RESEARCH ARTICLE

DEVELOPMENT OF A DUAL DEGREE INFORMATION SYSTEM FRAMEWORK: A TECHNOLOGY ACCEPTANCE MODEL

Muhammad Hafiz Aswad bin Ahmad Kamal[1]*, Hamirahanim binti Abdul Rahman[1], Jihae Suh[2]

[1] Faculty of Industrial Management, Universiti Malaysia Pahang Al-Sultan Abdullah, Lebuh Persiaran Tun Khalil Yaakob, 26300 Kuantan, Pahang Darul Makmur, Malaysia

[2] Department of Business Administration, Seoul National University of Science and Technology, 232 Gongneung-ro, Nowon-gu Mugeun-hall #512 Seoul, 01811, Republic of Korea

ABSTRACT - Universiti Malaysia Pahang Al-Sultan Abdullah is a public higher education institution in Malaysia, which has been offering dual degree programs since 2010 in collaboration with various international higher education institutions across Germany, Kazakhstan, and China. Due to the complexity of dual degree students' data, the current internal management system can only record primary data. Thus, this study aims to design a prototype of an integrated management system that can handle the complexity of dual degree data. The prototype was developed using Microsoft Access based on the design science research methodology and two expert users conducted the user acceptance test to assess its functionality. The findings showed that the prototype had a major potential and was recommended for implementation in a real-world environment. This study contributes to the advancement of dual degree program management and highlights the importance of considering end-user feedback in system development and acceptance.

1. INTRODUCTION

Wide range of engineering and technology-based technical programs. It stands as part of the Malaysia Technical University Network (MTUN) together with three technical universities, namely Universiti Malaysia Perlis (UniMAP), Universiti Tun Hussein Onn Malaysia (UTHM), and Universiti Teknikal Malaysia Melaka (UTeM) (Mohamed et al., 2015). MTUN aims to create highly skilled human capital through strategic partnerships with various businesses to promote Malaysia's competitive edge and sustainable growth (Jam & Puteh, 2022). To realise the country's current Technical Vocational Education and Training (TVET) objective, Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA) was also appointed as a TVET Collaboration Hub in the automotive industry through the Centre for Automotive Engineering (Abdul Wahit, 2022).

Aligned with the national TVET objective, UMPSA has partnered with German universities to establish dual degree programs. The earliest dual degree programs were introduced in collaboration with Karlsruhe University of Applied Sciences (HKA), namely the Bachelor of Mechatronics Engineering with Honours in 2010 and the Bachelor of Automotive Engineering with Honours in 2012. Another successful partnership was established with Reutlingen University (HsRT) in 2013, leading to the offering of the Bachelor of Business Engineering with Honours in 2015. The partnership between UMPSA and German institutions has lasted more than ten years and is continually growing. According to the UMPSA Strategic Planning 2021–2025, at least 12 dual degree programs will be offered by the university in 2025, some of which are connected to the partnership with German institutions (UMP, 2021). Currently, the Centre for Strategic Academic Collaboration (CSAC) is a one-stop centre for matters concerning all UMPSA dual degree programs.

The predominant system employed by most UMPSA personnel, specifically for academic, administrative, and financial matters, is the Integrated Management System (IMS). UMPSA began adopting this system in 2002 and its development was done through the Rapid Application Development (RAD) approach. According to Chien (2020), RAD emphasises swift development through frequent iterations and ongoing feedback. The methodology has been gaining global popularity in response to the escalating demand for new software and features in the modern tech era. IMS is the repository for a substantial portion of the data, particularly for dual degree students. However, some data points have been independently documented using alternative systems due to certain limitations as IMS often fails to capture them adequately. While substantial data can be sourced from the system, access is restricted to designated staff members and the respective person in charge of each department must grant access authorisation. However, a compounding challenge is the system's notable lack of user-friendliness. It persists in utilising the Just Another Virtual Accelerator (JAVA) platform, necessitating users to download the JAVA script as a prerequisite for access. Therefore, the objectives of this study are: (i) to design a prototype that can garner all relevant information related to the UMPSA dual degree program, and (ii) to gather feedback on users' perception of the new system using the Technology Acceptance Model (TAM).

This paper begins with an introduction to the topic under investigation. Section 2 presents a comprehensive literature review of relevant topics, ranging from the definition of dual degree programs to the history of dual degree programs in UMPSA. It also encompasses a concise overview of German language proficiency, the theoretical framework of this study, and the system and database aspects. Section 3 outlines the research methodology and steps involved in developing the prototype. Section 4 focuses on the discussion of results, followed by a conclusion of the findings in Section 5. Finally, Section 6 addresses the limitations of this study while Section 7 offers recommendations for future works.

2. LITERATURE REVIEW

The Malaysia Qualification Agency defines a dual degree program as a program that allows students to graduate with two different degrees in two discipline areas that are comparable or most likely comparable (MQA, 2019). This joint program has become a strategic marketing strategy for many Higher Education Institutions (HEIs), allowing them to improve, augment, and distinguish their brands in an increasingly competitive higher education environment (Kuder et al., 2014). The main driving forces for creating such programs are to increase students' exposure to the world, improve the internationalisation of the campus, and enhance the institution's reputation abroad (Culver et al., 2012).

In response to the Malaysian Government's directive in 2009, MTUN was mandated to align its programs with the German Fachhochschule concept. UMPSA promptly embraced the challenge by initiating collaboration with HKA on 23 November 2009, culminating in the successful launching of the first dual degree program, Bachelor of Mechatronics Engineering with Honours (BHM), in September 2010. Subsequently, UMPSA expanded its dual degree offerings by introducing the Bachelor of Automotive Engineering with Honours (BHA) program in partnership with HKA. Building on this success, UMPSA forged a collaboration with HsRT, leading to the enrolment of the inaugural cohort for the Bachelor of Business Engineering (BPN) program in 2015. Notably, BPN differs from BHM and BHA as it requires students to spend at least two years studying in Germany upon attaining German language competence at Level B1 or above; otherwise, they will continue and graduate with a single degree from UMPSA.

According to Dogra (2023), B1 is the third proficiency level in the Common European Framework of Reference (CEFR), succeeding A1 and A2. Successfully completing the B1 exam signifies an intermediate grasp of the German language, granting the title of an intermediate speaker. Meanwhile, B2 is the fourth language level in CEFR, which represents an advanced intermediate proficiency in German. It is typically attained by individuals studying German as a foreign language (Zürich, 2023). Lastly, Test Deutsch als Fremdsprache (TestDaF) is on the sixth level of the scale, which covers levels B2 to C1 (Goethe-Institut Malaysia, n.d.). Figure 1 summarises the sequential process that students will undergo from the commencement of their studies to the conclusion.
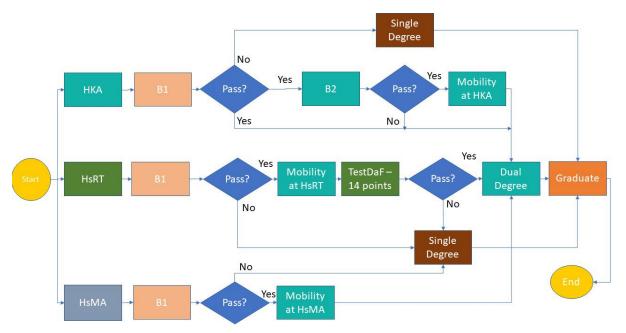

Figure 1. Dual degree program relationship diagram

2.1 Theoretical Background

Experts in the field of information systems have proposed various theories, such as the Behavioural Decision Theory, Complexity Theory, and Technology Acceptance Model, to explain events, identify connections, and predict future developments. The Behavioural Decision Theory is a descriptive psychological explanation of human judgment, decision-making, and behaviour (Takemura, 2020). It is commonly used in political science due to its connection with behavioural economics and behavioural finance. Meanwhile, the Complexity Theory is useful to better understand how organisations

can be resilient, flexible, and innovative (Park, 2017). This study utilises the Technology Acceptance Model (TAM) to investigate the key factors influencing users' adoption of new technologies (Surendran, 2012).

2.2   Technology Acceptance Model

The Technology Acceptance Model (TAM), proposed by Fred D. Davis in 1989, is one of the widely used models to forecast individual users' use and adoption of systems and technology (Surendran, 2012). It has been extensively researched and supported by several studies examining how people embrace new technologies in various information system structures. According to Davis et al. (1989), TAM offers a comprehensive explanation of the factors influencing computer acceptance while maintaining simplicity and theoretical justification. This is achieved by accounting for user behaviour across diverse end-user computing technologies and user demographics.
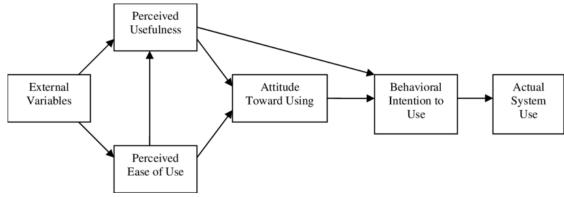

Figure 2. Technology acceptance model (Ma & Liu, 2011)

As shown in Figure 2, TAM consists of two independent variables: perceived usefulness (PU) and perceived ease of use (PEOU). These variables form users' end-views of technology, which forecast their end-attitude and adoption towards the technology (Ma & Liu, 2011). According to Marangunić and Granić (2015), the implementation of TAM can help developers understand users' decisions to adopt or reject technology and improve it based on received feedback. This suggests that a person's intentions to embrace the technology can affect their actual technology utilisation (Worthington & Burgess, 2021).

2.3   System and Database

Utilising data in decision-making improves decision quality by helping organisations spot occult patterns, trends, and correlations, leading to better informed and evidence-based judgments while reducing the chance of making bad or ignorant decisions (Calzon, 2022). Today, applications like Microsoft Access (MS Access) allow users to build databases and dashboards.

MS Access boasts numerous advantages compared to other system development applications. Its user-friendly interface enables individuals with limited technical expertise to navigate and interact with the system effortlessly. MS Access also offers the capability to store large amounts of data at a low cost compared to other software like SQL Server or Oracle (Rehman, 2022). It also allows the import and export of data from various sources, including MS Excel, Text Files, XML Files, and other database applications.

3.   METHODS AND MATERIALS

3.1   Design Science Research

This study employed a Design Science Research (DSR) methodology. Hevner et al. (2004) categorise the information systems field into two critical paradigms: behavioural science and design science. The behavioural science paradigm is dedicated to supporting organisational or human behaviour theories. In contrast, the design science paradigm focuses on how researchers push the boundaries by creating new methods or refining existing ones within information systems. This dual paradigm approach reflects a comprehensive understanding of the theoretical underpinnings of human and organisational behaviour and the practical aspects of advancing system design and improvement methodologies. Figure 3 illustrates the combination of both paradigms into a single framework, with design and behavioural sciences on the left and right side of the framework.
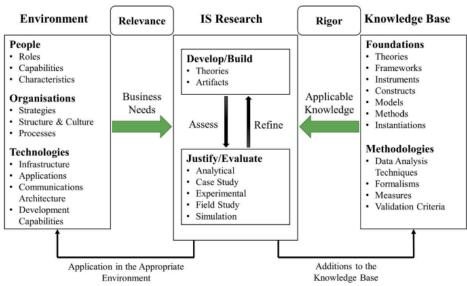
Figure 3. Information systems research framework (Hevner et al., 2004)

3.2   Design – IT Artefacts/Prototypes

The prototype developed at the end of this study can be considered an Information Technology (IT) artefact or prototype. According to Peffers et al. (2007), IT artefacts or prototypes are tangible or digital realisations of a suggested IT possible answer, such as a web app, database, or website. They are used to test an IT solution's viability and effectiveness before it is fully developed and implemented and to show how well it functions and looks.

The suggested integrated prototype has the flexibility to be utilised independently. However, adherence to specific regulations by the CICT may preclude its integration into the E-Community platform. To enhance user accessibility, a link can be strategically positioned on the E-Community home page, redirecting users to a dedicated page upon activation. A visual representation of the prototype is provided in Figure 4, showcasing the system's home page after successful navigation through the sub-menu.

Figure 4. Main page of the proposed prototype

3.3   System Development

The prototype development involved several steps using MS Access, as shown in Figure 5.
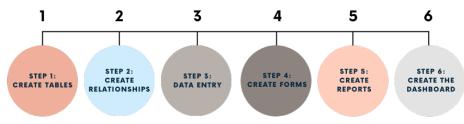

Figure 5. Steps to create the proposed prototype

3.3.1 Creating the tables

The data consisted of essential information according to the category/group of datasets, as shown in Table 1.

Table 1. List of datasets

Category	List of Data
Student Info	Student ID
	Name
	Program
	Program Code
	Gender
	Race
Program	Name of Program
	Name of Faculty
	Name of Partner University
Intake Details	Intake Batch
	Level of Entry
German Language	Level of Proficiency
	Exam Provider
	Date of Exam
Mobility	Company Name
	Country
	Category
	Year of Internship

3.3.2 Creating the relationships

The relationships between tables were built in MS Access to specify how the data in various tables is connected. These connections support the upkeep of data consistency, integrity, and efficiency of querying and analysis. The relationships between the tables constructed in the first step are shown in Figure 6.
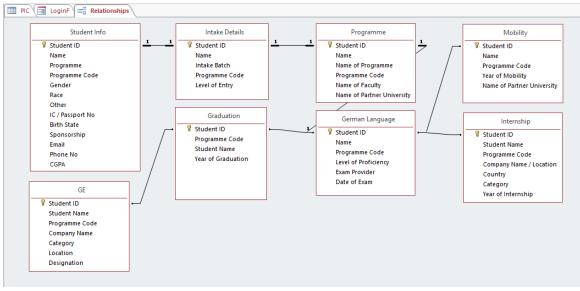

Figure 6. Relationships between the tables

Each table is linked by a primary key, which acts as a distinctive identifier inside a table and is often a single column. As illustrated in Figure 6, the primary key of each table is Student ID. Each student will be registered under a single ID, which will remain until graduation.

3.3.3 Database entry

Prior to developing the prototype, the initial step was to build a database using the data gathered from various sources. Using the Tables tool in MS Access, all data was organised into categories based on Table 1. The researcher had to define the data type for each information. Such process resulted in the creation of eight Tables.

3.3.4 Creating the forms

The primary purpose of creating a form template is to save users' time and effort by giving the form a default layout and style. The researcher selected a form template that roughly fit the system's requirements and it was edited to meet those demands.

3.3.5 Creating the reports

The objective of creating the reports is to offer database-derived, structured, and organised information in a print-ready and professional manner. The template has numerous elements and grouping alternatives, which provide reports in each area. An example of the report is shown in Figure 7.

Figure 7. Report template for program section

3.3.6 Creating the dashboard

The final step was to create an appropriate dashboard that would integrate all the information into a single interface. As previously noted, this dashboard offers a centralised and thorough view of the data and functioning of the dual degree programs. It offers an intuitive user interface that enables users to view and engage with a number of submenus from a single page. Figure 8 shows the workflow of the prototype once the dashboard is ready to use.
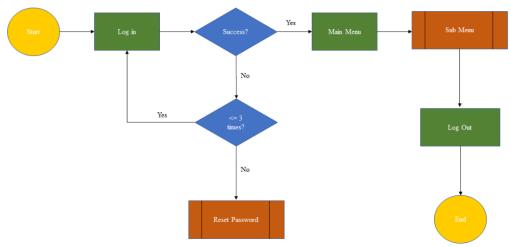

Figure 8. Proposed prototype flow

The workflow starts with a login process. The researcher implemented an authentication technique known as Single Sign-On (SSO), which allows users to use one set of login details to enter into numerous apps and services. SSO eliminates the need for users to repeatedly input login information for each application by allowing them to sign in once and access

all approved systems (One Identity, 2023). It aligns with the CICT currently implemented in UMPSA where most of the university's apps and systems use the same username and password for E-Community.

3.4 Measurement

The next step was to perform a brief User Acceptance Test (UAT). According to Leung and Wong (1997), UAT is often conducted by end-users to assess whether a system or application meets specified requirements. In this study, several users were selected to interact with the prototype. Data regarding the amount of time spent was elicited with shorter durations indicating the prototype's user-friendliness, aligning with the aim for a hassle-free design.

3.5 Procedure

The individual testing sessions involved several administrative staff members, including officers and supporting staff, with varied responsibilities. It comprised three phases. First, the users logged into the E-Community, searched for the system menu, and accessed the login screen. In the second phase, users freely explored the prototype options without time restrictions. Finally, they logged out from the system and completed a survey questionnaire, which elicited their feedback and comments based on their prototype experience.

3.6 Data Collection

Interview sessions were also conducted with other staff members involved in dual degree programs to gather additional information that can support the UAT results. The interviews were done either in person or online. These inputs are crucial because they can help the researcher to enhance the prototype.
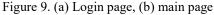
4. RESULTS AND DISCUSSION

4.1 System Overview

The dashboard offers a centralised and thorough view of the data and functioning of the dual degree programs. The researcher developed the IT Artefact as a representation of the integrated system in this project. This was done by merging all data from the Environment and Knowledge Base components (see Figure 3) using the Design Science Research (DSR) Framework.

Business requirements were conceptualised as a comprehensive information centre, encompassing needs from individuals, organisations, and technology within the Environment components. The researcher transformed this concept into a visualisation graph to enhance the understanding and streamline information processing. All data was consolidated onto a unified interface generated through forms. Subsequently, users initiated the process by logging in with their UMP email and password to access the main page (Figure 9).

(a)   (b)

Figure 9. (a) Login page, (b) main page

Upon accessing the system, users were greeted with an initial display featuring overview information about the program. This includes details such as gender distribution, the total number of students by program, and students' sponsorship statistics. Notably, the system administrator can modify this information as needed, providing an option for dynamic adjustments and ensuring that the displayed data remains accurate and up-to-date over time. Users can access more detailed data by navigating through the left-side submenus and the corresponding information will be displayed at the centre of the page. A notable feature is the system's design to avoid opening additional windows or screens while presenting information, ensuring a seamless and user-friendly experience. Additionally, users can retrieve, arrange, and download the information according to their preferences.

4.2   User Acceptance Test

The fundamental aim of UAT was to ensure that the proposed system satisfies the stakeholders' expectations, needs, and requirements. The researcher conducted a briefing with two CSAC officers in charge of UMPSA's dual degree programs to demonstrate the prototype's functions and how it can facilitate their everyday work. The officers' profiles are shown in Tables 2 and 3.

Table 2. Officer 1 profile

Item	Information
Age	35
Gender	Male
Race	Malay
Highest Education	Master
Current Position & Grade	Senior Executive, Grade N44

Table 3. Officer 2 profile

Item	Information
Age	41
Gender	Female
Race	Malay
Highest Education	Master
Current Position & Grade	Senior Executive, Grade N44

4.2   Findings from the Feedback Form

The system's perceived usefulness and perceived ease of use were assessed using a feedback form, which required the participants to answer several questions based on a scale of "1-Bad" to "5-Excellent". These questions and their categories are displayed in Table 4.

Table 4. Questions and categories

Category	Question
Perceived Ease of Use	Login page display
	Main page display
	List of menus
Perceived Usefulness	Data visualisation
	Content arrangement
	Overall features/design

The concept of perceived ease of use in a system is centred on the users' perception of how straightforward it is to navigate and access information within the system. It goes beyond mere simplicity, encompassing the ease with which users can enter the system and retrieve the required data. On the other hand, perceived usefulness is a measure of how effectively the system performs and how valuable it appears to users. It extends beyond functionality to encompass the system's overall impact and ability to convince users of its utility, ultimately influencing their decision to utilise it. Together, these dimensions provide a comprehensive understanding of user experience, considering both the accessibility and effectiveness of the system.

4.3   Discussion

The feedback form and survey questions were designed to gauge user satisfaction, particularly focusing on perceived ease of use and perceived usefulness. All participants agreed that the system's displays, specifically concerning the categories of data visualisation and content arrangement falling under perceived usefulness, were acceptable and should be retained. The survey results highlight strengths in data visualisation and content arrangement, as perceived by Officer 1. This information can be considered a positive aspect of the system. Officer 2's suggestion about the potential expansion of the system to include additional dual degree programs indicates an opportunity for improvement and growth.

Apart from the survey questions, the researcher included a section for the participants to offer additional opinions or feedback for system improvement. Officer 1 conveyed a positive view, expressing confidence in the prototype's excellence and anticipating its adoption to simplify daily tasks. Meanwhile, Officer 2 highlighted that the system's utility can be enhanced by including additional dual degree programs beyond the UMPSA-German dual degree programs. Furthermore, extending the use of this system will indicate a strategic consideration for the future. This can be crucial for decision-makers in planning the system's evolution and alignment with organisational goals.

5.   CONCLUSION

This study has determined the critical areas of information that must be constantly shared with the stakeholders, ranging from the students' profiles to their graduation. This information has been compiled onto a single platform to ensure free access by authorised users. Additionally, the information is visualised on the dashboard for better understanding. Users' opinions and experiences with the prototype are reflected in their feedback. The responses offer information on whether the prototype successfully captures the necessary data for the UMPSA dual degree programs by seeking comments on different areas of the system, such as data visualisation and content arrangement. The consensus about the acceptability and retention of specific displays indicates that the prototype has been achieved.

The UAT results provide information on the system's usefulness, simplicity, acceptability, and room for further development. Thus, the goal of obtaining input and comprehending user perceptions has been achieved, especially from the personnel in charge of managing this program. This will facilitate further changes towards the system's design in relation to the TAM framework. In summary, the user feedback and survey results provide valuable insights into the strengths and weaknesses of the current system. The university's management can utilise this information to make informed decisions about system improvements while addressing user concerns. It also facilitates future strategic planning, especially in the context of potential program expansions.

6.   LIMITATIONS OF THE STUDY

This study highlights several limitations for future improvement. First, revising the system's security level is essential, particularly regarding user verification and administration. This can be done by revising the security design to differentiate between user categories, such as standard users and administrators. The proposed solution involves authorising each role with appropriate privileges. For instance, only authorised administrators should be allowed to make changes or amendments to the system's existing data while standard users would have restricted access based on their functionalities.

Second, the study acknowledges a limitation in the scope of the prototype, which was developed explicitly for the UMPSA-German dual degree programs. This is attributed to the need for timely development within specific project constraints. Therefore, other dual degree programs, such as those in China, may face limitations in using certain features due to the prototype's specificity to the UMPSA-German programs. Future work in this area could involve expanding the prototype to accommodate a broader range of dual degree programs. Such expansion will enhance the system's versatility and applicability to different international programs, addressing language competencies and other specific requirements.

7.   FUTURE WORKS

Currently, the prototype only covers the requirements of the UMPSA-German dual degree programs. However, extending its usage to other dual degree programs is possible based on the feedback from the respective users. To achieve this extension, the design of the prototype's features must be comprehensive and capture all the unique requirements of various dual degree programs. This implies a flexible and adaptable design that can accommodate different program structures, courses, and student data specifications.

The prototype's integration with UMPSA's existing Information Management System (IMS) is motivated by the need to maintain consistency in student data across the university. The prototype is currently focused on the UMPSA-German dual degree programs and encompasses specific data elements like student profiles and graduation statistics. To broaden its scope, there is a proposal to integrate additional data from the IMS, thus ensuring a more comprehensive view. This integration aims to enhance user convenience, providing a unified system where users can access an extensive set of student data without having to navigate between different systems.

AUTHORS CONTRIBUTION

All authors contributed equally to this manuscript and each author has reviewed and approved the final version.

AVAILABILITY OF DATA AND MATERIALS

The data and materials used in this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

This study was conducted in accordance with ethical standards and all necessary approvals were obtained from the relevant institutional review boards. Informed consent was obtained from all participants involved, where applicable.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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