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EduFinBuddy: A Web-based Education Financial Aid Recommendation System using Web Scraping

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Abstract

Education plays a crucial role in shaping Malaysia's future development. However, access to higher education remains discriminatory, particularly for students from lower-income families, individuals with disabilities, and indigenous backgrounds, as they face challenges due to escalating living costs. The Malaysian government has initiated various education financial aid programmes to address this issue, encompassing scholarships, loans, and one-off aid. This initiative aligns with the broader goal of promoting inclusivity and ensuring all aspiring students have equal access to pursue their educational dreams. However, in many cases, some students apply for educational financial aid only to face rejection due to unmet requirements. Therefore, this paper proposes a responsive web-based system, namely EduFinBuddy, that will be able to identify the most suitable education financial aid based on student input. We begin the development process by extracting data from the targeted websites using a web scraping approach and storing it in a database. Then, we build the recommendation component using the cosine similarity algorithm to ensure accuracy based on the student's input. Thus, the student will get a list of educational financial aids according to their preference. The result shows that all the functionalities work well and can be implemented in any educational system of financial assistance to allow easier access to information for tertiary-level students in Malaysia. This initiative aligns with the broader goal of promoting inclusivity and ensuring all aspiring students have equal access to pursue their educational dreams.

Keywords: education financial aid, cosine similarity, web scraping, sustainable development goal, quality education.

INTRODUCTION

The development of a nation or country is significantly influenced by its level of education. Financial aid for education is a crucial component of ensuring that financially disadvantaged students at colleges and universities complete their courses successfully and advance educational equity (Zheng et al., 2019). Furthermore, a nation that has effectively eliminated poverty can offer education to all its people (Kartika, 2020). Due to a lack of funds, students struggled financially to adjust to the high cost of living; this is a serious problem that still affects university students and may have an impact on their academic performance (Norazlan et al., 2020).

With so much information available online these days, it can be very challenging for end consumers to find what they're looking for. Recommender systems are a well-known artificial intelligence used in information systems to deliver relevant content to consumers, thanks to the quick development of these technologies (Elwirehardja et al., 2022). The software tools and methods used in recommendation systems provide recommendations for products that are most likely to be of interest to a particular user (Kurniadi et al., 2019). Recommender systems also offer users customised displays that are continuously adjusted to their evolving preferences (Elattar & Fouad, 2022).

Web-scraping techniques are used to gather data from various financial assistance websites for students, which will then be processed and analysed. Web scraping is the process of collecting a large amount of data from websites and saving it as a local file on a computer or as a table-format database (Maheshwari & Chourey, 2019). In other words, web scraping is the process of automatically extracting web data rather than manually duplicating it. It is also referred to as screen scraping, web data extraction or web harvesting (Singrodia et al., 2019). The objective of a web scraper is to transform unstructured data while keeping it in organised databases. As a result, it saves us time by producing lightning-quick results, providing error-free data, and consolidating all the data into one place. Moreover, this eases access and simplifies data analysis.

The user's study level, household income, field of study and its disciplines, personal identity, state of residence, and cumulative grade point average (CGPA) are the six parts of requirements that the recommender system will use in this study. This is because each financial aid programme has different eligibility requirements. Furthermore, the desired financial aid data can only be extracted by web scraping when the pertinent websites have been found. Using scraped data from several web portals, the system can then list specific financial aids based on user constraints and desired attributes. Thus, this study presents a system for recommending student financial aid that attempts to offer consumers advice and a customised list of the best financial aid options, including study loans, one-time aids, scholarships, and convertible study loans. The system is designed as a web-based platform that is responsive to screen sizes and devices, and it makes use of data that is collected through web scraping.

RELATED WORKS

Hasdyna et al. (2017) implemented the TOPSIS method for a recommendation system for scholarship recipients at Universitas Islam Kebangsaan Indonesia. The TOPSIS method is used to provide the best alternative based on the highest rank, considering criteria such as GPA, achievements, parental dependents, and parental income. The research contributes to the selection process by recommending scholarship recipients based on specific criteria, ensuring that only deserving students receive the scholarship.

In 2018, Latumakulita and Usagawa proposed a new selection model for the scholarship in Indonesia, combining the Back-Propagation Neural Network (BPNN) as a candidate predictor and the Fuzzy Inference System (FIS) as a candidate selector. BPNN was used to classify candidates into two and three recommendation classes and perform FIS on the priority set of candidates derived from the intersection of the classification results. Thus, improving accuracy and efficiency in the selection process.

Similarly, in 2019, Khasanah et al. developed an informative decision support system that aims to enhance the scholarship selection process by providing a more comprehensive approach by comparing the effectiveness of different methods through sensitivity analysis using the Simple Additive Weighting (SAW) and Weighted

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Product (WP) methods.

In 2021, Aristamy et al. addressed the problem of many students with non-academic achievements not receiving scholarships, despite meeting the criteria for academic and non-academic achievements. The paper proposes the use of a Decision Support System (DSS) with the Fuzzy Multiple Criteria Decision Making (FMCDM) method to provide scholarship recommendations. The proposed decision support system can assist in providing scholarship recommendations that consider both academic and non-academic achievements, addressing the issue that deserving students with non-academic achievements do not receive scholarships.

In another study conducted in 2023, Khelifi et al. developed a smart scholarship system that streamlines the process of awarding scholarships, enabling students to apply for scholarships, verify their status, and expedite the operations of the scholarship office.

Although the field of study on education financial aid has grown, inadequate work has been done to explore the possibility of combining web scraping methods with recommender systems to create a platform that is user-customisable, responsive, and capable of producing thorough and efficient recommendations for student financial aid. Therefore, this paper proposes to develop a web-based recommender system to facilitate the identification of educational financial aid for tertiary-level students using a web-scraping approach.

METHODOLOGY

This study will use a waterfall model to construct the EduFinBuddy, as illustrated in Figure 1. The waterfall model, often referred to as a sequential design process, is frequently employed in software development processes. It depicts the stages of analysis, design, implementation, testing and maintenance as descending in a steady stream (Sulaiman et al., 2023).

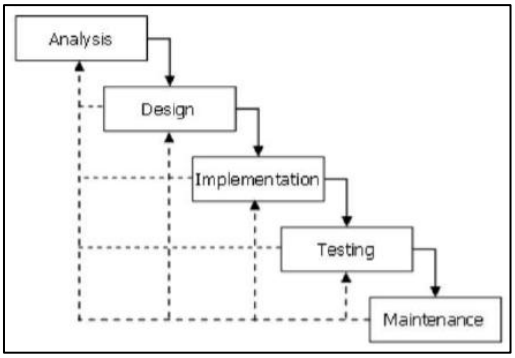

Figure 1: Waterfall model

Phase 1 – Analysis

The first step in the project methodology, currently in the analysis stage, involves conducting a requirements study. To accomplish the first goal, a phase that identified the web scraping technique to use to scrape data from different websites for student financial aid offers was carried out. The use of machine learning in a recommender system, clustering algorithms and data extraction using web scraping techniques have all been

the subject of extensive research in this phase from a variety of sources, including journals, articles, books, and websites. Similarly, relevant literature plays a crucial role at this stage in defining the project's goals, scope, significance, and problem statements. Similar to that, the proper method had to be employed in the development of this project. Numerous methods can be found in the relevant literature. Therefore, a thorough literature review of relevant studies, information sharing, and web scraping techniques was needed to determine the best and most appropriate method for this project's development. Figure 2 illustrates the use case diagram for EduFinBuddy. The use case diagram explains how the user interacts with the application's functional requirements (Sulaiman et al., 2021).

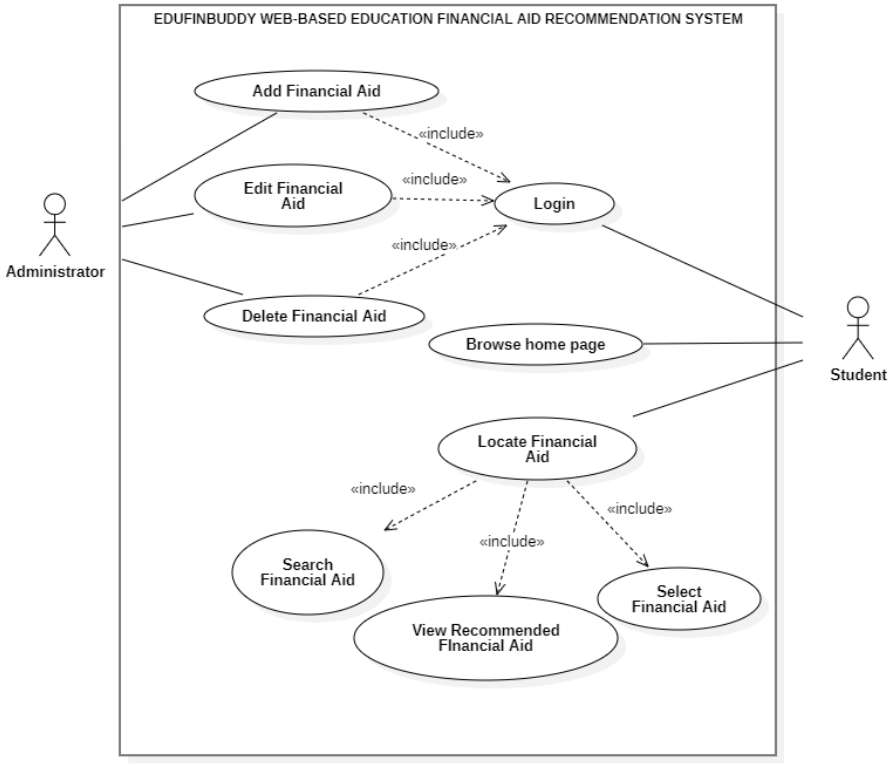

Figure 2: Use case diagram for EduFinBuddy

Phase 2 – Design

The project methodology's second phase, or design, is carried out during the implementation stage. The chosen web scraping technique has been used to develop a web-based application through the design and implementation phases. The system flowchart, as illustrated in Figure 3, demonstrates the flows of the EduFinBuddy system.

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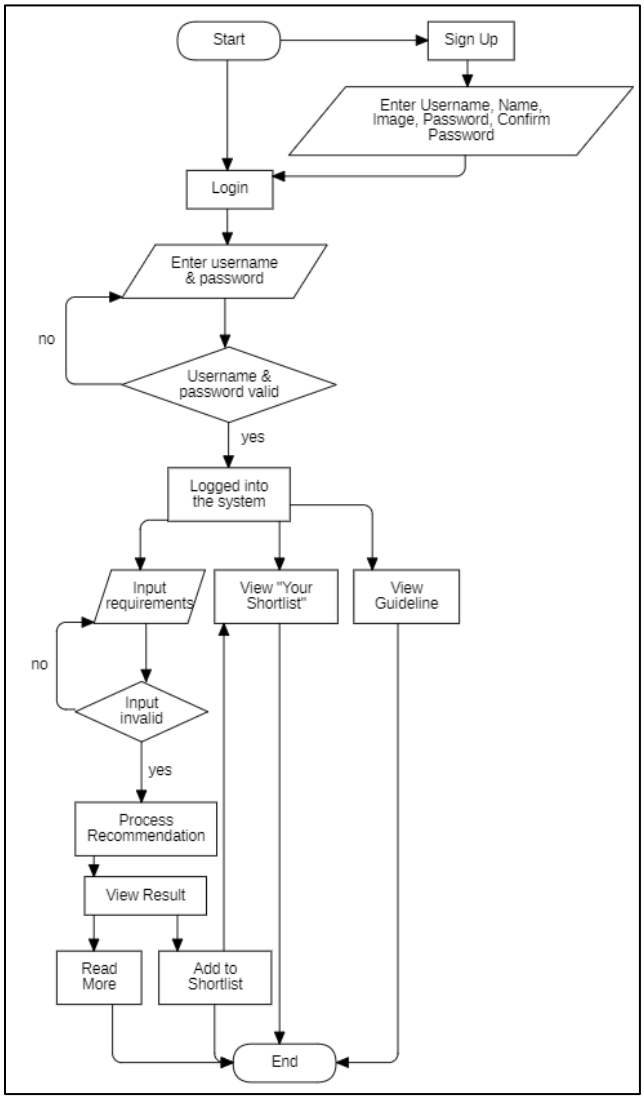

Figure 3: System flowchart for EduFinBuddy

Figure 4 illustrates the system architecture of the EduFinBuddy system (Azmy et al., 2021). Based on Figure 4, the data from targeted websites will be collected using web scraping tools. This extracted data is then stored in a database. The stored data undergoes a data preparation process to clean and organize raw data, ensuring it is accurate, consistent, and in a suitable format for effective analysis and use in the recommender system. This includes data pre-processing, feature extraction, and data transformation. After preparation, the processed data is updated in the database. In the recommendation system, the processed data and user input are compared using the cosine similarity algorithm. This algorithm measures the similarity between the user's input and the financial aid options, allowing the system to generate personalized recommendations. The recommender system is rigorously tested to ensure accuracy and reliability. This involves conducting test runs and making necessary adjustments, as indicated by the dotted arrows in the diagram. Once the system is validated, it provides results to the user through a user-friendly interface, represented by solid arrows.

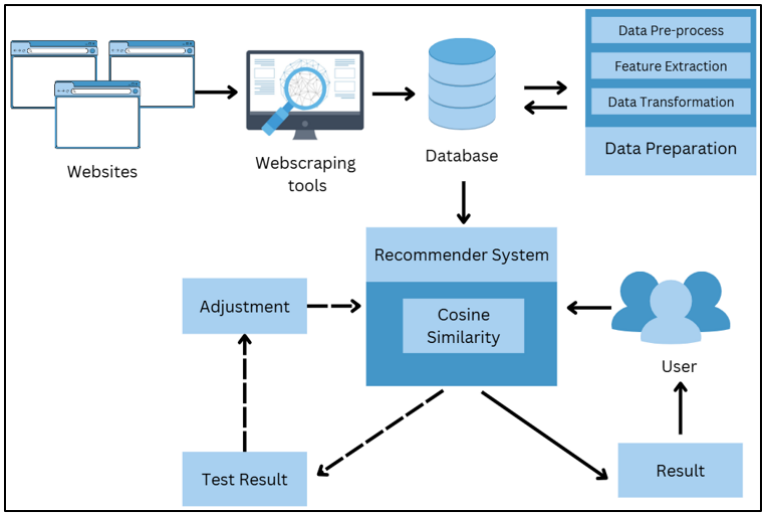

Figure 4: System architecture for EduFinBuddy

Phase 3 – Implementation

System development is the third stage of the project methodology. The two main phases that will be covered in this phase are the hardware requirements and the software requirements, as illustrated in Table 1 and Table 2, respectively. This section also includes a list of the different kinds of hardware and software.

Table 1: Hardware requirements

No	Hardware	Specification
1	Laptop	11th Gen Intel(R) Core (TM) i5-1135G7 @ 2.40GHz (8 CPUs), ~2.4GHz, 8GB for RAM and 512GB SDD
2	Smartphone	Android version 11

Table 2: Software requirements

No	Software	Description
1	Python/CSS/HTML	Programming Language
2	FastAPI	Web (back-end) framework
3	Bootstrap	Front-end framework for building responsive and visually appealing user interfaces.
4	Chrome or Microsoft Edge	Web browser
5	Microsoft Windows 10	Operating systems (64-bit)

Implementation of Web Scraping Method

This section focuses on the crucial data analysis phase of building the EduFinBuddy. For making tailored recommendations for student financial aid packages, the system primarily depends on data. The steps in the data analysis process are as follows: data preparation, which entails preprocessing and cleaning using tools like Microsoft Excel, and data collection, which includes scraping data using code-based and tool-based methods. To provide students looking for financial aid with accurate and pertinent recommendations, the

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system requires data-driven processes to extract valuable insights and patterns from the financial aid data. Gathering data is one of the most important stages in creating the system for recommending students for financial aid. In this step, relevant websites to be scraped are found using code-based (Beautiful Soup) and tool-based (Octoparse) methods, and the data needed for analysis is extracted (Ahamad et al., 2017; Khder, 2021).

The next step is to find websites that offer useful information on financial aid for education. These websites may include financial aid pages for colleges, government portals, scholarship databases, and other resources that provide extensive financial aid information. Initially, more than 100 websites were identified for the data collection process. The following criteria were used in the careful selection of these websites, as illustrated in Table 3.

Table 3: Target website criteria

Criteria	Description
Website Reputation	Well-known and reputable scholarship portals in Malaysia with a track record of providing accurate and reliable information.
Relevance to Research	Websites specifically curated to offer scholarship opportunities relevant to Malaysian students and their research objectives.
Diversity of Scholarships	Websites covering scholarships across various academic disciplines, study levels, and eligibility criteria for Malaysian students.
Geographical Coverage	Websites catering to scholarships offered in Malaysia, as well as international scholarships available to Malaysian students.
Accessibility	Websites that allowed public access to scholarship information without any subscription or membership requirements, ensuring transparency and inclusivity for Malaysian students.

In the data collection process, web scraping was performed using Beautiful Soup. Beautiful Soap is a Python library that provides tools for scraping HTML and XML files. It creates a parse tree from the page's source code, which can be used to extract data in a hierarchical and more readable manner. The output, then, will be stored in a CSV file, as shown in Table 4.

Table 4: Scholarship data in CSV file

	A	B	C	D	E	F	G	H	I	J
1	Name	Link	Deadline	Study Level						
2	Gamuda S	https://afi	May 31 20	Degree,Diploma,Pre University						
3	IUKL Cares	https://afi	Dec 31 20	Degree						
4	IUKL Schol	https://afi	Dec 31 20	Degree,Pre University						
5	Yayasan Li	https://afi	Dec 31 20	Degree,Diploma,Master,ODL,PhD,Pre University,Professional Qualification						
6	UniCAM Ir	https://afi	Dec 31 20	Degree						
7	Tune Libra	https://afi	Dec 31 20	Pre University						
8	Southamp	https://afi	Dec 31 20	Degree,Pre University						
9	2020 - Cur	https://afi	Dec 31 20	Degree,Diploma,Master,PhD						
10	2020 - Cur	https://afi	Dec 31 20	Degree						
11	UOW Mal	https://afi	Dec 31 20	Degree						

In the data preparation phase, the primary focus is to refine the collected data, ensuring its quality and relevance for generating personalised recommendations. The RapidMiner tool was used as a strong data analysis and machine learning platform, as well as a powerful data preprocessing and cleaning technique, to accomplish this. In order to produce clean and trustworthy data, these methods handle missing value handling, duplicate detection and resolution, data compilation, and adding required columns, among other things.

Implementation of Cosine Similarity Method

Cosine similarity is a measure of similarity between two non-zero vectors in an inner product space. In recommendation systems, the cosine similarity technique is employed to identify commonalities between users or items. The fundamental idea behind cosine similarity is to represent two strings as vectors in a multidimensional space. The TF-IDF vector, which combines the Term Frequency (TF) and Inverse Document Frequency (IDF) for each term in the string, is a popular option for converting a string into a vector (Al-Otaibi et al., 2022).

$$similarity\ (A,B) = \frac{A.B}{||A||.||B||} = \frac{\sum_{j=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2}\sqrt{\sum_{i=1}^{n} B_i^2}}$$

Here, the vectors A and B are respectively made up of A and B. The cosine similarity value, which has a maximum value of 1, indicates that the two vectors are very similar. Cosine similarity is used to rank vectors and sort them according to the cosine similarity value that is obtained when calculating the similarity between users or items. Then, by comparing vectors, we can view users or items that have a high degree of similarity. Let us assume that, as shown in Table 5, 'A' represents a user input vector and 'B' represents a PTPTN vector.

Table 5: Sample user input vector and PTPTN vector

	User Input Vector, A		**PTPTN Vector, B**	
Study level	Foundation	1	Foundation, Diploma, Bachelor, Master, PhD	1
Family income classification	B40	1	B40, M40, T20	1
CGPA	3.5	1	0, 4	1
Major of study	Plantation	1	Applied Sciences-Civil Engineering-Electrical Engineering-Medicine-Sports Science & Recreation-Architecture, Planning & Surveying-Computer & Mathematical Sciences-Health Sciences-Pharmacy-Chemical Engineering-Dentistry-Mechanical Engineering-Plantation & Agrotechnology-Administrative Science & Policy Studies-Education-Music-Art & Design-Film, Theater & Animation-Communication & Media Studies-Law-Accountancy-Information Management-Business & Management-Hotel & Tourism Management	1
Identity	Default	0	Default	0
State	Default	0	Default	0

Figure 5 shows the sample calculation of cosine similarity based on the user input vector and PTPTN vector from Table 5.

Cosine similarity
$$= \frac{1\times1+1\times1+1\times1+1\times1+0\times0+0\times0}{\sqrt{1^2+1^2+1^2+1^2+0^2+0^2}\times\sqrt{1^2+1^2+1^2+1^2+0^2+0^2}}$$
$$= \frac{4}{\sqrt{4}\times\sqrt{4}}$$
$$= \frac{4}{4}$$
$$= 1$$

Figure 5: Sample calculation of cosine similarity

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Phase 4 – Testing

Common testing types include unit tests, integration tests, system tests and acceptance tests. However, this study will solely focus on the system tests. The acceptance test with the end user is not implemented because this study has not reached this phase yet. Assessing the degree to which the application satisfies both functional and non-functional requirements is known as system testing. In order to carry out the system tests, test cases are created. A test case is a specification of the inputs, execution conditions, testing process, and expected outcomes.

Functionality Testing

Functionality testing ensures that the developed prototype complies with the software requirements. Functionality testing sometimes referred to as "black box" testing, focuses on an application's external features but ignores its internal functions (Sulaiman et al., 2023). Five test cases have been provided to test the system's functionality. The test cases are welcome, sign-in, sign-up, recommendation dashboard and result.

Table 6: Welcome page test case

Function	Functionality Testing	Result
Try FinBuddy Button	When users click the button, they will be navigated to the Recommendation Dashboard	Pass
Sign In Button	When users click the button, they will be navigated to the Sign-In Page	Pass

Table 6 shows the test case for the welcome page to provide users with an informative introduction to the application.

Table 7: Sign-in page test case

Function	Functionality Testing	Result
UiTM FinBuddy Logo Button	When users click the button, they will be navigated to the Welcome Page	Pass
Home	When users click the button, they will be navigated to the Welcome Page	Pass
Enter Username	The input field cannot be empty. Input must be in Integer which is the student's student ID	Pass
Enter Password	The input field cannot be empty	Pass
Slide Button	When users click the button, they will be navigated to the Sign-Up Page	Pass
Sign up now	When users click the text, they will be navigated to the Sign-Up Page	Pass
Login Button	When users click the text, they will be navigated to the Recommendation Dashboard	Pass

Table 7 shows the test case for the sign-in page. The sign-in page plays an important role in user authentication and access control for the application.

Table 8: Sign-up page test case

Function	Functionality Testing	Result
UiTM FinBuddy Logo Button	When users click the button, they will be navigated to the Welcome Page	Pass
Home	When users click the button, they will be navigated to the Welcome Page	Pass
Enter Student ID	The input field cannot be empty. Input must be in Integer which is the student's student ID	Pass
Enter Name	The input field cannot be empty	Pass
Choose File	The input field cannot be empty. Input must be in image format	Pass
Enter Password	The input field cannot be empty	Pass
Enter Confirm Password	The input field cannot be empty. The input field must match the entered password	Pass
Slide Button	When users click the button, they will be navigated to the Sign-In Page	Pass
Signup Button	When users click the text, they will be navigated to the Sign-In Page	Pass

Table 8 displays the test case of the sign-up page. The sign-up page is a critical component for onboarding new users to create a new application account.

Table 9: Recommendation Dashboard page test case

Function	Functionality Testing	Result
UiTM FinBuddy Logo Button	When users click the button, they will be navigated to the Welcome Page	Pass
Guideline	When users click the button, they will be navigated to the Guideline Page	Pass
Recommend Me!	When users click the button, they will be navigated to the Recommendation Dashboard	Pass
My Shortlist	When users click the button, they will be navigated to the My Shortlist Page	Pass
Study Level Dropdown Button	Selection cannot be empty	Pass
Family's Income Dropdown Button	Selection cannot be empty	Pass
Major of Study Dropdown Button	Selection cannot be empty	Pass
Field of Study Dropdown Button	Selection cannot be empty	Pass
Identity Dropdown Button	Selection cannot be empty	Pass
State Dropdown Button	Selection cannot be empty	Pass
CGPA Input Field	Input cannot be empty	Pass
Confirm Button	When users click the button, the system will process the recommendation and will be navigated to the Result Page	Pass
User Profile Dropdown Button	When users click the button, the user details such as Name and Student ID will be displayed	Pass
Toggle Sidebar Button	When users click the button, the user details such as Name and Student ID will be displayed	Pass
Logout Button	When users click the button, the user will be navigated to the Welcome Page and the session will be cleared	Pass

Table 9 displays the test case for the recommendation dashboard page. On this page, the user is required to provide several important inputs. The application will recommend appropriate educational financial aid for the user based on their input.

Table 10: Result page test case

Function	Functionality Testing	Result
All Button	When users click the button, they will see all the results of recommended financial aid(s).	Pass
Scholarship Button	When users click the button, they will see the results of recommended scholarships.	Pass
One-off Aid Button	When users click the button, they will see the results of the recommended One-off Aid(s).	Pass
Study Loan Button	When users click the button, they will see the results of the recommended study loan(s).	Pass
PBU (Pinjaman Boleh Ubah) Button	When users click the button, they will see the results of the recommended PBU(s).	Pass
Symbol "+" Button	When users click the button, they will see the selected financial aid description	Pass
Symbol "-" Button	When users click the button, they will hide the selected financial aid description	Pass
Read More Button	When users click the button, they will be navigated to the selected financial aid website	Pass
Add to Shortlist Button	When guests click the button, they will be prompted to sign in with a pop-up message. When signed-in student clicks the button, they will save the selected financial aid.	Pass
Scroll Button	When users scroll the button, they can see the bottom part of the Result Page.	Pass
Up Button	When users click the button, they will be navigated to the top of the Result Page	Pass

Table 10 displays the result page's test case. On this page, all the recommended educational financial aid will be displayed to the user.

Phase 5 - Maintenance

Maintenance is the longest life cycle phase in the waterfall model. Once installed, the system is used in real life. Correcting mistakes that were missed in earlier life cycle stages is part of maintenance. This phase of the study has not yet been reached, though.

RESULTS AND DISCUSSION

High-level Graphical User Interface

The EduFinBuddy graphical user interface (GUI) will enable system communication with the end user. The GUI is composed of five web pages that have input and output for educational financial aid (Sulaiman et al., 2023).

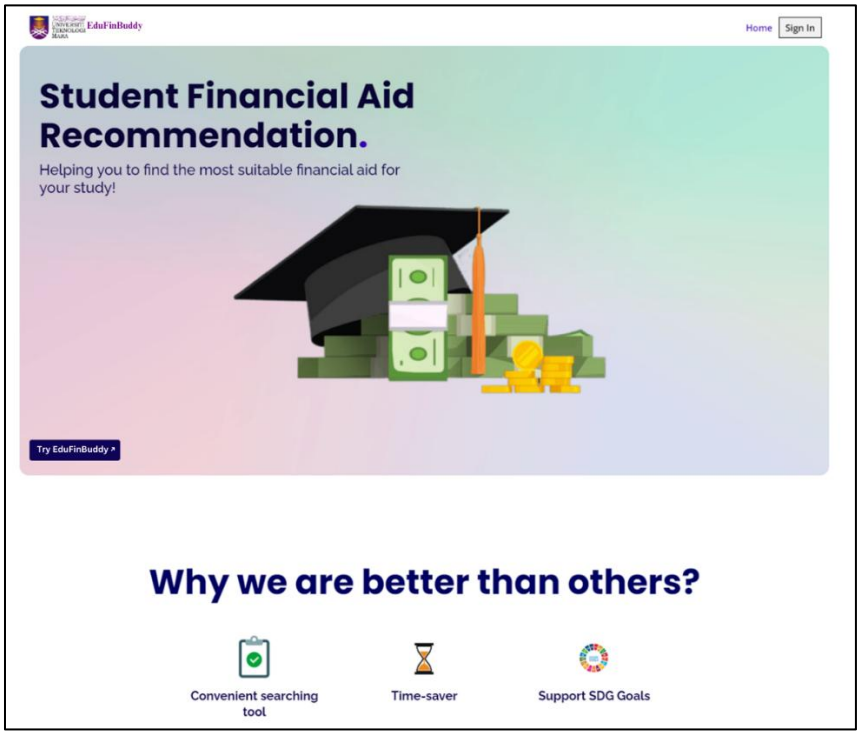

Figure 6: Welcome page

Figure 6 illustrates the welcome page of EduFinBuddy. The user can click on the 'Try EduFinBuddy' button and be navigated to the recommendation dashboard page or click on the 'Sign In' button to be navigated to the sign-in page as illustrated in Figure 7.

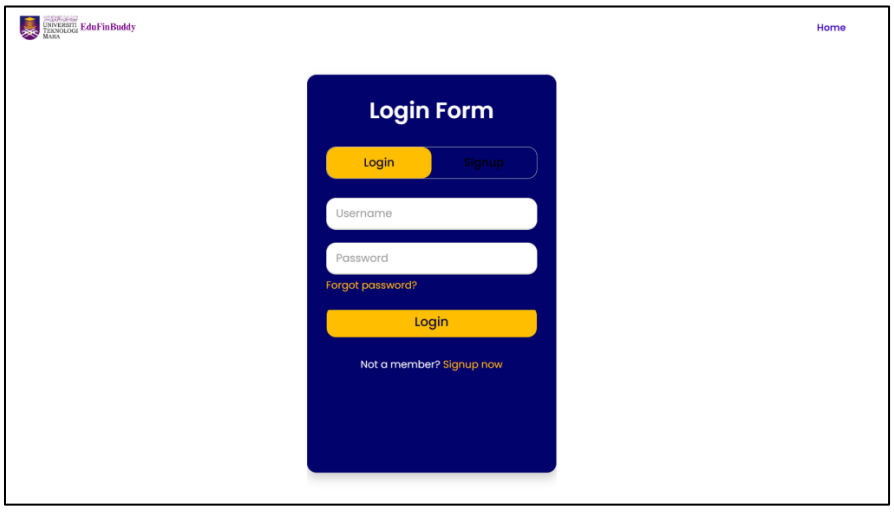

Figure 7: Login page

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The user needs to enter the username and password as illustrated in Figure 7 to log in. A new user can slide right to the 'Sign up' button to register, as illustrated in Figure 8.

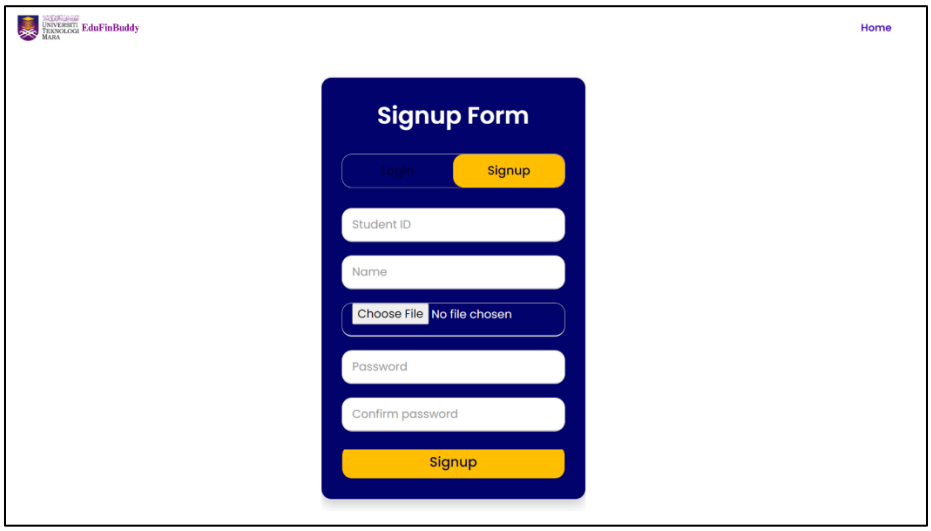

Figure 8: Sign-up page

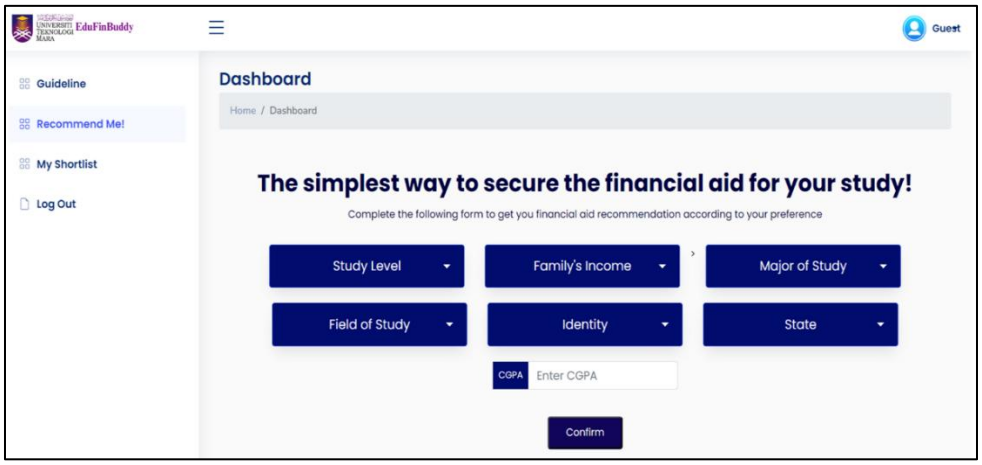

Figure 9: Recommendation Dashboard page

There are four menus located on the left side of this page, such as 'Guideline', 'Recommend Me!', 'My Shortlist' and 'Log Out', as illustrated in Figure 9. A new user can click on the 'Guideline' menu to learn how to use this system. The user needs to click on the 'Recommend Me!' menu to navigate to the recommendation dashboard page as illustrated in Figure 9. The user then needs to provide input based on the study level, family's income classification, major of study, field of study, identity, state and CGPA data, as illustrated in Table 11.

Table 11: Sample user input

No	Data Item	User Input
1	Study level	Foundation
2	Family income classification	B40
3	Major of study	Plantation & Agrotechnology
4	Field of study	Science & Technology
5	Identity	Bumiputera
6	State	Selangor
7	CGPA	3.50

The user then needs to click on the 'Confirm' button so that the system will process the recommendation result and navigate to the result page, as illustrated in Figure 10. The financial recommendation will be displayed to the user based on five categories, such as 'All', 'Scholarship', 'One-off Aid', 'Study Loan' and 'PBU (Pinjaman Boleh Ubah)'. The student can choose their preferred educational financial aids and save them in the 'My Shortlist' menu.

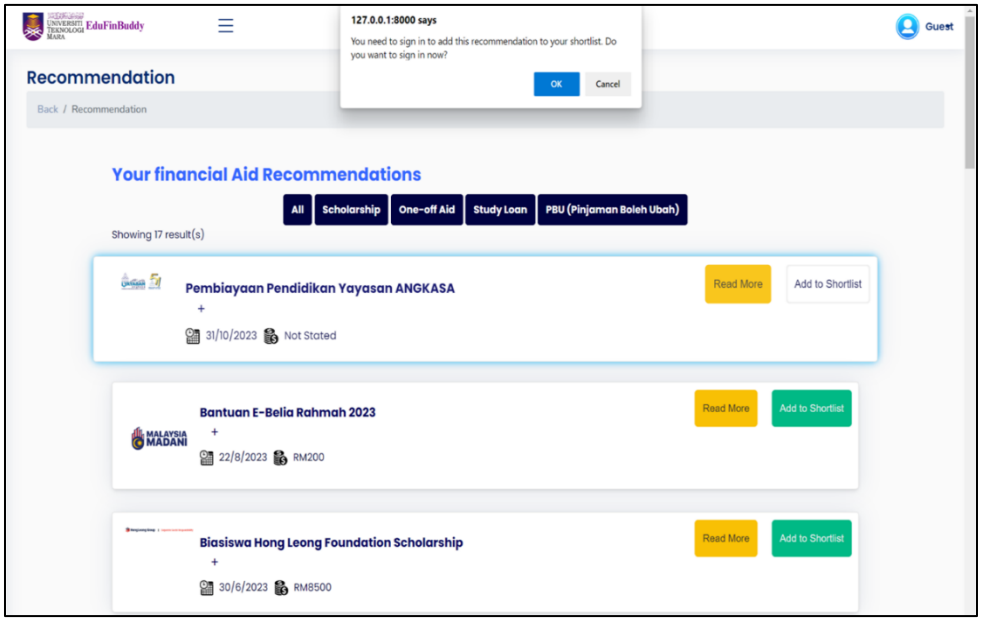

Figure 10: Result page

A cosine similarity of 1 indicates a perfect match between the user input and the expected result. In this case, the vectors are identical, meaning that the user input matches the expected result 100%. Therefore, the PTPTN will be displayed as a higher ranking of results on the result page in EduFinBuddy.

CONCLUSION

This paper discussed the development of a web-based education financial aid recommendation system using a web scraping approach. This study aims to provide personalised recommendations for financial assistance based on the user's input. The systems utilise web scraping techniques to extract relevant data from various

sources, enabling the generation of comprehensive and up-to-date information about available educational financial aid programs. For future research, EduFinBuddy can cooperate with machine learning techniques to enhance the recommendation system's accuracy and personalization. Through the examination of past data and user input, the system can adapt and enhance its suggestions in real-time, accounting for personal preferences and shifting financial assistance patterns.

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CONFLICTS OF INTEREST

The authors declared that they have no conflict of interest to disclose.

AUTHOR CONTRIBUTIONS

Mohd Suffian Sulaiman wrote, edited, and conducted the article. **Nur Nafesza Asyikin Ismail** built the EduFinBuddy application and conceptualised the core idea of the research. **Azri Azmi** and **Fakhrul Hazman Yusoff** anchored the review and made the required revisions. **Zuraidah Derasit** validated the mathematical formula and technique calculation.

DATA AVAILABILITY STATEMENT

Data available within the article or its supplementary materials.

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