information must be aggregated and anonymised to protect the people's privacy. The data will be used in accordance with relevant privacy laws and regulations. Additionally, it is important to promote inclusiveness and respect for all individuals in the academic environment regardless of their race or religion.

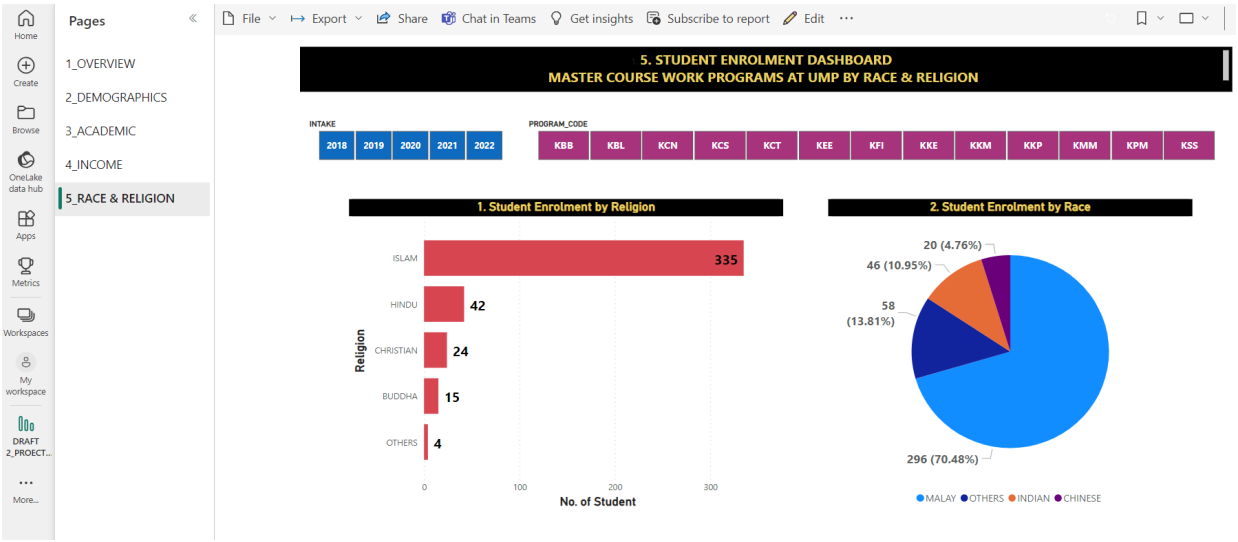

Figure 8. Example of dashboard – student enrolment dashboard for the Master's by Coursework Programs at UMPSA by race and religion

4.5.7 Dashboard Evaluation

An evaluation of the designed dashboard aims to monitor and evaluate its performance and impact. It enables UMPSA management to monitor important metrics, visualise data, and make defensible decisions by considering the results of this evaluation. The assessment dashboard is reviewed and updated frequently to reflect the most recent data and assessment conclusions. It involves tracking the dashboard performance, fixing any flaws or problems, and accepting adjustments to stakeholder or assessment needs. It is feasible to design and create an assessment dashboard that effectively presents evaluation data, simplifies decision-making, and offers insightful information to the stakeholders engaged in the dashboard development project by regularly assessing the dashboard.

4.5.8 Dashboard Testing

Several factors must be taken into account throughout the dashboard testing process to guarantee its dependability, performance, and usability. In this testing phase, it is important to concentrate on the following areas:

i) Data Accuracy: This ensures that the data on the dashboard is correct and consistent with the anticipated outcomes. It is done by checking the values against the original data and making manual calculations.

ii) Functional Testing: It examines the dashboard's interactive features and functionality, including data manipulation, drill-down, sorting, and filtering. This procedure ensures that the function performs as expected and yields the desired outcomes.

iii) Test dashboard adaptability to various screen sizes and types, including PCs, laptops, tablets, and mobile devices. It is tested against various systems and browsers for any display flaws, layout issues, or usability issues.

iv) Track any problems, bugs, or suggestions for improvement that are discovered during testing by documenting them and tracking their resolution. It involves iterative testing, refining, and updating the dashboard in response to user and stakeholder feedback.

4.6 Data Synchronise and Update

It is important to have up-to-date dashboards and reports before making any assessments. At this stage, an interactive dashboard will be created to compile all important performance metrics for UMPSA's LLL programs student data. In this study, a data synchronisation and updating mechanism must be implemented to ensure that the interactive dashboard provided for LLL programs student data at UMPSA is up-to-date and offers accurate information. This is achieved via the following general strategies:

i) Determine how often the data on the dashboard needs to be updated by determining the frequency of source system updates and the need to have real-time or near-real-time data. Common update intervals include daily, hourly, and even real-time.

ii) Perform Data Transformations: Once the data has been integrated, perform any necessary data cleansing or transformations to ensure accuracy and consistency. This can involve data standardisation, de-duplication, validation, or formatting changes. A clean and consistent dataset is required for analysis and visualisation.

5.0 CONCLUSION

This study shows that CRIPS-DM is a reliable tool that can be used by any organisation for data analysis purposes. It allows the identification and preparation of data required for analysis. Student enrolment trends based on data from the previous five years enable UMPSA to predict student enrolment trends in the coming year. Conversely, UMPSA management can predict and make early decisions in the admission management of LLL students, resulting in better decisions. This can ensure the readiness to accept the admission of new students by providing suitable infrastructure and facilities, hostels, lecturers, teaching materials, and scholarships.

These tools can be used for other departments in UMPSA. Additionally, UMPSA management must adapt to the needs of the ongoing IR4.0, which relies heavily on automation, machine learning, the Internet of Things (IoT), and real-time data. UMPSA must be relevant in its operating methods, keep up with the current technology, and be able to compete with other competitors. This can be achieved through an emphasis on data culture and data analysis used in its operations.

In conclusion, the data analysis enables UMPSA to make decisions concerning academic development that involve offering new programs in the future. The management can also make decisions involving the planning of student recruitment as well as formulating an effective marketing strategy. They must implement drastic changes to increase the number of student enrolments. Among the initiatives to be implemented include targeted academic collaboration with several overseas universities by signing an agreement aimed at implementing academic collaboration and getting students to continue their studies at UMPSA. The university also can establish a Satellite Campus in Kuala Lumpur to offer programs with high potential. Like any other research, the present study has its own limitations in terms of time, lack of reliable data, and financial resources. This study only focused on the use of existing data which requires extensive data preparation and data cleaning due to the quality of the data which had missing values, duplicate values, and errors. For example, the range used for household income data did not follow the national standard set by the Department of Statistics Malaysia (DOSM). Furthermore, this dashboard did not reflect the entire LLL students at UMPSA but rather focused only on formal LLL student data, which was geared towards the master's by coursework programs. Future research can analyse the data as a whole using Power BI by incorporating other LLL programs offered at UMPSA.

This study can be further expanded by including the data of all LLL students at UMPSA, allowing for a more comprehensive analysis. The UMPSA management can also obtain more accurate decisions regarding LLL program offerings. Additionally, future dashboard construction proposals should include data from formal and informal LLL programs, including short-term courses as well as diploma, degree, and doctoral programs.

6.0 ACKNOWLEDGEMENTS

The authors would like to thank Universiti Malaysia Pahang Al-Sultan Abdullah, Malaysia and Telkom University, Indonesia for funding this work under an international matching grant (RDU232711 and UIC231520).

7.0 CONFLICT OF INTEREST

The authors declare no conflicts of interest

8.0 AUTHORS CONTRIBUTION

Each author involved and contributed evenly to this manuscript. All authors read and approved the final manuscript.

9.0 REFERENCES

Abdelhadi, A., Zainudin, S., & Sani, N. S. (2022). A Regression Model to Predict Key Performance Indicators in Higher Education Enrollments. International Journal of Advanced Computer Science and Applications, 13(1), 454–460.

Albright, S. C., & Winston, W. L. (2017). Business analytics: Data analysis and decision making. Cengage Learning, Inc.

Alida, S., Abdullah, J., Wati, F., & Ibrahim, B. (2007). Memenuhi Keperluan Pelajar di Universiti Awam Malaysia: Aspek Pendapatan dan Perbelanjaan Meeting the Needs of Students of Public Universities in Malaysia: Income and Expenditure Aspects. REKAYASA-Journal of Ethics, Legal and Governance, 3, 50–60.

Almadhoun, N. M., Dominic, P. D. D., & Woon, L. F. (2011, September). Social media as a promotional tool in higher education in Malaysia. In 2011 National Postgraduate Conference (pp. 1-7). IEEE.

Arnaboldi, M., Robbiani, A., & Carlucci, P. (2021). On the relevance of self-service business intelligence to university management. Journal of Accounting and Organizational Change, 17(1), 5–22.

Ayele, W. Y. (2020). Adapting CRISP-DM for idea mining a data mining process for generating ideas using a textual dataset. International Journal of Advanced Computer Science and Applications, 11(6), 20–32.

Azmi, T., & Salleh, D. (2021). A Review on TVET Curriculum Practices in Malaysia. International Journal of Education, Psychology and Counseling, 6(40), 35–48.

Bakar, A. (2019). Technical Vocational Education & Training (TVET) in Malaysia: (Issue January).

Bhargava, M. G., Kiran, K. T. P. S., & Rao, D. R. (2018). Analysis and design of visualization of educational institution database using power BI tool | global journal of computer science and Technology. Global Journal of Computer Science and Technology(C), 18(4).

Cazacu, M., & Titan, E. (2020). Adapting CRISP-DM for Social Sciences. BRAIN. Broad Research in Artificial Intelligence and Neuroscience, 11(2sup1), 99–106.

Delen, D., & Ram, S. (2018). Research challenges and opportunities in business analytics. Journal of Business Analytics, 1(1), 2–12.

Dipace, A., Fazlagic, B., & Minerva, T. (2019). The design of a learning analytics dashboard: Eduopen MOOC platform redefinition procedures. Journal of E-Learning and Knowledge Society, 15(3), 29–47.

Evans, J. R. (2020). Business Analytics, Global Edition. Pearson

Finance, M. of. (2021). Malaysia Budget 2022 (M. of Finance (ed.); 1st ed. Percetakan Nasional Malaysia Berhad.

Kholiavko, N., Grosu, V., Safonov, Y., Zhavoronok, A., & Cosmulese, C. G. (2021). Quintuple Helix Model: Investment Aspects of Higher Education Impact on Sustainability. Management Theory and Studies for Rural Business and Infrastructure Development, 43(1), 111–128.

Lepenioti, K., Bousdekis, A., Apostolou, D., & Mentzas, G. (2020). Prescriptive analytics: Literature review and research challenges. International Journal of Information Management, 50, 57–70.

Ministry of Economic Affairs. (2019). Shared Prosperity Vision 2030. Attin Press Sdn.Bhd.

Mohd Ishar, M. I., Wan Derahman, W. M. F., & Kamin, Y. (2020). Practices and Planning of Ministries and Institutions of Technical and Vocational Educational Training (TVET) in Facing the Industrial Revolution 4.0 (IR4.0). Malaysian Journal of Social Sciences and Humanities, 5(3), 47–50.

MOHE. (2015). Malaysia Education Blueprint. 1(1), 40.

MQA. (2019). Pekeliling MQA Bil 9 2019 Pelaksanaan Sistem Jaminan Kualiti Tunggal TVET: Penambahbaikan Laluan Pendidikan TVET.

Munisamy, S., Mohd Jaafar, N. I., & Nagaraj, S. (2014). Does Reputation Matter? Case Study of Undergraduate Choice at a Premier University. Asia-Pacific Education Researcher, 23(3), 451–462.

Mutanov, G., Mamykova, Z., Kopnova, O., & Bolatkhan, M. (2020). Applied research of data management in the education system for decision-making on the example of Al-Farabi Kazakh National University. In E3S Web of Conferences, 159.

Nafiisah, N., Noor, N., Lufti, S. L., Darweena, S., Ahmad, S., & Feisal, A. (2021). Interactive Dashboard for Tracking System Dashboard Using. Inacix, 43–50.

Norhidayah Hussin, M. H., Mujahideen, H. & Najmuddin, W. S. (2017). Faktor-Faktor Pendorong Pemilihan Kursus Di Institusi Pengajian Tinggi - Satu Ulasan. Journal of Humanities, Language, Culture and Business, 1, 139–145.

Nur Fatin, M. S. (2015). Technical and Vocational Education Transformation in Malaysia: Shaping the Future Leaders. Journal of Education and Practice, 6(22), 85–90.

Rajadurai, J., Sapuan, N. M., Daud, S., & Abidin, N. (2018). The Marketability of Technical Graduates from Higher Educational Institutions (HEIs) Offering Technical and Vocational Education and Training (TVET): A Case from Malaysia. Asia-Pacific Education Researcher, 27(2), 137–144.

Raje, M., Jain, P., & Chole, V. (2021). Sales Analysis and Prediction Dashboard Using Power Bi. 06, 522–529.

Ramalingam, V. A., & Ramalingam, V. A. (2018). Introduction to Microsoft Flow. Introducing Microsoft Flow: Automating Workflows Between Apps and Services, 1-32.

Rehman, M. H., Yaqoob, I., Salah, K., Imran, M., Jayaraman, P. P., & Perera, C. (2019). The role of big data analytics in industrial Internet of Things. Future Generation Computer Systems, 99, 247–259.

Saggi, M. K., & Jain, S. (2018). A survey towards an integration of big data analytics to big insights for value-creation. Information Processing and Management, 54(5), 758–790.

Saputra, D., Soleh, O., & Dewi, M. A. (2013). Dashboard Marketing System for Student'S Enrollment Case Study: Unis Tangerang. In Information Systems International Conference, 294-299.

Schröer, C., Kruse, F., & Gómez, J. M. (2021). A systematic literature review on applying CRISP-DM process model. Procedia Computer Science, 181(2019), 526–534.

Susnjak, T., Ramaswami, G. S., & Mathrani, A. (2022). Learning analytics dashboard: a tool for providing actionable insights to learners. International Journal of Educational Technology in Higher Education, 19(1).

UMP. (2021). Pelan Strategik UMP 2021 - 2025 (P. UMP (ed.); 1st ed.). Penerbit UMP.

Van Rooij, E. C. M., Jansen, E. P. W. A., & van de Grift, W. J. C. M. (2018). First-year university students' academic success: the importance of academic adjustment. European Journal of Psychology of Education, 33(4), 749–767.