

iClaim: An Optical Character Recognition Based, Expense Reimbursement and Budget Management System

Eric Blancaflor¹, Jaqlyn Mae Blanco¹ and Jared Ysrael Dona¹

¹Mapua University, Philippines

Abstract. Reimbursement of expenses is the method repaying an employee's expended money during business-related travel. Organizations often suffer from various expense reimbursement problems, such as a missed receipt, inaccurate receipt details, and multiple submissions of a single receipt, to this day. Additionally, there is also the problem of budget control, such as over-spending due to unmanaged company policy. The key objective of this paper is to create an automated system that provides a solution for the issues on expense reimbursement, budget management, and company policy management with the integration of Optical Character Recognition (OCR). OCR is the process of recognizing printed text and convert it into a digitally editable format. The OCR feature in the system will decrease manual entry of inputs thus decrease in human-caused error since OCR will automatically extract necessary information from the printed receipt and use it as inputs for the reimbursement report. This paper uses Open-Source Vision Library (OpenCV) for image processing and Firebase for text recognition and extraction. This paper uses Firebase Hosting in connecting the web application to the internet.

Keywords: reimbursement system; optical character recognition; travel expense tracker; budget management; policy management

1. Introduction

Expense Reimbursement is defined as the action of compensating employees for the money they spent to cover expenses they incur while working on company time. It is an essential process wherein every employee must comply with. Most expense reimbursements occur when an employee travels for business; expenses include accommodations, flights, transportation, meals, and other miscellaneous expenses of an employee.

There are different issues in reimbursement which are common to most companies today. In an interview conducted by the researchers, companies experienced issues such as a lost receipt, incorrect information, and invalid receipts. For instance, when an employee lost his receipt, the employee is required to meet the staff in charge of the reimbursement process and justify his claims that he had a specific expense but unfortunately, the receipt got lost. Another company, which has an existing system, also encountered the same issues regarding incorrect information. Incorrect details were spotted such as no breakdown of purchases, and the date of a transaction is not within the approved dates of the trip. Incorrect details are written in the report usually causes a delay when filing an expense reimbursement report. Additionally, individual users can only monitor their expenses. The user can check whether the expenses made within the timeframe of the trip are still covered by the approved amount on the pre-trip approval.

Aside from reimbursement issues, travel budget management has also been proven as vital in the expense management of a company. Budget is the amount of money specifically allocated to specific items that require to be funded. Budget Management is an act of balancing a certain level of cash flow without exceeding the budget limit.

This study utilized the use of Optical Character Recognition (OCR) in scanning printed receipts. It is composed of a mobile and a web application. The intended users for the mobile application are the employees. In this platform, employees can submit pre-trip and reimbursement requests, scan receipts and monitor requests. Web application, on the other hand, is being used by the management to oversee pre-trip and reimbursement requests, modify and implement company policy, manage employee accounts, and generate reports.

1.1 Objective of the Study

This study aims to measure the effectiveness of change of implementing an automated reimbursement process of paying back employees by creating a system that utilizes Optical Character Recognition (OCR) which will allow small businesses to address expense reimbursement issues such as a lost receipt, incorrect receipt information, and multiple submission of single receipt and to prevent over-the-budget travels by creating a module that allows the management to implement company policies and allow employees to track their remaining allowable expense to make in real-time.

1.2 Scope of the Study

The system is composed of a mobile and web application. The intended for the mobile application are users with an employee account. Web applications, on the other hand, are used by users with management type of account. Management user accounts are also subdivided into two levels: executives and managers. Executives can perform a management task to all manager accounts while managers can only perform management tasks to employees under his specific department.

This study utilizes Optical Character Recognition in converting the scanned receipt and convert it into text which will be used as the expense information inputs in the mobile application. The images of the receipts scanned are also stored in the system database. In the case of the OCR malfunctions, users can manually input or edit the receipt details on the app. The mobile application allows employees to view the status of their reports and the history of reports that they have already been submitted. On the side of the web application, management can approve, approve with a comment, and reject reports pending for approval; the management can also generate a summary report of all the expenses made by employees.

This study allows the management to monitor and manage the company's travel budget. The system will check if the employees' expenses are in line with the pre-defined value stated in the company policy. The valid maximum allowable amount of expense can only be modified by the management. Trips can either be international or local and amounts specified in each category differ. The amount specified on this module only covers a day of the trip. In case the duration of the trip is more than a day, the amount will be multiplied by the days the employee will be out for the business-related trip. The web application includes the following modules (a) Login and Account Management, (b) Pre-trip and Reimbursement Approval, (c) Pre-Trip and Reimbursement Tracking, (d) Policy Management, (d) Auto-generated Report.

The system only covers travel in the Philippines and Southeast Asia. Receipts that can be scanned are only the ones printed in a paper and has the English language.

2. Literature Review

Corporate travel is part of the growth of client partnerships, organizational presence, and customer relationships. With too much money at stake on corporate travels, companies are capitalizing on the use of software solutions to their advantage. Based on the 2018 Expense Management Trends Report, U.S Companies spend billions of dollars when it comes to travel and entertainment which is a big part of company's budget. Survey is collected and analyzed from 546 CFO, Controllers and other finance professionals [1].

Some companies face problems like reducing costs and streamlining their processes as they grow. Increasing numbers of workers would need a more reliable system that can process loads of records simultaneously without collapsing. Outdated and manual expense management solutions may not be able to cope up with the surge in the increasing number of employees.

An automated expense management system would be beneficial for companies who want to take advantage of the technologies available today.

Integration of technology like Optical Character Recognition (OCR) to extract information from the receipts would be a great advantage for companies since everything is digital and can be stored in a single repository and the time to retrieve and time to store company information would be faster.

According to the Global Business Travel Association, in 2017 companies spent \$292 billion and a sudden rise of \$305 billion in 2018. GBTA has projected that the spending by these companies may rise to another 3.1% in 2019.

In a survey conducted by Certify, out of the 585 respondents, 37% came from the small business sectors composed of 100 or fewer employees. 46% of the organizations do not track the cost to process expense reports and 43% of them still manage their expense reports manually. For small businesses, only 47% have dedicated solution for expense management such as ERP or accounting package. 53% says that their biggest pain point is employees losing paper receipts or submitting reports without receipts. 43% of organizations take 8 days or more for the expense report to be submitted, approved, and reimbursed. Only 22% of the companies have done it in 1 to 3 days [2].

With these benefits, small business tends to switch to web-based compared to the middle and enterprise business. "Manual" Systems such as using excel spreadsheets, pen and paper can be reduced with the help of the automation.

To prevent expense reimbursement issues, the company should establish policies that will make reimbursement schemes difficult to commit for employees. Policies listing the valid types of expenses that can be reimbursed and their limitations should be publicized to all employees. During reimbursement, the organization should always require a detailed expense report which includes the original supporting documents for the reimbursement that include the date and time of business-related expense, mode of payment, and the purpose of the expense [3].

Digital image processing requires the use of computer algorithms to process images on digital files. It allows the application of a much wider variety of algorithms to the input data and can prevent problems such as noise build-up and signal distortion during processing.

Numerous external factors will adversely affect the quality of the pictures when they are taken such as low lighting, blurring, and insufficient resolution. Image pre-processing techniques are used to eliminate noise or boost image quality. Besides, since each picture has a background and foreground, techniques can either be used to highlight it as needed.

Successful image processing leads to a faster and more precise text analysis since unnecessary information has already been eliminated and reduced [4] [5] [6] [7].

An example of an image processing software is the Open-Source Computer Vision or simply, OpenCV. OpenCV is an open-source software library built to provide an infrastructure for computer vision applications and aims to promote the use of machine perception in commercial products and academic use. It contains a library collection of different algorithms of pre-defined functions helpful for image processing [4] [8].

There has been a huge influx of data over the past few years, especially in the form of digitization. As of 2017, an estimate of 90 percent of the world's data has been generated in just two years, at a rapid rate of 2.5 quintillion bytes per day. As a result, data collection and information processing methods have become more important. The information has historically been kept in the document format, physically. Nevertheless, recent developments in computing, data retrieval technologies (such as Big Data), and image processing led to a move to digitized content. The term "Document Image Analysis" (DIA) is used to refer to a collection of techniques that perform digital translation, text or image recognition, and a practical arrangement of content. One example of a DIA technique is Optical Character Recognition (OCR) [9].

Optical Character Recognition (OCR) is a technology that recognizes printed or written text within a digital image. OCR processes digital images by analyzing the characters, such as letters, numbers, and symbols. It can convert a hard copy of documents into soft copy documents which can be edited later [10].

The accuracy of the recognition results of OCR is highly dependent on the quality of the printed material being scanned. In a study made by some researchers from the University of Pennsylvania, out of the 2.7 million-word Faroese corpus 7.6% of the words contains an error. Because of this, manual post-correction checking should be implemented on the system and manual entry of data that was not recognized well can be a fallback plan [11] [12].

The traditional way of entering information using a keyboard to the computer is not always the best or not the most efficient way to perform such a process hence, automatic identification of characters can be used as an alternative way to enter information in the computer [13].

Moreover, in a study made by Shivanku Mahna et. al., introduced OCR to capture documents using a mobile phone camera than a bulky scanner is a more efficient and easier alternative. Processing of the captured images works efficiently when there are more text and lesser graphics. Pre-processing of images is done to improve accuracy, due to distortion and noises in the images can be seen when capturing using the digital camera than scanning [14].

The overall functionality of the OCR, given that the image can be any document that includes text. Figure 1 shows the step-by-step process of the construction of OCR.

- Scanning – the Android mobile camera is used to capture the document and convert it into a digital image.
- Segmentation – Regions of text is detected in where it differentiates the text from other graphics in the document.
- Pre-processing – noise is reduced made by the scanning process. During this process smoothing and normalization are done.
- Feature Extraction – it extracts symbols from the image and unnecessary attributes are ignored. Using the tesseract algorithm, the feature extraction is implemented.
- Recognition – identifying characters and recognized in words. Contributions to the congress are welcome from throughout the world.

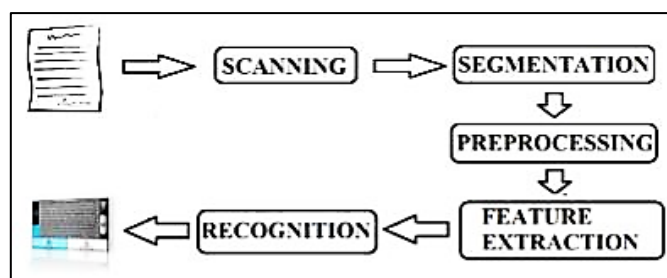


Fig. 1. Construction of OCR

The problem encountered is the accuracy of the system, where it depends on the quality of the captured document because of the noise present and the distortion. However, the system exceeds the 90% accuracy mark.

Every year, there are approximately 445 million business-related trips are being made. In terms of the availability of travel policy, 40% of businesses still don't have their travel policy and 60% of business travelers still don't understand the need to have a travel policy. 27% of those who have an existing policy say that their company's travel policy is ill managed [15].

3. System Design

To evaluate our approach, it has four different phases that focus on four different areas, namely, Idea Generation, Feature Development, Product Development, and Product Testing. The first phase includes the gathered and examined existing research and journals to identify what is the research problem and how to address it. During this phase, the technology to be used has been established. The second phase defines the system requirements to establish possible solutions in addressing the research problem. Issues about reimbursement that were identified during the idea generation phase were used as the basis for the solution. The third phase converts the system design into software instructions and code iterations using Java as the programming language for mobile and web applications. In integrating OCR to the system, OpenCV was used for image processing, and once captured, the Firebase Text Recognition will then extract the necessary details from the receipt and will serve as inputs for the system. The system is deployed using the Firebase Hosting so that it will run in the cloud and users will have an easier time accessing the system. The last phase

tests how the system works when each module is integrated. This also assesses the overall performance of the system and if it has met the system user requirements. A test case is used to test each component of the system and to also test the integration of each module.

- Account Management

There are two types of users in the system namely the employees and the management which have different access to the system. Employees cannot access the web application since it contains the approval of reports and budget allocation. Employees can only log in to the mobile application using the credentials created by the management.

- Pre-trip Module

The pre-trip module for the mobile is different from the web application. The mobile application is used for employees requesting a budget for their trip and necessary information should be filled up. The date and country should be filled up first to determine the allowable budget and duration of the trip. After filling up, the expense category and budget can now be added, and it will be requested for approval to the management. While the web application allows the management to monitor all reports regarding pre-trip; and approve or reject pre-approval in real-time.

- Reimbursement Module

In the reimbursement module, the employee can edit the report generated by the system. Once a report has been chosen, the employee can now add expenses to the report. When adding, the employee should scan the receipt using OCR and use it as report details. After scanning and extracting details, the user should check if the details on the app and on the receipt are tally; and if tally, the employee can save and proceed on the report.

Like the pre-trip module, the reimbursement module in the mobile is for the tracking of expenses made by the employee and for the receipt capture. This is where OCR will take place. A receipt can be stored on the mobile phone, or it can be captured right away. Cropping of the image makes it easier and data to be extracted are accurate. The extracted information can be edited when there is misspelled or wrong information. While for the web application it has the same functionality as the pre-trip module.

The scanned input of the employee will be read by the system and convert it into digitally editable text using OCR. Reimbursement report will be automatically generated by the system with details from the Pre-Trip Request. Employees can add as much expense he wants if the receipt scanned is valid. For every transaction or adding of expense, the system will refresh the values such as total expenses made and remaining allowable expense for the user to know the remaining budget for his trip. If the system fails to identify some receipt details, the employee can manually edit or enter it in the app.

- Policy Module

This module allows the management to modify reimbursement policies of the company and allot a certain budget to a specific expense category. The policy module is reflected when an employee is submitting his pre-approval request. The system will check if the request satisfies the budget allotted by the management.

- Status Notification Module

With the Status Notification module, employee users will be notified when their request has been approved or denied. The system will send a pop-up notification to the employee's smartphone. For the management, they will be notified if there are reports that need approval. The notification will be sent to their desktop. All actions made by the users are recorded and the other party will be notified right away.

As shown in figure 2, the employee users will be interacting with the interface provided by the mobile application, while the management is provided by the web application. All the process will be done in the cloud for the data to be sync. The system will have the Reimbursement Report, Preapproval Report, Report Notification, Budget Management, Policy Management, and Receipt Verification. The information will be sent thru mobile and web application through internet connection and OCR will be used for receipt scanning.

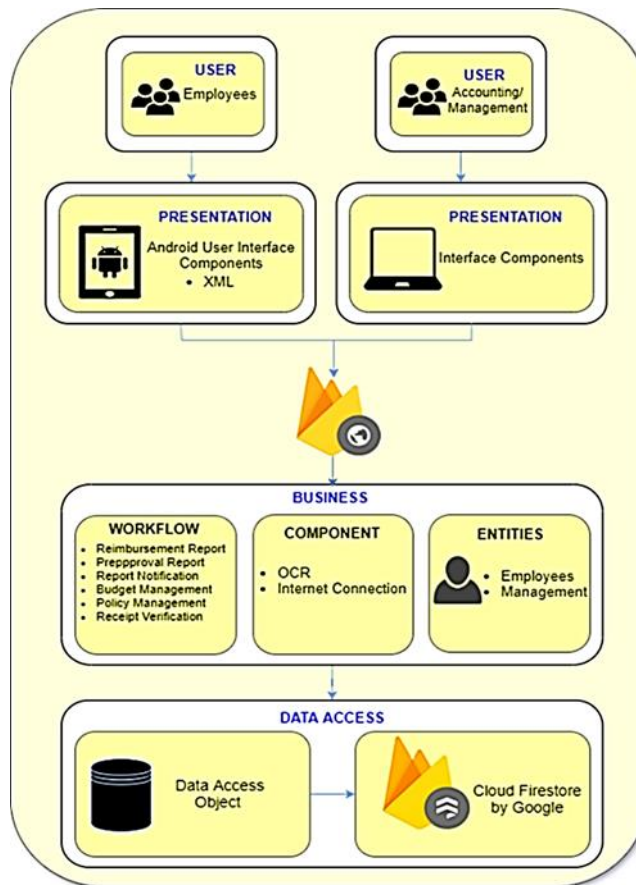


Fig. 2. Systems Architecture

4. Results and Discussion

This study used a Quasi-Experimental Research design. This research design is used to answer the research question in assessing measuring the effectiveness of change after implementing an automated expense reimbursement and budget management system that was created by the researchers which are iClaim.

A total of 10 randomly selected employees of a company participated in this study. 9 of them are regular employees and 1 is a manager. The 9 regular employees tested the mobile application, and the manager tested the web application.

This study uses a pretest-posttest survey to know the employee's opinion before and after using the system. The survey questionnaire is composed of 14 questions for the employees and another 14 for the management. Survey questionnaires generally seek an individual's assessment of situations specifically relevant to the objectives of the research study.

The data gathered in the Pretest served as the baseline in knowing if the treatment is effective or not. After the treatment, the respondents will undergo the Posttest survey with the same set of questions. The participants had to answer the Pretest Survey Questionnaire, use the mobile or web application, and answer the Posttest Survey Questionnaire.

4-point Likert Scale is used for the scoring system of the survey questionnaire. Questions can only be answered by Strongly Disagree (1), Disagree (2), Agree (3), and Strongly Agree (4). As stated above, a specific value is given in each option to know the total value, or score acquired by the respondent. Figure 11 shows the dataset and the inputs for the paired sample t-test. Each subject or variable is assessed twice in a paired sample t-test which results in pairs of observations.

Employee	Pretest	Posttest
1	27	49
2	26	48
3	28	50
4	27	50
5	26	48
6	34	48
7	28	46
8	29	46
9	30	49
10	26	50

Fig. 3. Data Set

To test the normality of the data set, the Shapiro-Wilk test was utilized. Based on the results, the significance value ($p = 0.154$), as shown in figure 4, of the differences between the related groups (Pretest and Posttest) is greater than the chosen alpha level ($\alpha = 0.05$). Because of this, normality can be assumed for this study's data set.

Tests of Normality						
Kolmogorov-Smirnov				Shapiro- Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Difference	0.304	10	0.009	0.886	10	0.154

Fig. 4. Shapiro-Wilk Normality test

The Paired Samples Statistics in Figure 5 shows that between the two means, the 10 respondents scored higher during the Posttest with a mean of 48.40 comparing to 28.10 mean scores during Pretest.

Paired Sample Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	28.1	10	2.47	0.781
	Posttest	48.4	10	1.506	0.476

Fig. 5. Paired Sample Statistics

As presented in figure 6, significant values like $t(9) = -20.289$ show that there is a significant difference between the two variables namely Pretest and Posttest.

95% Confidence Interval of the Difference								
		Std. Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	Sig (2- df tailed)
Pretest-								
Pair 1	Posttest	-20.3	3.164	1.001	-22.563	-18.037	-20.289	9 0

Fig. 6. Paired Samples test result

At a 95% confidence interval, the null hypothesis, H_0 , is rejected since the p-value is $8.001E-9$ and is less than 0.05 ($p < 0.05$) and because of this, the alternative hypothesis, H_1 , is accepted.

On the average, Pretest Scores were -20.300 lower than the Posttest Scores [95% CI $(-22.563, -18.037)$] after using the mobile or web application. This result indicates an improvement in the system thru the application of the proposed platform.

5. Conclusion & Recommendation

The automatic extraction of receipt information decreases the manual entry of inputs by the employees. Information like the date of purchase is checked by the system to know if the receipt scanned is within the time frame of the trip and if not, the receipt will be tagged as invalid, or the receipt information is incorrect. Another case of invalid receipt is when the serial number of the submitted receipt matches with a receipt previously submitted by another employee. A Pre-Approval module has also been implemented in the mobile application to foresee possible expenditures to be made by an employee during the trip. Remaining allowable expense and expenses incurred can be monitored and tracked using the Reimbursement module in the mobile application. The tracker automatically refreshes after every expense added into the report. The Policy module in the web application allows managers or executives to implement policies to avoid the overspending of employees.

To answer the research question of the effectiveness of change in implementing the system, the researchers used pretest-posttest survey questionnaires and measured the scores before and after the implementation. Based on the t-test results, it shows that there is a significant difference before and after the implementation of the system which indicates the proposed system did improve the target process.

For future research, it is recommended to enhance the OCR text recognition and extraction feature of the application. Additionally, the design of both mobile and web applications can also be enhanced. Additional features can also be added like booking of flights or accommodation and a messenger or chat feature within the application can be added for future developments. Subscription based model is further recommended as it may continue to grow the business and maintain customer retention over time, provide a real yet realistic solution to the demographic's specific set of problems, create a unique and relatable customer experience, establish a significant online presence through engaging marketing, and provide overall pleasant customer service. [16]

6. References

- [1] Certify Inc., "2018 Expense Management Trends Report: Annual T&E Outlook and Benchmarks," 2018. [Online]. Available: <https://www.certify.com/2018-Travel-ExpenseManagement-Trends-Report.aspx>. [Accessed 6 November 2019].
- [2] Certify Inc., "2019 Expense Management Trends Report: Annual T&E Outlook and Benchmarks," 2019. [Online]. Available: <https://www.certify.com/2019-Travel-ExpenseManagement-Trends-Report.aspx>. [Accessed 2020].
- [3] M.-J. Kranacher and R. Richard, *Forensic Accounting and Fraud Examination*, Hoboken, NJ: John Wiley & Sons, Inc., 2019.
- [4] R. Palekar, S. Parab, P. Dhruvil and V. Kamble, "Real-Time License Plate Detection Using," *International Conference on Communication and Signal Processing*, pp. 2111 - 2115, 2017 International Conference on Communication and Signal Processing.
- [5] A. Chakraborty, "Image Processing and Image Pattern Recognition," *2018 First International Conference on Artificial Intelligence for Industries*, pp. 122 - 123, 2018.
- [6] Y.-M. Su, K.-W. Huang and C.-S. Yang, "Image processing technology for text recognition," *2019 International Conference on Technologies and Applications of Artificial Intelligence*, 2019.
- [7] A. Suponenkovs, A. Sisojevs, G. Mosins, J. Kampars, K. Pinka, J. Grabis, A. Locmelis, and R. Taranovs, "Application of Image Recognition and Machine Learning Technologies for Payment Data Processing," *2017 5th IEEE Workshop on Advances in Information, Electronic and Electrical Engineering*, 2017.
- [8] "About," OpenCV, [Online]. Available: <https://opencv.org/about/>.
- [9] M. Madhuran and A. Parameswaran, "A Text Extraction Approach towards Document Image Organisation for the Android Platform," *2018 International Research Journal of Engineering and Technology*, pp. 1560 - 1565, 2018.
- [10] P. Christensson, "TechTerms," Sharpned Productions, 16 April 2018. [Online]. Available: <https://techterms.com/definition/ocr>. [Accessed 21 October 2019].
- [11] C. Richter, M. Wickes, D. Beser, and M. Marcus, "Lowresource Post Processing of Noisy OCR Output," *Eleventh International Conference on Language Resources and Evaluation*, pp. 2331-2339, 2018.

- [12] S. Schulz and J. Kuhn, "Multi-modular domain-tailored OCR post-correction," *2017 Conference on Empirical Methods in Natural Language Processing*, p. 2716–2726, 2017.
- [13] R. Adhvaryu, R. Parikh and K. Vora, "Design and Implementation of OCR to identify English Characters and Numbers," *International Journal of Scientific Research in Science, Engineering and Technology*, vol. 4, no. 2, pp. 5762, 2018.
- [14] S. Ch, S. Mahna, and N. Kashyap, "Optical Character Recognition on Handheld Devices," *International Journal of Computer Applications*, vol. 115, no. 22, pp. 10-13, 2015.
- [15] N. Gilbert, "93 Critical Business Travel Statistics: 2019 Spending & Concerns Analysis," *FinancesOnline*, 2019. [Online].
- [16] Blancaflor, E. and Julian, J., *KingsmanMNL: A Proposed Web Application Designed for Male Grooming Essentials Services*. In *2021 5th International Conference on E-Society, E-Education and E-Technology (ICSET 2021)*. Association for Computing Machinery, New York, NY, USA, 283–289. DOI:<https://doi.org/10.1145/3485768.3485793>, 2021.