Personal Financial Planner: A Mobile Application that Implementing Forward Chaining Technique for Notification Mechanism

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Abstract— **The emergence of mobile devices and the rapid growth of mobile application development, many mobile users utilize the used of application Play Store (e.g. Google Play Store). They tend to do everything using their mobile device as it can be used at anytime and anywhere. This generates the idea of developing a mobile financial planner application due to most individuals have poor money management skill. They tend to spend much money on short term things like cars, clothing and accessories. These cause burdens to the individuals as they do not have enough money to bear with all the expenses. So, this financial planning helps the individuals to balance the income and the expenses by prioritizing their needs and desires. This paper applies the forward chaining that can determine the suggestion and tips according to their money environment. Hence, this paper focuses on providing a decision mechanism solution using forward chaining technique that able to further improve the individuals' money management and decision making skill.**

Keywords— decision mechanism; financial planner; mobile application

I. INTRODUCTION

A personal financial planner application can be defined as a program that assist user in examining the income and expenses thus comparing the actual income received with the target saving in order to satisfy user needs [11].The issue of financial planner arises when some people cannot manage their budget in a good manner. This led to poor money management skill and affects their cost of living and life.

The evolution of personal financial planner starts with pencil and paper. The traditional method is not suit to people because it is difficult to keep track their daily expenses and take a lot of time in finding the document. Then it moves to desktop and web-based application.

Today, the most essential part of human life communication tool is mobile devices. This includes smart phones, tablet PCs, personal digital assistants and others. This is due to the portable and light in weight of the mobile devices. As mobile device is rich in various services and application, the mobile users can download the application provided by Play Store. Once install, the users can run the application through their mobile device.

The desire of making personal financial planner in micro browser application is high since there are approximately 1.3 million of Android smart phones that are activated daily [1]. Once the smart phones are activated, the user will check the phone almost 150 times daily with an average of once in every 6.5 minutes [1]. Due to this, a personal financial planner is developed in mobile device together with artificial intelligence technique.

Towards artificial intelligence system, the proposed decision mechanism applies forward chaining inference technique. This technique is applied in the budget calculation and tips module. The proposed approach will alert the money usage to the application user.

The rest of the paper is organized as follows. Section II reviews some of the preliminaries work which includes inference introduction technique. Section III presents the proposed decision mechanism using forward chaining technique and the final section concludes the paper with future works.

II. PRELIMENARIES

A. Expert System

There are several definitions of expert system defined by several researchers. According to Negnevitsky [12], an expert system can be defined as a computer program that is capable to carry out level of human skill in a minor problem area. Durkin [10] stated that expert system is a computer program that is designed to represent the problem-solving skills by a human expert. Meanwhile, Ignizio [9] explained that it is a model and procedure related to a particular domain in which the level of expertise can be compared with the expertise of a human specialist. As claimed by to Giarrantano and Riley [8], an expert system is a computer system that able to imitate the ability of a human expert.

In terms of rule-based expert system, it is a production model based on the idea of human expert knowledge in solving a specific problem [12]. Therefore, according to Negnevitsky [12], Sasmito et al. [5] and Cawsey[2], the components of a rule-based expert system consists of the knowledge base, the database, the inference engine, the explanation facilities and the user interface. The knowledge base contains a set of rule produced based on the useful knowledge of a domain. The database is a set of facts used to match against the rule that stored in a knowledge base. The inference engine executes the reasoning whereby the expert system reaches a conclusion. The explanation facilities enable the user to ask the expert system about the conclusion. Finally, the user interface is a mechanism used by user to communicate with an expert system.

B. Inference Introduction

The domain knowledge of a rule-based expert system is represented using a set of IF-THEN production rules and data is represented by a set of facts about the current situation [2, 12]. The inference engine processes the rules stored in a knowledge base and facts stored in a database via match-fire procedure.

A rule may contain has one consequence and multiple antecedents joined by the keyword AND. A simple chaining inference technique can be described by considering the following rules.

Rule 1: IF <antecedent> THEN <consequent>
Rule 2: IF <antecedent 1> AND <antecedent 2>
THEN <consequent>

There are two types of inference techniques in executing the rules: forward chaining (data directed) and backward chaining (goal directed) [10]. This paper only focuses on the forward chaining technique.

C. Forward Chaining Inference

Forward chaining is a data driven reasoning [2, 5, 12, 14]. The reasoning starts from the existing data and continue forward with the data. When the topmost rule is executed, it infers new fact in the database. Any rule can only be executed once. The cycle will stop when there are no other rules that can be fired [2, 5, 12]. The rule represents the possible action to take when a specific condition can control the facts [2].
An example of forward chaining rule set is as follows:

Rule 1: IF (Today Ali is fasting)
THEN (Ali is hungry)

Rule 2: IF (Today Ali is fasting)
THEN (Ali is tired)

Rule 3: IF (Ali is tired) AND (Ali is hungry)
THEN (Ali is not happy)

Rule 4: IF (Ali is tired) OR (Ali has a fever)
THEN (Ali is sleepy)

From the example above, assuming the first fact in the database is (Today Ali is fasting) then, two new facts will be drawn which is (Ali is hungry) and (Ali is tired) where rule 1 and rule 2 is being executed. These new facts satisfy rule 3. After executing rule 3 it fires (Ali is not happy). Rule 4 will not being executed since there is no fact that satisfies the rule. This is how facts are being chained. It moves from a single fact to match a rule then move forward to find a conclusion [2, 5, 12].

The forward chaining technique is applied because some information needs to be gathered and then inferring from it whatever can be inferred [12]. Besides, according to Bacchus and Ady [4], forward chaining is suitable to be a very productive basis to implement high-performance planner. In addition, forward chaining also ease in modifying data, for example updating a data, adding a data or deleting a data [2,5].

D. Related Work

In recent works, numerous applications have applied forward chaining technique. Doherty and Kvarnström [13] used forward chaining approach in their application. They have proved that forward chaining is the most suitable technique to be used in temporal action logic planner. Moreover, Bacchus and Ady [4] has used forward chaining approach in their application. The result shows that it increases the performance and solves the problem in planning with resources and concurrency.

Besides, forward chaining is also being used as a basis for a planner, forward chaining also helps to diagnose pest and disease of red onion and chili plant simulation [5]. Forward chaining is also being used for e-Government application where it helps the user to interact with administration to identify in an efficient way the relevant information that the user's need [3].

E. Existing Solution

Nowadays, many mobile personal financial planners have been developed but most of them do not have notification features. Most of them will alert the user when they reach the limit. Based on Duffy [6], Mint mobile personal financial planner application offers the user to categorize transaction, notification on bills and smart alert. Mint do have smart alert but it only notify the user when they reach the limit of credit card and when they spend more than the user usual spend. However, Mint is only limited to one user and do not show pending transaction. Another high rated mobile financial planner application is Pageonce [7]. Pageonce offers user with recommendation on how to pay bills and remind the user with all upcoming bills.

Generally, all mobile financial planner application offers notification, but the only difference between the proposed project and the existing solution is the proposed project offers the user with a notification about the daily money balance. It will notify the user three times. The first alert is when the user reaches 50% of daily expenses. The second alert is when the user reaches 80% of daily expenses and last is when the user used up all their daily expenses. It does not only notified the user but also provide the user with tips and balance of money that they can used to achieve their goal. TABLE I show the summarization of existing solution.

TABLE I: Summary of Existing Solution

Features	Pageonce	Mints	Proposed Project
Enable & disable password	/	-	-
Account history	-	/	/
Over budget alert	-	/	/
Score for good financial habit	-	-	/
Wish list	-	-	/
Reliability	/	/	/
Simple layout	-	/	/
Suggestions & tips	/	-	/
Technique	-	-	Forward chaining

III. THE PROPOSED APPROACH

A. Formula Metrics

The formula metrics are used to calculate the actual user budget. The formula metrics consist of three formulas: Total balance, target saving and limit of daily expenses. The formulas are as follow.

Total Balance ($t_{Balance}$) can be defined as the deduction of total income received with total daily expenses used by the user.

$$t_{Balance} = t_{Income} - t_{Expenses} \quad (1)$$

Where:

t_{Income} = Total of income between the dates
$t_{Expenses}$ = Total of expenses between the dates

Target saving (t_{Saving}) is the goal of total saving desired by the user.

$$t_{Saving} = uip * t_{Income} \quad (2)$$

Where:

uip = User input (Percentage)
t_{Income} = Amount of money received at first

Limit of daily expenses (D_{Limit}) can be defined as the subtraction of income with target saving and then the result is divided with the timeframe inserted by the user.

$$D_{Limit} = (t_{Income} - t_{Saving})/Timeframe \quad (3)$$

Where:

t_{Saving} = Targeted Saving
t_{Income} = Total of income
Timeframe = The duration between start and end date

B. Forward Chaining Process in Budget Calculaion and Tips Module

This section presents the process involved in budget calculation and tips module. The structure of this module that applied forward chaining technique is illustrated in Fig. 1:

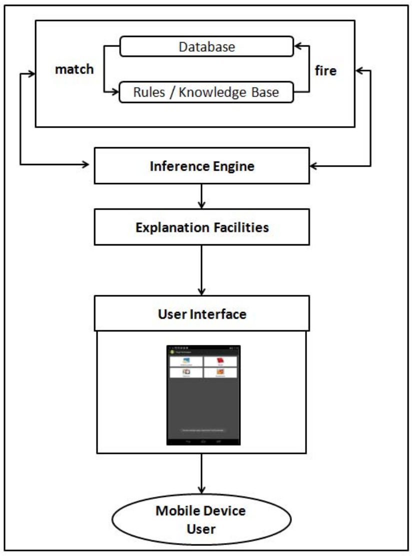

Fig.1: Structure of budget calculation and tips module

Based on Fig. 1, the knowledge base consists set of rules where the database consist a set of facts. The rules are conditions that control the facts which represented in the IF-THEN statement. This application used rule-based reasoning which it will resolve the issues systematically and sequentially. It fires conclusion based on the patterned condition. This application used one set of rules that contains three rules. TABLE II show the rule set of budget calculation and tips module.

TABLE II: Rule Set

If	Then
$\frac{Total\ Expenses}{Daily\ limit} > 1$	Display "You have used all your quota for today. Spend More? You'll Over budget."
$\frac{Total\ Expenses}{Daily\ limit} > 0.8$	Display "Still on track.You can use only RMx. Try to compare prices of things you want to buy."
$\frac{Total\ Expenses}{Daily\ limit} > 0.5$	Display "Still on track.You can use only RMx. Buy only necessary things."

TABLE II shows that there are three rules to be satisfy. Once the fact satisfied the rule, it will notify the user about the financial condition whether the user is on budget or over the budget. The rule set is also being illustrated in a hierarchy view as in Fig. 2.

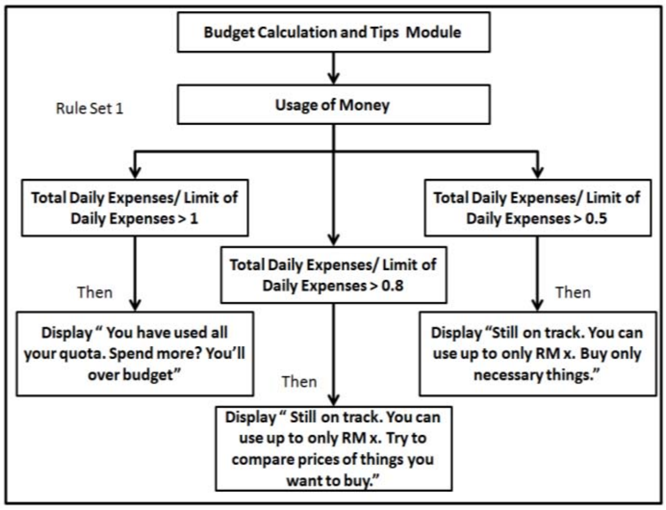

Fig.2: Hierarchy view of the rule set

Fig. 2 shows the usage of money that will be calculated by the financial planner application. If the value satisfy one of the rule, then a notification will be fired. The usage of money is calculated by using a formula which is $t_{dExpenses}/D_{limit.}$ This will result with a value between 0 and 1. For example if the usage is 0.6, the user has satisfy the rule and a notification will pop up with a message "Still on track. You can use only RMx. Buy only necessary things".

Fig. 3 shows how the inference process works. It shows that the first fact from the working memory will determine the possible rules to be fired in which the fact will shift to knowledge base to find a suitable rule to be executed. If a suitable rule is found, the rule will be executed. If there is another suitable rule to be executed then it will pass the new fact to the working memory. Otherwise, it will draw a conclusion based on the rule that has been executed. If no rule found in the knowledge base, no conclusion will be drawn.

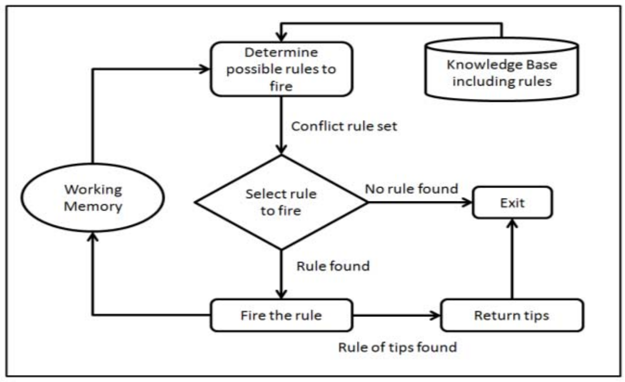

Fig.3: Structure of how inference process works

IV. Experimental Result

This section presents the achieved result of the proposed approach. The structure of the mobile financial planner application using forward chaining inference technique is illustrated in Fig. 4.

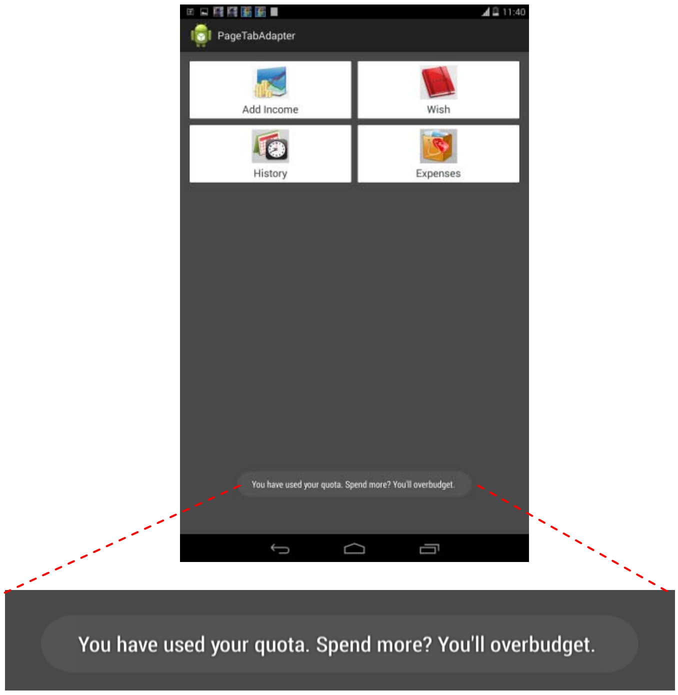

Fig.4: The Notification Interface

By using Java programming language and array list, a mobile financial planner that implement forward chaining has been developed. The application will notify the user if the user has exceeded his/her budget limit. This shows that the forward chaining technique is successfully implemented in this application.

V. CONCLUSION

This paper proposed forward chaining technique for mobile financial planner that can be used among mobile device users. The purpose of this paper is achieved by providing decision mechanism using forward chaining inference technique. This suggests that the proposed solution can be applied in a rule based expert system environment.

However, the proposed solution is only catered for forward chaining techniques. For future work, other techniques like backward chaining or combination of both forward and backward chaining can be applied. Furthermore, fuzzy logic technique can also be applied in order to enhance the proposed approach.

The proposed solution can improve user's money management skill and improve their decision making through the implementation of artificial intelligence technique. Finally, this paper enables the mobile device users to use financial planner application at anytime and anywhere.

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