

# A Design of Multi-Criteria Recommender System Architecture for Mobile Banking Business in Thailand

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## Abstract

*Mobile banking has played an important role in Thai business world. Business utilizes existing wireless network provided by local cellular network operators to save transaction processing overhead. There are three main communication channels in implementing IT support. One tries to utilize the SMS in order to run the business, other applies data connection available providers, such as EDGE or GPRS, bank services are requested and responded via SOA implementation. To increase the value for banking services, we introduce a recommendation system by applying a multi-criteria recommendation algorithm. Design of the underlying architecture will encompass this recommendation system to support existing mobile banking process.*

**Keyword:** multi-criteria recommender system, SOA, EDGE/GPRS, mobile banking.

## 1. Introduction

Mobile banking has been introduced around the world [4] for some time. Thailand is no exception. Popular three communication channels are SMS (Short Message Service), EDGE/GPRS (Enhanced Data Rate for Global Evolution/General Packet Radio Service), and SOA (Service-Oriented Architecture). For banking service in Thailand, SMS and EDGE/GPRS involve participation between cellular network providers and mobile phone clients. For SOA, most developers implement a wide array of web services for communicating between cellular network providers and bank servers.

In mobile banking service domain, a number of services may not be seen by a user. Fortunately, one research endeavor has introduced various techniques to assist in deciding item selection process, presently known as a recommendation system. Recent innovative development has led to more meticulous techniques predominantly called "Multiple Criteria" which has been used in many e-business domains,

e.g., <http://movies.yahoo.com>. The recommendation principally concerns preference expressions on multiple criteria suggesting an item or service. The strength of this technique lies in its capability to recommend unseen items in large item spaces, thereby users are introduced to the designated domain of banking services. This will lead to value increase in mobile banking business in the sense that the never-seen services previously regarded as no profit venture will have more chance to reach potential users. Search time for service will also be reduced. Numerous efforts on incorporation of banking service into mobile network framework by the recommender system [1] or specific platform restaurant mobile recommender system [6] are underway. The model is dubbed "A Hybrid Recommendation Architecture for Mobile Commerce System."

In this paper, we suggest two multi-criteria recommendation techniques which employ different approaches for web-based movie multiple criteria recommender system [2]. They propose multiple-aspects and adaptive user preference representation, together with how to utilize the multiple preference data in producing accurate recommendation. Unfortunately for mobile applications, it is not suitable to let the users express their preference directly as the case in [2]. Proper profiling technique should be implemented to collect behavioral data derived from user-specified preference based on a profiling technique proposed in [3].

The proposed design of mobile recommender system rests principally on refining the model described in [1]. Some operational framework on how to combine and fine tune different methods adopted from [2] and [3] are furnished to supplement the reference architecture.

The rest of this paper is organized as follows. Theoretical recommendation process is elucidated in Section 2. Section 3 describes the proposed mobile recommender system architecture. Future enhancement and conclusion are given in Section 4, and 5, respectively.

## 2. Multiple criteria recommendation algorithm

Recommender systems, especially for multiple-criteria consideration, were introduced in many domains of products and services. Effectiveness of the systems attested to many applications such as e-commerce [5], restaurant [6], learning quality approach [7], and course [8], as some of the techniques were presented in [9].

Multi-criteria recommendation can be performed in three steps according to [2], i.e., neighbor formation, score estimation, and recommendation. These three steps are exemplified to describe procedural technicality of each step.

Generally, it is important to first know the characteristic of products or services to be explored by the recommender system. In [2, 3], the domain of products are primarily movie related, where user's preference can be expressed via web-based rating based on a set of movie criteria. Such a procedure is not suitable for the mobile phone context. Under such setting, a service is treated as an item. Combination of methods in [2] and [3] furnishes a viable configuration.

In order to make the rating-based multi-criteria recommendation possible for mobile banking services, some procedural details described in [2] must be compensated by a technique given in [3], as follows.

### 2.1 Neighbor formation

A multi-criteria user profile which is the summary of user's preference must be introduced. According to [2, 3], the multi-criteria user profile can be described by a vector. Let  $up(a) = (e_1, e_2, \dots, e_n)$  be an  $n$ -element user profile that belongs to the user  $a$ , and the element  $e_i$  is an element in the user profile representing the  $i^{\text{th}}$  criteria.

Computations of the profile involve profiling comparison technique [3] in the context of mobile banking service under mobile commerce environment. One type of profile introduced [3] is the movie profile which can be thought of as a service profile vector. Let  $sp(s) = (c_1, c_2, \dots, c_n)$  be an  $n$ -element service profile that belongs to the service  $s$ , and the element  $c_i$  is a numerical value toward the  $i^{\text{th}}$  criteria. The  $c_i$  can be different for each criterion, and this depends on the characteristics of the criteria. For example, if a criterion for a bank service is the service fee, numerical values for this criterion might be denoted by discrete values, i.e., 0, 1, and 2, representing "cheap", "reasonable", and "expensive", respectively.

The last input that plays a very important role in producing the user profile is the rating score that a user assessed toward a particular service. Moreover,

the score might not be just capable of expressing preference of user, but also expressing the level of familiarity or friendliness. Unfortunately, in the mobile context, the user might not prefer or available to participate. So we suggest a way to address this situation. The recommender system can be performed based on the above meanings to recommend a service that might be useful and easy to get familiar by a user. The score can be obtained from the frequency of accessing the  $i^{\text{th}}$  service for user  $a$ , denoted by  $r_{i,a}$ .

User  $a$ 's profile can be determined using the following equation

$$up(a) = \frac{\sum_{i \in S} r_{i,a} \times sp(i)}{|S|}.$$

where  $S$  represents the set of services that user  $a$  has selected. After the user profiles for all bank services are prepared, the system will try to find a set of neighbors that is similar to user  $a$ 's characteristics. This can be done by measuring dissimilarity (or similarity) between multivariate user profile vectors. One well known measurement that has been used for this proposed scheme is the Euclidean distance. Finally, after the dissimilarity measurement has been done, the system will be able to determine the set of similar users by produce descending order of users according to their dissimilarity value toward a user  $a$ .

### 2.2 Score prediction

Realizing on the applied MCDM prediction technique used in [2], the system will then form a set of similar users that already rated for a particular service. Their profile criteria elements, together with related element weights, are used to estimate the score for that service.

### 2.3 Recommendation

Last of all, the system will recommend top- $n$  items that has high estimated score to the user  $a$ .

## 3. Mobile reference architecture design

A design architecture on mobile hybrid recommendation system has been proposed [1]. Unfortunately, it is not suitable for recommender system inclusion to existing mobile networks in Thailand. Actually, from the mobile hybrid recommendation architecture, there are four agents working together, namely, Profile Management Agent, Customer Agent, Interface Format Agent, and Recommendation Agent. In this work, we introduce one additional agent to make the architecture applicable for Thailand situation. It is Bank Service Agent. The reference architecture is depicted in Figure 1.

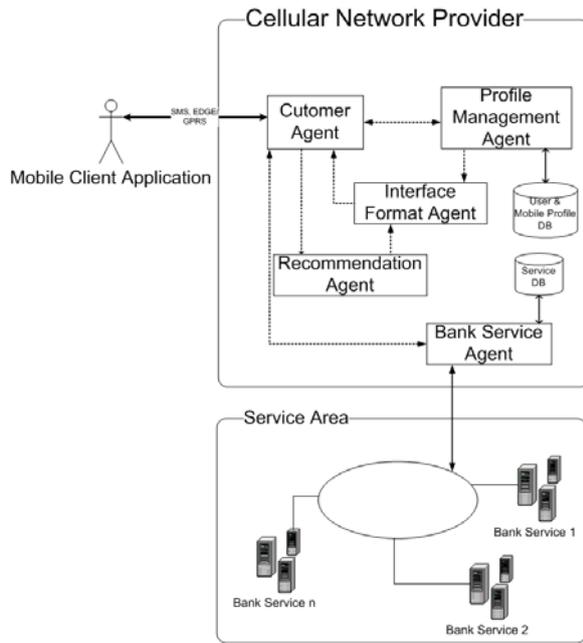


Figure 1. The Mobile Multi-Criteria Recommendation Architecture

### 3.1 Customer Agent

The Customer Agent is responsible for communicating with users via SMS and/or EDGE/GPRS to process general bank transactions and retrieving recommendation results, working with the Profile Management Agent to manage user profiles, receiving the formatted recommendation results to be sent to users, respectively. In the scope of cellular network providers, we use the dotted arrow to represent the internal user-defined SOA message communicated with the mobile connection process, banking services, and recommendation processes.

### 3.2 Profile Management Agent

This Agent is capable of processing the user profile update, creating a user profile for a new member, and searching for a needed user profile. The Agent also processes general database management commands, manages the profile of user's mobile phone for the Interface Format Agent to arrange in a proper recommendation format for each specific type of mobile phone.

### 3.3 Recommendation Agent

This is the flexible part because any types of recommendation modules can be put here. Additional recommendation methodologies can be added to process the set of recommendations independently aggregated by a hybrid recommendation module [1].

In our case, the multiple criteria recommendation module can be uniquely put here.

### 3.4 Interface Format Agent

This agent will incorporate with the profile management agent to support appropriate recommendation format for each mobile client operating system, realizing on each mobile profile and its specifications.

### 3.5 Bank Service Agent

The agent which is already embedded to the existing mobile banking service system has two important responsibilities. First, it must incorporate with the banking service server to process all necessary bank transactions via the external SOA messages represented by the arrow. Second, it increments the frequency of accessing various banking services. This is accomplished by a database containing all banking services registered with the cellular network providers.

### 3.6 Architecture adjustment

One aspect that has not been stated in [1] is the mobile client application which receives data from SMS and/or EDGE/GPRS as inputs. If there are server agents who provide distinct output formats, there must also be corresponding client applications to accommodate those output formats for user display.

According to the designed architecture, when a user intends to use a service without the right services, it is helpful to let other experienced users recommend suitable services to the requesting user.

The adjustment proceeds to send the request to the customer agent. The customer agent extracts the identifiable key from the request and sends the key to obtain the active user profile from the profile management agent. The user profile will then be sent to the recommendation agent and supplied to the multi-criteria recommendation algorithm embedded in the recommendation agent. After the recommendation result is prepared as a list of banking services, it will be sent for formatting by the interface format agent. The interface format agent will require the mobile device profile from the profile management agent to process such a list properly for each mobile hardware platform. The formatted result is sent to the customer agent. Finally, as the front-end agent, the customer agent consecutively sends the formatted result to the mobile client. In a usual situation, these processes will be skipped to allow the requests passing through the bank service agent who participates with external farm of banking service servers to process general bank transactions.

From Figure 1, when a cellular network provider has more banking services to offer from participating banks, or more recommendation techniques, the architecture can be modified to accommodate such enhancement.

#### 4. Future work

The proposed mobile multi-criteria recommendation architecture is somewhat inflexible for distributed work flow to reach wider clients or alliance banking services. As data are dispersed among SOA repositories, the resulting recommendation must be versatile and transparent to make the users feel “more decision criteria means wider service selections and reach” impressions. The issues of data warehouse and mining to arrive at satisfactory recommendation are a tall order for future mobile recommender systems to fulfill.

#### 5. Conclusion

We present a design for a theoretically viable recommendation methodology which is suitable for mobile banking service domain. The reference architecture permits naive users to choose an unfamiliar mobile banking service without disturbing normal banking service transactions. The choice recommended by the proposed system is based on multi-criteria that entails as close to users’ satisfaction as possible. Implementing the proposed architecture and performing experimental activities cannot be achieved, unless authorization for accessing both banking service systems and cellular networks are open for researchers since they are commissioned services. Fortunately, the accuracy of recommendation technique is independent from the implemented architecture. Besides, the proposed algorithm has already been proved successful in other domains, especially in the web-based movie recommendation [2] when comparing to current available methods. The adjusted part (Profiling Technique) may not be affected for any unexercised experiments if the change is taken care of in every candidate methodology. In offering a powerful recommender system for domestic mobile banking business, we envision that broader mobile-based applications will proliferate not only the banking business, but also other industries which profoundly intertwine and affect our daily lives as a whole.

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