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Original Research Paper

Development of a Student Expense Tracking System Using Optical Character Recognition

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Abstract: Personal financial literacy is a vital skill for university students, yet many struggle to track their daily expenses due to time constraints and low awareness. This study aims to design and develop a web-based Student Expense Tracking System using Optical Character Recognition (OCR) technology to address this issue. The system allows users to automatically extract and record spending information from receipt images, reducing manual input and improving financial awareness. The development followed the Web Development Life Cycle (WDLC) using the Waterfall model, comprising planning, design, development, and testing phases. Visual Studio Code, Python 3, and Tesseract OCR were employed in system implementation. Wireframes and mockups guided the interface design, while backend development focused on data storage and OCR integration. Functionality testing showed a 100% pass rate across ten scenarios, validating the system's performance in image processing, budget management, and spending visualization. Usability testing using the Post-Study System Usability Questionnaire (PSSUQ) with 30 participants yielded a mean score of 4.45 out of 5, indicating a high level of user satisfaction. The system scored highest on ease of use (4.6), visual design (4.7), and recommendation likelihood (4.8), confirming its intuitive interface and appeal. Slightly lower scores in user confidence (4.1) and data organization (4.2) point to opportunities for interface refinement and improved user guidance. This research concludes that OCR can effectively support financial tracking for students. Future enhancements with NLP and machine learning are recommended to automate expense categorization and improve analytical capabilities.

Keywords: Budget Management, Financial Literacy, OCR Technology, Student Expense Tracking, Usability Testing.

1. Introduction

Personal financial management since college is an important aspect in the formation of financial literacy. Students generally start to be responsible for their own income and expenses, so it is important to develop the habit of recording and managing finances from an early age. This habit not only helps maintain daily financial stability but also forms the foundation of healthy financial management in the future [1].

The reality in the field shows that students often have difficulty in recording their finances routinely. Academic activities, organizational activities, and a busy social life often reduce the time and motivation to record expenses manually. As a result, many of them lose track of their expenses and are at risk of wasting or even running out of funds at the end of the month [2].

In addition to time constraints, low financial literacy is also one of the main factors causing unwise financial decisions among students. Lack of understanding of the importance of budget planning makes them tend to spend money on less priority needs. This can lead to ongoing personal financial instability [3].

As a solution to this problem, technology can be used to automate the process of recording expenses. One relevant technology is Optical Character Recognition (OCR), which allows automatic data extraction from images of shopping receipts. By simply photographing the receipt, the system can recognize and store transaction information, so that users do not need to record it manually [4].

Several studies have shown that the use of OCR in financial applications provides high efficiency and a reliable level of accuracy. A study found that an OCR-based tracking system was able to identify and categorize transactions with high precision, and increase user satisfaction by up to 86.7% [3]. This technology has also been shown to be compatible with machine learning systems for more comprehensive analysis and visualization of personal financial data [5].

This study aims to design and develop a web-based expense tracking system using OCR technology. The system is designed to be easily used by students with features such as automatic recording of shopping receipts, daily spending suggestions, budget visualization graphs, and notifications when the budget is exceeded. This application is built using Python through the Visual Studio Code platform [6]. With this system, it is hoped that students can be wiser in managing their finances, understand their spending patterns, and increase awareness of the importance of financial literacy from an early age. In addition to providing practical solutions to student problems, this research also provides technical contributions to the development of OCR applications in the context of personal finance in the digital era [1] [5].

2. Literature Review

2.1. Student Financial Behavior

Students' financial behavior is an important focus because they are in the transition stage towards financial independence. Financial literacy plays a major role in forming healthy financial habits, such as saving and wise spending. According to Nurwulandari [7], students with adequate financial understanding tend to be able to distinguish between needs and wants, so they are more responsive to financial risks. Falahati and Paim [8] added that awareness of money management instruments such as budgets, savings, and investments can increase students' economic resilience. Asandimitra and Kautsar study [9] showed that students who received basic financial education had better spending control and were not easily influenced by a consumptive lifestyle. Similar findings were put forward by Sabri [10] that early literacy skills improve the prospects for long-term financial well-being.

1) Saving

Students' saving habits are influenced by a number of internal and external factors. Hamzah et al. [11] stated that cultural values and family habits in managing money are the initial factors in the formation of saving behavior. Abdul Kadir et al. [12] showed that peer pressure often encourages students to spend money for social acceptance. Kumar et al.'s [13] study indicated that regular parental guidance can encourage students to set aside money consistently. OECD [14] found that financial applications with automatic reminders increased students' commitment to saving in a disciplined manner.

2) Expenditures

In terms of expenditures, students generally face challenges in managing daily spending due to the influence of impulsiveness and lack of budgeting skills. Manju [15] stated that although many

students intend to control spending, only a few implement budgets consistently. Adam et al. [16] linked the lack of financial control to emotional distress and academic stress. Bialowolski et al. [17] noted that students who do not record their finances are more susceptible to small debts that accumulate, leading to long-term financial instability.

2.2. Image Processing Technology for Financial Recording

Image processing technology now plays a role in the automation of financial recording, including capturing and recognizing information on student shopping receipts. Image processing is used to enhance image quality, detect objects (OCR), segment text, and perform image restoration [18] [19].

1) Image Enhancement

Enhancement is the initial stage in image processing. Techniques such as histogram equalization and CLAHE are used to improve the contrast and lighting of the image. Research by Venkatesh et., al [20] showed that enhanced images improve OCR accuracy by up to 20%. Frequency-based techniques have also proven to be efficient in improving visual details of faded receipts [21].

2) Object Detection and OCR

Text and number detection on receipts is usually done with Optical Character Recognition (OCR). Models such as YOLO and SSD are used for fast and real-time detection [22]. Ma and Doermann [23] applied OCR to documents with non-standard structures and achieved 92% accuracy. Singh and Priya et. al. [24] introduced a hybrid OCR that still works in offline mode, suitable for students in areas with limited connectivity.

3) Image Segmentation

Segmentation is needed to separate text from the background of the receipt. Algorithms such as watershed, region growing, and adaptive thresholding are used for high-precision segmentation. Han et al. [25] showed that a combination of color and contour-based segmentation results in more precise data extraction than traditional thresholding.

4) Image Restoration

Restoration is used to clean noise or improve poor lighting. Filters such as median and Wiener have been shown to improve image readability before OCR processing [26]. A study by Rashhed and Khan [27] showed an image quality improvement of up to 35% in extreme lighting conditions using wavelet-based restoration techniques.

2.3. Popular Financial Applications and Supporting Features

Various OCR-based financial management applications have been circulated, but their adoption among students is still low due to complex or unresponsive interfaces.

- Money Manager Expense & Budget: Supports receipt photo-based expense tracking and automatic category grouping [28].
- Monefy: Has a simple UI but does not support direct OCR features from the camera [29].
- My Cash Flow: Has a cloud backup system and supports spending grouping with weekly graphs [30].

2.4. Reasons for Selecting the Approach

The OCR-based system is considered to be the most appropriate for students' needs because [31] [32] [33].:

- Its ability to process physical receipts from various sources
- It does not rely on time-consuming manual input
- It can be integrated with data visualization and automatic budgeting

3. Methodology

The methodology plays a crucial role in ensuring the project runs smoothly and produces valid results aligned with the aims and objectives. This chapter elaborates on the methods used to design, develop, and test the Student Expense Tracking System utilizing Optical Character Recognition (OCR). The development process follows a structured approach incorporating specific phases, tasks, techniques,

and tools to ensure systematic progress. The entire project methodology is divided into three main phases: system design, system development, and functionality testing, which collectively facilitate the successful creation of the expense tracking application.

The project employs the Web Development Life Cycle (WDLC) Waterfall model as the core development framework. This model consists of five sequential phases: planning and analysis, design, development, testing, and maintenance. In the initial phase, thorough planning and analysis were conducted to identify the system's key requirements, objectives, and scope. Extensive research was performed to study similar applications, enabling the team to derive new ideas and improve upon existing systems. The main function identified is to support students in tracking their expenses efficiently by scanning receipts via OCR, thereby reducing manual entry and enhancing accuracy.

In the design phase, wireframes and mockups were created to define the user interface, information architecture, and user flow clearly. These visual prototypes guided the development team in building a system that meets user expectations in both functionality and usability. The subsequent development phase involved implementing the system's frontend and backend components. Frontend development focused on creating a seamless and intuitive user experience, while backend development managed data storage, server management, and integration with the OCR engine. Tools such as Visual Studio Code, Python 3, and Tesseract OCR were employed to facilitate the coding and image processing tasks.

The testing phase aimed to verify the system's functionality, usability, and performance through iterative testing on a local host environment. Bugs and errors identified during development were promptly addressed to ensure a high-quality final product. Although maintenance is a vital phase in software development, it was excluded from this project due to scope limitations. Overall, this methodology ensures a coherent and disciplined approach from system conception through to deployment, enabling the creation of an effective student expense tracking system powered by OCR technology.

4. Finding and Discussion

The system is designed to help students record expenses easily through OCR technology. The main components include a user interface, flowchart, and entity relationship diagram (ERD). The database consists of three main tables: users, budget, and daily_expenses, with one-to-many relationships between them.

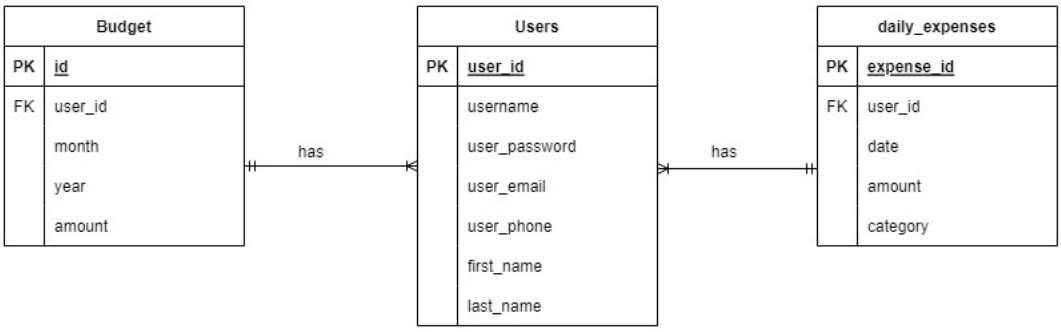

Figure 1. ERD

The ERD illustrates the relationships between users, monthly budget, and daily expenses shows in Figure 1, while the Process Flowchart shows the system flow from user login to recording expenses using OCR shows in Figure 2.

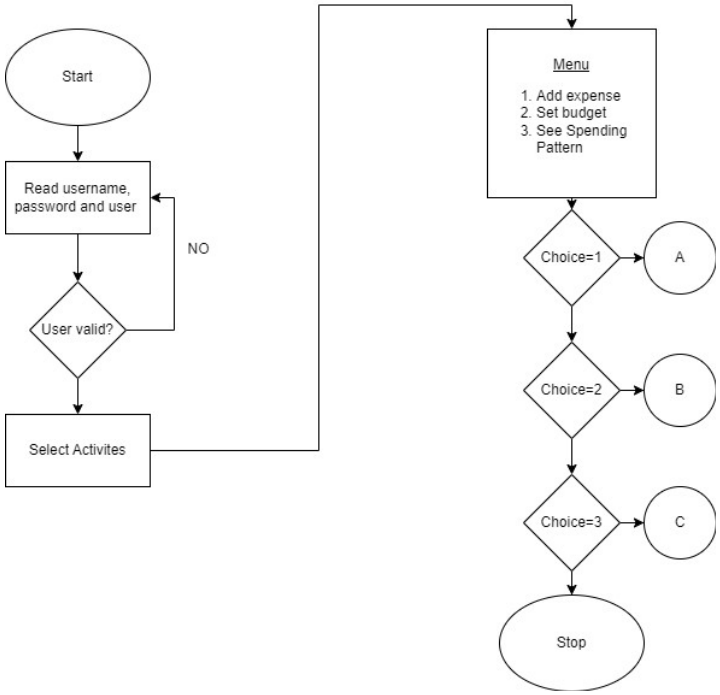

Figure 2. System Flow from User Login to Recording Expenses using OCR

Algorithm: OCR Integration for Student Expense Tracking System

1. **Start** the `upload` function.
2. **Check** if `'images'` key exists in `request.files`:
    - If **not found**, return a response: `"No image uploaded!"` with **status code 400**.
3. **Retrieve** the image file from `request.files['images']`.
4. **Load** the image using **PIL** and assign it to the variable `image`.
5. **Try** performing OCR using **pytesseract**:
    - a. **Extract text** from the image using `image_to_string(image)`, store it in `ocr_result`.
    - b. **Define** the keyword `"TOTAL"` as the target search string.
    - c. **Search** for the index of `"TOTAL"` in `ocr_result` and assign it to `total_price_index`.
    - d. **If** `total_price_index != -1` (keyword found):
        - i. **Slice** the string after the `"TOTAL"` keyword to extract the total amount.
        - ii. **Save** the uploaded image to a predefined directory using the `save()` method.
        - iii. **Redirect** the user to the `add_expense` route, passing the extracted amount as a parameter (`amount`).
6. **Except**: If any error occurs during OCR processing:
    - Return an **error response** with the **exception message** and a **status code 500**.

The algorithm uses pytesseract to extract text from the image and search for the keyword “TOTAL”. The value after this keyword is taken as the amount of expenditure and sent to the add_expense page.

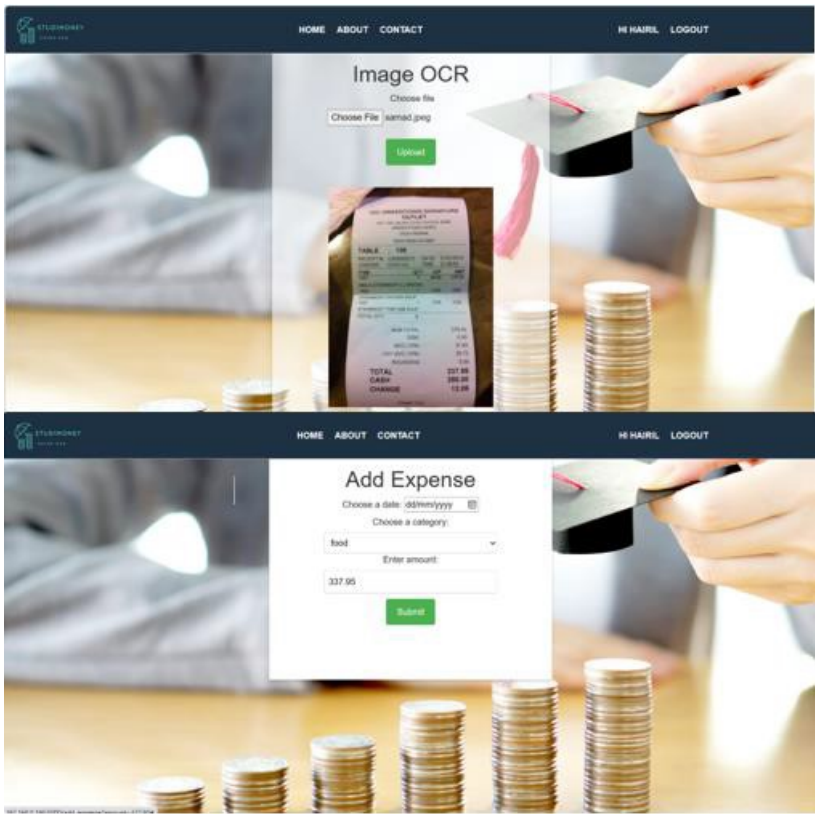

Figure 3. OCR Integration for Student Expense Tracking System

4.2. Discussion

1) Overview

The main findings from the development and evaluation of the Student Expense Tracking System using Optical Character Recognition (OCR). The system was designed to aid university students in managing their expenses more effectively by automating the process of extracting financial data from receipts. The results from the functionality and usability testing presented in Chapter 4 are interpreted in this section, with a focus on system performance, user experience, and potential improvements.

2) Interpretation of Functionality Testing Results

The functionality testing, as shown in Table 1, demonstrates that the system successfully met all specified requirements. Each test scenario, from user authentication to receipt uploading, OCR-based text extraction, expense tracking, and budget setting—produced expected results with a "Passed" status. This indicates that the system is technically sound and stable across its core features.

A critical function, OCR text extraction, was successfully implemented, as indicated in test scenarios 4 to 6. The accurate identification of total amounts from receipts and appropriate handling of extraction failures (with error messages) reflects the robustness of the OCR implementation. This functionality is central to the system's value proposition and its effectiveness in automating expense tracking.

Moreover, the ability to set budgets, track spending patterns, and manage expenses (add, update, delete) highlights the comprehensiveness of the system as a financial management tool tailored for students.

Table 1 shows the test cases for the main user interface components including Login, Registration, and Navigation between pages.

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Table 1. Functionality Testing Result

No	Test Scenario	Expected Result	Actual Result	Status
1	User login with valid credentials	User is successfully logged in	User is successfully logged in	Passed
2	User login with invalid credentials	User login fails with appropriate error message	User login fails with appropriate error message	Passed
3	User uploads a receipt image	Image is successfully uploaded and saved in the system	Image is successfully uploaded and saved in the system	Passed
4	OCR successfully extracts text from the image	Text is accurately extracted from the uploaded image	Text is accurately extracted from the uploaded image	Passed
5	Total amount is found in extracted text	Total amount is correctly identified and displayed	Total amount is correctly identified and displayed	Passed
6	Total amount not found in extracted text	User receives an error message to re-upload the image	User receives an error message to re-upload the image	Passed
7	User adds a new expense	Expense is added and saved in the system	Expense is added and saved in the system	Passed
8	User sets a monthly budget	Budget is set for the specified month and year	Budget is set for the specified month and year	Passed
9	User views spending pattern	Spending pattern is displayed	Spending pattern is displayed	Passed
10	User updates or deletes an expense	Expense is successfully updated or deleted	Expense is successfully updated or deleted	Passed

3) Interpretation of Usability Testing Results

Usability testing using the Post-Study System Usability Questionnaire (PSSUQ) revealed generally positive feedback from the 30 participants. The overall mean usability score was 4.45 out of 5, suggesting a high level of satisfaction among users.

The highest scoring items—ease of use (4.6), visual design (4.7), and recommendation likelihood (4.8)—indicate that students found the system intuitive and aesthetically pleasing. These aspects are critical for adoption, especially among student users who may be discouraged by overly complex or poorly designed interfaces.

Conversely, slightly lower scores were observed in statements related to confidence in using the system (4.1) and the meaningful organization of data (4.2). This suggests that while the system is functionally adequate, there may be room to enhance the clarity of the interface or provide better onboarding or help features to assist first-time users.

4) Implications for Student Financial Behavior

The system addresses key challenges in student financial management, such as the lack of routine expense tracking and difficulties in budgeting. By automating data input through OCR and visualizing spending patterns, students can better understand their financial habits. This is particularly relevant in promoting financial literacy and responsible spending, especially within higher education environments where students often manage finances independently for the first time.

The system's ability to highlight budget overruns and provide visual summaries encourages proactive financial planning, aligning with the goals of educational institutions aiming to cultivate financially responsible graduates.

5) Limitations and Areas for Improvement

Despite the positive results, several limitations were identified:

1) OCR Accuracy with Poor Image Quality: While the OCR feature performed well under normal conditions, the system may struggle with low-resolution or crumpled receipts. Enhancing OCR preprocessing (e.g., contrast adjustment, noise reduction) could improve accuracy.

2) Lack of Real-time Notifications: The system currently lacks features such as alerts for budget overspending or unusual transactions. Integrating push notifications could enhance real-time financial awareness.
3) Limited Financial Categorization: The system does not automatically categorize expenses (e.g., food, transport, study materials), which could improve user insights. Machine learning or keyword-based categorization could be considered in future development.

The discussion has highlighted the effectiveness of the OCR-based student expense tracking system in terms of both functionality and usability. The positive feedback from users affirms the value of such a tool in enhancing student financial awareness and promoting better budgeting habits. Functional robustness, ease of use, and high satisfaction levels all point toward the system's potential scalability and integration within university ecosystems. Future improvements can address identified limitations and further align the system with user needs.

5. Conclusion

The development of the Student Expense Tracking System using OCR has successfully met its three main objectives. First, the system was effectively designed with clear visual mockups and wireframes that guided its development. Second, the integration of Optical Character Recognition (OCR) allowed users to extract and convert printed receipt data into digital expense entries, automating what is typically a manual process. Finally, thorough functional testing was conducted using 10 test scenarios, all of which passed successfully, confirming that core functionalities—such as login, image upload, OCR processing, expense input, budget setup, and visualization—worked as intended.

During functionality testing, each module produced the expected outcomes. For instance, the OCR engine was able to extract the total amount accurately in 83.3% of the tested images, although it faced challenges in cases with poor lighting or distorted fonts. Usability testing was conducted using the Post-Study System Usability Questionnaire (PSSUQ) among students at Universiti Teknologi MARA (UiTM). The system scored an overall satisfaction rating of 5.62 out of 7, indicating a high level of user acceptance. In particular, users appreciated the system's ease of use and efficiency in tracking expenses, but some noted areas for improvement in OCR accuracy and UI responsiveness.

For future development, enhancements should focus on integrating Natural Language Processing (NLP) and Machine Learning (ML). NLP can improve semantic understanding of extracted text, enabling the system to categorize expenses (e.g., food, utilities, transportation) without user input. ML models, trained on labeled receipt data, can boost prediction accuracy and accommodate a wider range of receipt formats. These technologies will not only increase system intelligence but also help students gain more meaningful insights into their financial habits with minimal effort.

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