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Procedia Computer Science 157 (2019) 596–604

Procedia Computer Science

www.elsevier.com/locate/procedia

4th International Conference on Computer Science and Computational Intelligence 2019 (ICCSCI), 12-13 September 2019

Mobile Financial Management Application using Google Cloud Vision API

Kurniawan Dwi Saputra[a], Della Anggi Rahmaastri[a], Karina Setiawan[a], Dewi Suryani[a], Yudy Purnama[a,*]

[a]*Computer Science Department, School of Computer Science, Bina Nusantara University, Jakarta, Indonesia 11480*

Abstract

Money is the main potential conflict in every individual life. Inability to understand financial concepts and risks may lead to wrong decision making then further worsen someone's financial condition. Therefore financial literacy became significant knowledge to have. This financial literacy should be supported by some mechanism to record, monitor, and control an individual financial activity. This study observed the potential value of an mobile-based application "Manage on Money (MoM)" to solve those problem. MoM has three main features for each of those problems. First, "Add Income" and "Add Expense" menu, which is implemented using Google Vision Cloud API Optical Character Recognition (OCR). This menu helps the user record their income and expenses. Second, "Buy or Bye" menu, which is utilizing 50/20/30 budgetting rule. This menu helps the user control their budget usage. Third, "Recurring Transaction" menu, which is implemented using OneSignal API. This menu helps the user monitor their regularly expense and notify them during the due date. Overall score of over than 3 out of 4 was given by the respondent as evaluation of Manage on Money performances and usefulness.

Peer-review under responsibility of the scientific committee of the 4th International Conference on Computer Science and Computational Intelligence 2019.

Keywords: Financial; Mobile; Android; Google Vision Cloud API; Optical Character Recognition; 50/20/30 Rule; Notification; OneSignal API;

1. Introduction

A surveys found that a surprising number of Americans are quite literally worried sick about money even they are considered financially secured [1]. One third of respondent, which mostly Americans couples stated that money is the main potential conflict in their life. Hence, financial literacy became significant knowledge to have. According to Organisation for Economic Co-operation and Development (OECD), financial literacy is knowledge and understanding of financial concepts and risks [2]. This concept and knowledge should be followed by such motivation and confidence

* Corresponding author. Tel.: +62 812 9069 7604
E-mail address: ypurnama@binus.edu

1877-0509
Peer-review under responsibility of the scientific committee of the 4th International Conference on Computer Science and Computational Intelligence 2019.
10.1016/j.procs.2019.09.019

to apply those knowledge and understanding in order to make effective decisions across a range of financial contexts. In the end, the main goal is to improve the financial well-being of individuals and society, and to enable participation in economic life.

In Indonesia, of 9680 repondents, only 29.66% is financially well literate [3]. Compared to the importance of financial literacy, this number is considerably low. This condition is worsen by very high level of wasteful lifestyle. Wasteful lifestyle can be depicted as spending money on wants, not needs. Other study indicated that wasteful lifestyle originated from the inner cycle of their community [4]. The community 'demanded' each individual to have what others had. This prolonged condition may lead to hedonism, a life style that considers the pleasure and enjoyment of life as the main goal in one's life [5].

Based on the survey and research presented, can be concluded that there are many Indonesians who do not have control over their financial condition. This has been proven by low financial literacy and high level of wasteful lifestyle. To overcome these problems, a certain method for recording, monitoring, and controlling financial activity is neccesary.

Financial recording tools was only pen and paper. However this method is no longer efficient because it is difficult to manually keep track of an individual daily expenses. High amount of papers required makes it difficult to organize the records. Therefore, a computerized system such as desktop, web, and mobile-based application can become solution. Nowadays most people use their mobile device to manage their daily life, starting from communication, entertainment, and even planner. Therefore, the usage of mobile devices will be further explored.

The main contribution of this research is to take the advantage of existing technology such as Google Cloud Vision API and OneSignal API, and combine them into a single mobile-based application named "Manage on Money (MoM)" to solve problems stated above, which are recording, monitoring, and controlling an individual financial activity. MoM has three main features: income and expenses recording, buying recommendation, and recurring transaction notification. This aplication will be developed in Android operating system. Android is chosen because it has a very broad future and opportunity to be developed further. At the time this publication was made, 93.52% of the Mobile Operating System Market Share in Indonesia was occupied by Android [6].

Further explanation will be detailed in the next chapter. Chapter 2 discussed about previous related works. Chapter 3 explained the details of each main features of MoM. Chapter 4 discussed the result and evaluation of MoM performance. Finally, chapter 5 concluded this research.

2. Related Works

Google Cloud Vision API allows development of applications that need machine learning support, especially in understanding images [7]. Vision API capable of remotely process the content of an image, in order to extract information from visual data, such as: image labeling, face and landmark detection, optical character recognition (OCR), and tagging of explicit content.

Several research has succesfully made using Cloud Vision API. Nurzam dan Luthfi succesfully made Javanese to Indonesian translator [8]. Meiliana et al. used Vision API to detect several landmark in Indonesia [9]. Shih-Hsin Chen succesfully implemented Cloud Vision API for content-Based Image Retrieval (CBIR) [10]. Combining Google Cloud Vision API and WordNet, this combination provide better precision than other method. WordNet fill up the semantic gap between the labels generated by Google Cloud Vision API and the image dataset. Mulfari implemented OCR capability of Cloud Vision API to developed assistive technology for people with disabilities, specifically for users who are blind or visually impaired [11]. They extracted text from images then vocalize it through an embedded text-to-spech software.

Refers to previous works mentioned, Google Cloud Vision API has been proven to provide one of reliable OCR tools. Therefore, its capability will be further explored in MoM development as an alternative input method for user to entry their income and expenses data by scanning their bills.

Notifications are one of the core features in mobile applications. Users may take immediate action or ignore them depending on the importance of a notification as well as their current context. Shirazi et al. conducted a large-scale assessment of mobile notifications [12]. They collected almost 200 million notifications generated on the mobile phones of more than 40,000 users. Overall users neglect notifications from system applications. Meanwhile users value notifications from messengers, other communication apps, and calendars. They also stated that notifications from apps that can be used for communication with others as well as calendars are rated significantly more important than notifica-

tions from all other categories. Notifications are considered important if they are about events or provide information about the users context or contacts.

Manage on Money notified user actions via mobile notifications. Especially when a recurring transaction approaching due date. OneSignal is a high volume and reliable push notification service for websites and mobile applications [13].

3. System Overview

Manage on Money (MoM) is an Android mobile application which aims to facilitate public society in recording, monitoring, and controlling their financial activity. MoM has three main features: income and expenses recording, buying recommendation, and recurring transaction notification as shown in the use case diagram in Figure 1.

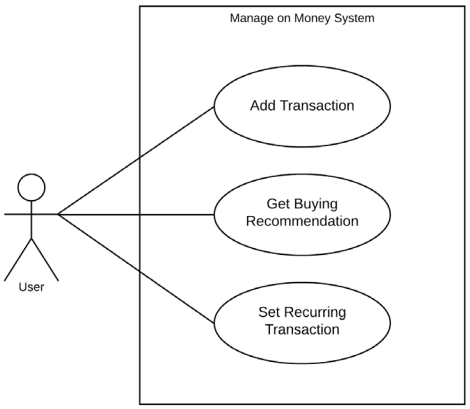


Fig. 1: Use Case Diagram of "Manage on Money" System

Each of the main features will be explained below. Figure 2a is the sidebar navigation of MoM. Meanwhile Figure 2b is the dashboard of MoM. Sumary of user's financial record will be shown in the dashboard.

3.1. "Add Income" and "Add Expense" Menu

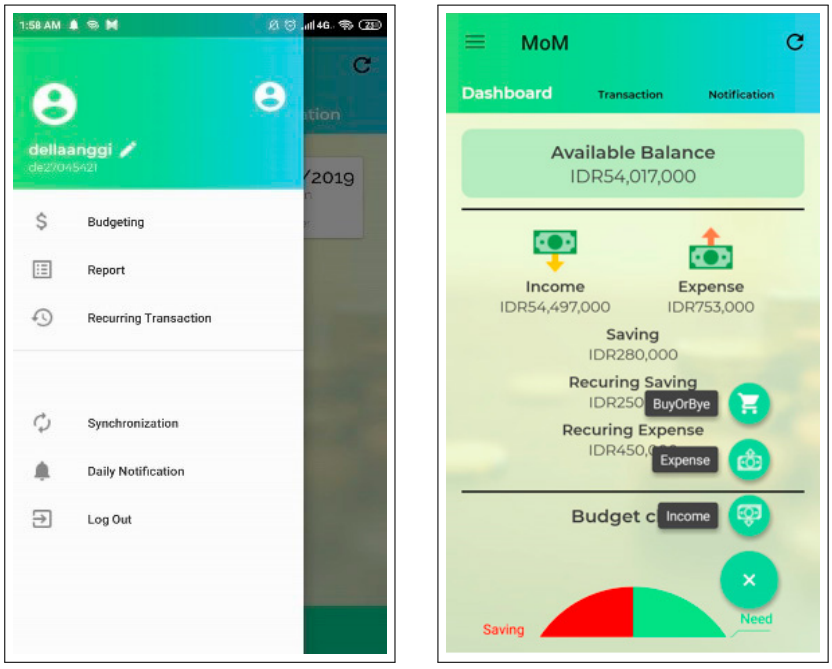
This menu is used by user to record their income and expenses. There are several input method to choose: (1) manual input by utilizing form in the user interface; (2) upload a receipt image; (3) scan a receipt. Method (2) and (3) utilizes Optical Character Recognition (OCR) of Google Cloud Vision API. The recognition process is happened real-time, therefore internet connection is a must. OCR processing happens in stages, as shown in Figure 3. This proccess is explained by Walker et al [14].

Using the OCR, the system will detect any value that contain text: "Total", "Change", "Discount", "Kembalian", or "Diskon". The value then will be added to the corresponding category, either income or expense. The user interfaces can be shown in Figure 4a and Figure 4b.

3.2. "Buy or Bye" Menu

Senator Elizabeth Warren popularized the 50/20/30 budget [15]. She stated that ideally after-tax income should be divided into spending 50% on needs and 30% on wants, while allocating 20% to savings. Needs are expense which is necessary for survival. Needs including but not limited to foods and drinks, shelter, and clothing. Wants are expense spent on that are not essential, such as entertainment and luxuries. Savings could be in the form of bank savings account, stock market, or proerties.

"Buy or Bye" menu was developed based on this rules. User can input the price of the item to be purchased and determine the category, either needs, wants, or savings. The system then will recommend buying the item if the user's current financial condition is still sufficient to buy the item and vice versa. After that, the user can choose to "Buy"



(a) Sidebar Navigation (b) Dashboard

Fig. 2: Screenshot of Sidebar Navigation and Dashboard

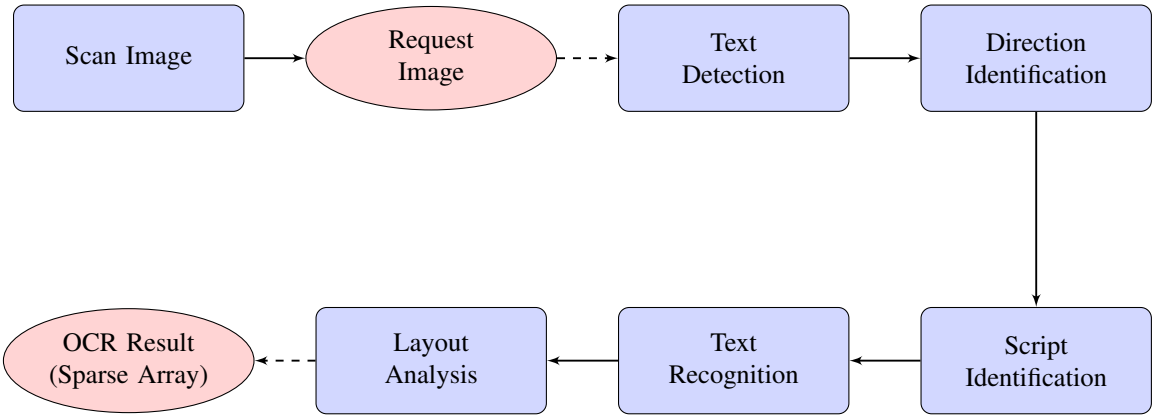
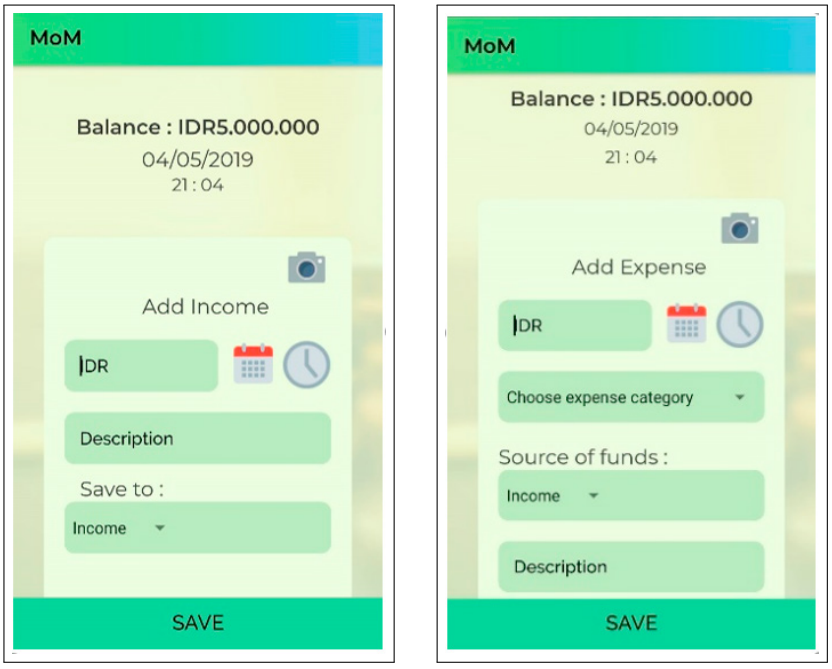


Fig. 3: Five stages of OCR Processing of Google Cloud Vision API [14]

and the system will include this into expense. Or, the user can choose “Bye” and cancel the input process. The user interfaces can be shown in Figure 5a and Figure 5b.

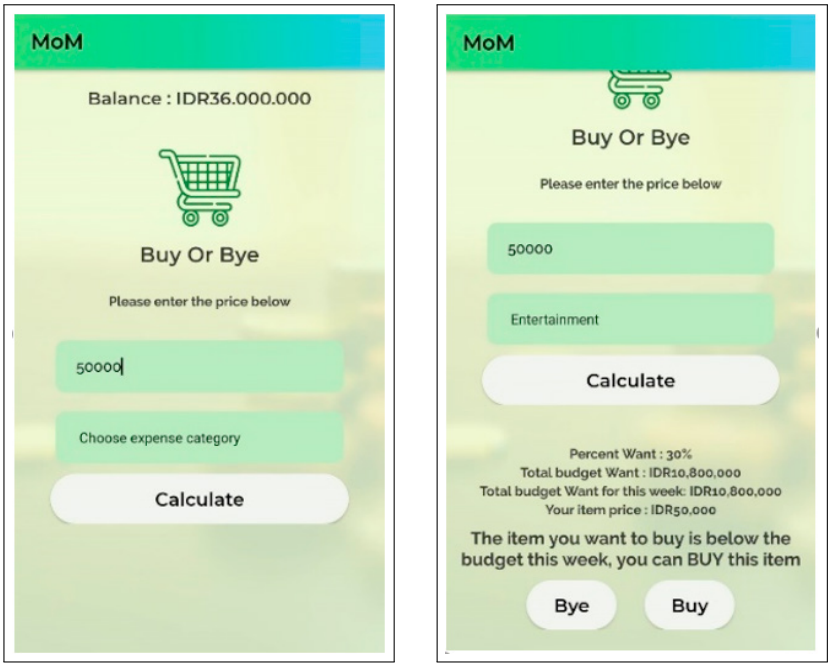
3.3. “Recurring Transaction” Menu

This menu is used by user to schedule a recurring transaction for a specific date and time that occur for a monthly period. Before the due time, the system will send the user a push notification to remind the user. The notification implements OneSignal API. The user still receives the notifiaction even the MoM is in the idle condition. The user interfaces can be shown in Figure 6.



(a) “Add Income” Input (b) “Add Expense” Input

Fig. 4: Screenshot of “Add Income” and “Add Expense” Menu



(a) “Buy or Bye” Input (b) “Buy or Bye” Recommendation

Fig. 5: Screenshot of “Buy or Bye” Menu

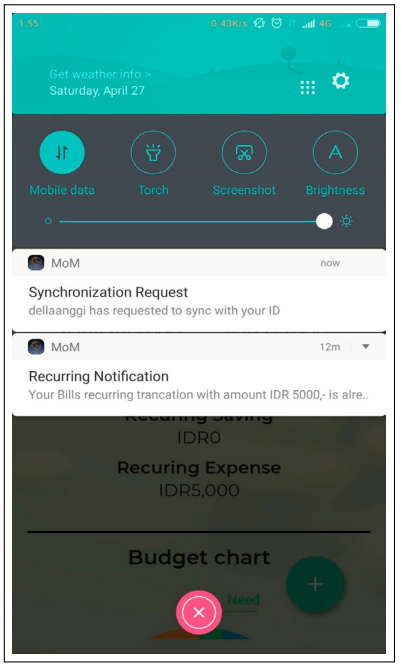


Fig. 6: Screenshot of Notification on Recurring Transaction

4. Evaluation

There are three types of evaluations carried out: (1) OCR accuracy of "Add Income" and "Add Expense" Menu; (2) black box testing of overall features; (3) user satisfaction through questionnaire. Below are details of each evaluation.

4.1. OCR Accuracy Evaluation

Receipts to be evaluated are separated based on three categories, they are:

1. Ink color, most receipt in Indonesia are either printed using black or blue ink.
2. Keyword, receipt that contains keyword "Total" and contains keyword "Change", "Discount", "Kembalian", or "Diskon".
3. Length, receipt whose length ≤15cm. and whose length > 15cm.

For each composition of each category, 60 receipt are being tested using the OCR. The accuracy of the OCR will be calculated using below formula:

$$accuracy = \frac{correct}{numberofreceipt} \times 100\% \quad (1)$$

where *correct* is number of successful OCR processes and *numberofreceipt* is number of receipt tested.

Table 1 shows the accuracy for each category for the receipt that only contains keyword "Total". Receipt with black ink whose length ≤ 15cm. has 100.00% accuracy. Receipt with black ink whose length > 15cm. has 96.67% accuracy. Receipt with blue ink whose length ≤ 15cm. has 60.00% accuracy. Receipt with blue ink whose length > 15cm. has 66.67% accuracy. Google Cloud Vision API OCR performance was very satisfying on identifying one keyword. The OCR works best in identifying black ink receipt, while the accuracy drop significantly on blue ink receipt.

Table 2 shows the accuracy for each category for the receipt that contains keyword "Change", "Discount", "Kembalian", or "Diskon". Receipt with black ink whose length ≤ 15cm. has 63.33% accuracy. Receipt with black ink whose length > 15cm. has 63.33% accuracy. Receipt with blue ink whose length ≤ 15cm. has 50.00% accuracy. Receipt with blue ink whose length > 15cm. has 50.00% accuracy. Google Cloud Vision API OCR performance drop

Table 1: Table of OCR Accuracy for Scanning Receipt Contains Keyword "Total"

	Black Ink		Blue Ink	
	Length ≤ 15cm	**Length > 15cm**	**Length ≤ 15cm**	**Length > 15cm**
Number of Receipt	60	60	60	60
Correct	60	58	36	40
Incorrect	0	2	24	20
Accuracy	100.00%	96.67%	60.00%	66.67%

significantly on identifying multiple keywords compared to identifying one keyword. The OCR still achieve better accuracy on identifying black ink receipt rather than blue ink receipt.

Table 2: Table of OCR Accuracy for Scanning Receipt Contains Keyword "Change", "Discount", "Kembalian", or "Diskon"

	Black Ink		Blue Ink	
	Length ≤ 15cm	**Length > 15cm**	**Length ≤ 15cm**	**Length > 15cm**
Number of Receipt	60	60	60	60
Correct	38	38	30	30
Incorrect	22	22	30	30
Accuracy	63.33%	63.33%	50.00%	50.00%

4.2. User Satisfaction

Black box testing used to test the functionality of overall features presented in the Manage on Money applications. One hundred respondents are chosen randomly to test the software. Respondent criteria are above seventeen years old, financially independent, and either married or not. Respondent can submit their satisfaction level through a likert style questionaire. Out of 100 respondents, there are 65 married couples. There are four main statements that respondent can respond with "strongly agree", "agree", "disagree", or "strongly disagree". Each response are weighted 4 ("strongly agree") to 1 ("disagree") for final score calculation. Below are the formula used to calculate the result:

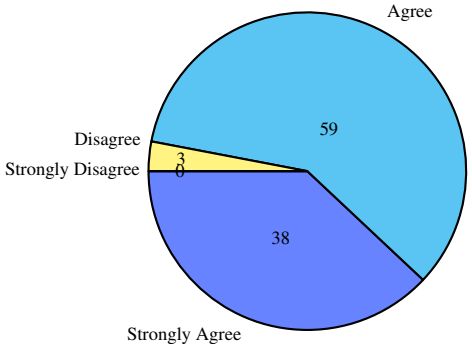
$$score = \frac{(w \times 4) + (x \times 3) + (y \times 2) + (z \times 1)}{numberofrespondent} \tag{2}$$

where w is number of respondent respond with "strongly agree", x is number of respondent respond with "agree", y is number of respondent respond with "disagree", z is number of respondent respond with "strongly disagree", and $numberofrespondent$ is number of respondent, which is 100. The following are the four main statements:

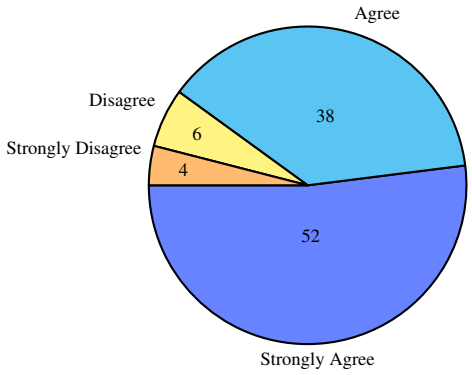
1. Manage on Money help user records their incomes and expenses.
2. Receipt scan feature help user input their incomes and expenses.
3. Buy or Bye feature helps user decision on purchasing certain items.
4. Recurring Transaction features help user monitor their recurring transaction.

Figure 7 and 8 display the result of the respondent's respond for each statement. Figure 7a shows that 38 respondents strongly agree, 59 respondents agree, and 3 respondents disagree that MoM help them records their incomes and expenses. Figure 7b shows that 52 respondents strongly agree, 38 respondents agree, 6 respondents disagree, and 4 respondents strongly disagree that receipt scan feature help user input their incomes and expenses. Figure 8a shows that 39 respondents strongly agree, 45 respondents agree, 11 respondents disagree, and 5 respondents strongly disagree that Receipt scan feature help user input their incomes and expenses. Figure 8b shows that 32 respondents strongly agree, 56 respondents agree, 4 respondents disagree, and 8 respondents strongly disagree that Receipt scan feature help user input their incomes and expenses.

Based on achieved result, final score for user satisfaction can be calculated. Table 3 shows the result summary and overall score for each statement given. The score has a range between 1 and 4, with 1 being strongly disagree and 4 are strongly agree. Overall, respondent agree to the statement given, shown by score of over than 3 for each statement.

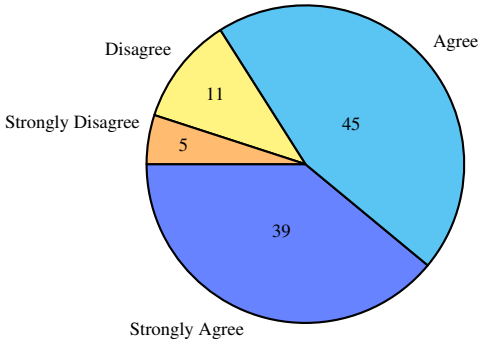


(a) Respondent Result for Statement 1

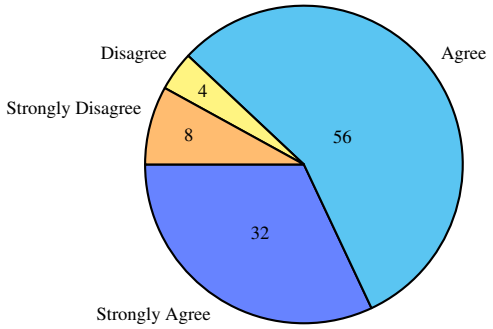


(b) Respondent Result for Statement 2

Fig. 7: Pie Chart Showing Respondent Response For Statement 1 and 2



(a) Respondent Result for Statement 3



(b) Respondent Result for Statement 4

Fig. 8: Pie Chart Showing Respondent Response For Statement 3 and 4

Table 3: Summary and Overall Score For Each Respondent Response

Statement	Strongly Agree	Agree	Disagree	Strongly Disagree	Overall Score (0-4)
Manage on money help user records their incomes and expenses	38	59	3	0	**3.35**
Receipt scan feature help user input their incomes and expenses	52	38	6	4	**3.38**
Buy or Bye feature helps user decision on purchasing certain items	39	45	11	5	**3.18**
Recurring Transaction features help user monitor their recurring transaction	32	56	4	8	**3.12**

5. Conclusion

This study observed the potential value of an mobile-based application “Manage on Money (MoM)” to solve three main financial problem, which is recording, monitoring, and controlling an individual financial activity. MoM has

three main features to overcome each of those problem. “Add Income” and “Add Expense” menu help user record their income and expenses. User can input the data manually or by scanning a receipt. Google Cloud Vision API was implemented as OCR solution. This method performs best for identifying single specific keyword on black ink receipt as discussed in chapter 4. Overall score 3.35 was given by respondents in the event that MoM helped them records their incomes and expenses. Meanwhile overall score 3.38 was given for receipt scan feature that help user to input their incomes and expenses.

Buy or Bye feature helps user controlling their expenses, by helping them calculate and distribut their budget into needs, wants, and savings. The system provide reccomendation whenever the user buying certain item based on the user’s current financial condition. Overall score 3.18 was given by the respondents for the helpfullnes of this feature.

Monitoring transaction would be easier by utilizing Recurring Transaction menu. MoM helps user to schedule their periodical expense and send a push notification before the due time. This notification is built around OneSignal API. User will still receive the notification even the application is in idle state. Overall score 3.12 was given by the respondents for the helpfullnes of this feature.

References

1. Schwartz, S.. Most americans, rich or not, stressed about money: Surveys. CNBC: https://www.cnbc.com/2015/08/03/most-americans-rich-or-not-stressed-about-money-surveys.html; 2015. Accessed: February 2019.
2. *PISA 2015 Assessment and Analytical Framework*. Organisation for Economic Co-operation and Development; 2017. doi:\bibinfo{doi}{https://doi.org/https://doi.org/10.1787/9789264281820-en}. URL https://www.oecd-ilibrary.org/content/publication/9789264281820-en.
3. Keuangan, O.J.. Survei nasional literasi dan inklusi keuangan 2016. OJK: https://www.ojk.go.id/id/berita-dan-kegiatan/siaran-pers/Documents/Pages/Siaran-Pers-OJK-Indeks-Literasi-dan-Inklusi-Keuangan-Meningkat\/17.01.23%20Tayangan%20%20Presscon%20%20nett.compressed.pdf; 2017. Accessed: February 2019.
4. Pergiwati, G.E.. Konformitas dan perilaku konsumtif pada mahasiswi fakultas ilmu sosial dan ilmu politik dengan status sosial ekonomi ke bawah di universitas mulawarman.(versi elektronik). *Jurnal Psikoborneo* 2016;**4**(3):494–506.
5. Trimartati, N.. Studi kasus tentang gaya hidup hedonisme mahasiswa bimbingan dan konseling angkatan 2011 universitas ahmad dahlan. *PSIKOPEDAGOGIA Jurnal Bimbingan dan Konseling* 2014;**3**:20. doi:\bibinfo{doi}{10.12928/psikopedagogia.v3i1.4462}.
6. Statcounter, . Mobile operating system market share indonesia — statcounter global stats. Statcounter: http://gs.statcounter.com/os-market-share/mobile/indonesia; 2018. Accessed: October 2018.
7. Statcounter, . Cloud vision api documentation — cloud vision api documentation — google cloud. Google Cloud: https://cloud.google.com/vision/docs/; 2018. Accessed: October 2018.
8. Nurzam, F.D., Luthfi, E.T.. Implementation of real-time scanner java language text with mobile vision android based. In: *2018 International Conference on Information and Communications Technology (ICOIACT)*. IEEE; 2018, p. 724–729.
9. Irmanti, D., Hidayat, M.R., Amalina, N.V., Suryani, D., et al. Mobile smart travelling application for indonesia tourism. *Procedia computer science* 2017;**116**:556–563.
10. Chen, S.H., Chen, Y.H.. A content-based image retrieval method based on the google cloud vision api and wordnet. In: *Asian Conference on Intelligent Information and Database Systems*. Springer; 2017, p. 651–662.
11. Mulfari, D., Celesti, A., Fazio, M., Villari, M., Puliafito, A.. Using google cloud vision in assistive technology scenarios. In: *2016 IEEE Symposium on Computers and Communication (ISCC)*. IEEE; 2016, p. 214–219.
12. Shirazi, A.S., Henze, N., Dingler, T., Pielot, M., Weber, D., Schmidt, A.. Large-scale assessment of mobile notifications. In: *CHI*; vol. 14. 2014, p. 3055–3064.
13. OneSignal, . Onesignal api. OneSignal API: https://documentation.onesignal.com/docs/onesignal-api; 2018. Accessed: October 2018.
14. Walker, J., Fujii, Y., Popat, A.C.. A web-based ocr service for documents. In: *Proceedings of the 13th IAPR International Workshop on Document Analysis Systems (DAS), Vienna, Austria*. 2018, .
15. Warren, E., Tyagi, A.. *All Your Worth: The Ultimate Lifetime Money Plan*. Free Press; 2005. ISBN 9780743269872. URL https://books.google.co.id/books?id=cr5EAQAAIAAJ.