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**Tuzhilin Smith and Chen Huong**

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# Context Aware Recommender System for Online Grocery Markets in Indonesia

**[*1]Tuzhilin Smith & Chen Huong[2]**

**[1]Indonesian Computer University**

**[2]Bandung Institute of Technology**

**[*]Corresponding Author's Email: Tuzhilin@ICU.ac.id**

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**Abstract**

Creating superior customer experience seems to be one of the central objectives in today's retailing environments. Retailers around the globe have embraced the concept of customer experience management, with many incorporating the notion into their mission statements. It is necessary to establish an online platform that helps customers search products, compare prices and indicate their location. The primary step is classifying and examining some influencing factors for online purchases, so examining those factors that influence consumers 'behavior via the internet is vital. Information retrieval techniques have matured with time and search engines have done a great job in indexing online content. A recommender system aims to provide users with personalized online product or service recommendations to handle the increasing online information overload problem. The goal of personalization is to provide users with what they want or need without requiring them to ask for it explicitly. This is a literature based review study. To facilitate development of the system a high quality, instructive review of current trends is conducted, not only of the theoretical research results but more importantly of the practical developments in recommender systems. This paper reviews up-to-date application developments of recommender systems and clusters their applications. It systematically examines the reported recommender systems through four dimensions: recommendation methods (such as CF), recommender systems software (such as BizSeeker), real-world application domains (such as e-business) and application platforms (such as mobile-based platforms).

Key words: *Context Aware Recommender System, Online Grocery Markets, Indonesia*

### 1.1 Introduction

Availability of immense amount of online information makes it difficult for users to find their desired products and at the same time compare prices that suit their budget constraints in a reasonable time. Recommender systems solves this problem by searching through a dynamically generated large volume of information to provide content and services based on user's personal taste and preferences. However, many research findings believed that beyond user-item ratings, enhancing the recommendation process by incorporating contextual information, such as location, time and price helps to generate accurate recommendations and these are called Context-Aware Recommender Systems (CARS) (Isinkaye, Folajimi, & Ojokoh, 2015).

Given profile of user and a target item, the task of recommender systems is to predict users' rating for that item that reflects the degree of his/her preference towards the item. Particularly, the task of a recommender system is to estimate the rating function: R: User × Item → Ratings that maps user-item pairs to an ordered set of rating values (Adomavicius & Tuzhilin, 2011). However, in providing the most relevant items to users, the classic recommender systems center their recommendation decision by relying on user profiles that reflect their personal preference and taste but ignore the importance of understanding the situation in which users consume the items called context. In other words, user preferences for items are a function of items themselves as well as a function of the context in which items are being considered.

According to Dey, Abowd and Salber (2001), context is any information that characterizes the situation of an entity. Such entity might be a place, person, or object that is considered essential to the interaction between a system and the user. Here, the context considers every aspect of the time, location, activity and preferences of each of the entities. Incorporating relevant contextual information when generating or providing recommendations improve the accuracy of prediction and efficiency of the recommendation. A type of recommender system that utilizes contextual information to adopt its recommendations to users' contextual situations is known as context-aware (Gao et al., 2013). A context-aware recommendation system labels each action of the user with an appropriate context and effectively adopts the system output to the user in that given context.

Various recommender approaches that boosted with contextual information have been developed for several application domains to enhance recommendation results making use of domain-specific context variables selected based on those applications. To mention some, a context-aware recommender system is proposed by (Panniello et al 2009) that suggest context-based relevant movies based on a technique called Markov random walk in which the movie actors, genre and ratings are taken as contextual information for the experiment. Hyung et al. (2013) developed a context-based recommender system that suggests music based on textual inputs. The authors applied latent semantic analysis and probabilistic latent semantic analysis for the recommendation process. Kothari et al. (2015), proposed a context-based trip advising recommender system by utilizing both context dependent and context independent user preferences data by integrating Support Vector Machine (SVM) classifier model to the recommendation process. They argue that their reason to integrate this classifier model into their proposed contextual recommender system was that SVM has performed consistently well in amplifying the accuracy of the recommendations in maximum domains and has worked towards reducing the errors.

Tang, Tsai and Wu (2015) state that there are lots of people online around the world, and each of them represent possible customer of stores which offer online sale. While there are a lot of them, it is essential to know what they really need and want from the product. The primary step is classifying and examining some influencing factors for online purchases, so examining those factors that influence consumers 'behavior via the internet is vital. In Web 2.0 era, the Internet has played a more and more important role in people's daily life. It has made the online shopping a common thing, beside, the consumers can also express their opinions conveniently on the website, including the quality, the price, and the style of the product, the service of the website and the online sellers and the delivery speed. The research shows that the potential online consumers may refer to other consumers' comments and recommendation when they are about to shop (Chen & Li 2009).

In a context-aware recommender system, relevant contextual information's are collected to generate a context-aware user profile for the prediction tasks. Asabere, (2013) asserted that most traditional recommender systems such as Collaborative Filtering (CF) and Content-Based Filtering (CBF) generate recommendations by using two main attributes, namely; users and items i.e. recommendations are generated based on a user having an interest or preference of a particular item resource. Context such as location, time, activity, physical conditions, and social interaction are very important and can be used in addition to users and items to generate trustworthy and accurate recommendation. Location and time context for examples are important in mobile computing recommendations, due to the fact that a user may require a recommendation at a particular location in a particular time. According Seifu and Mogalla (2016) context recommender systems enhances recommendation process by incorporating contextual. It is believed that the continuously improved context-aware recommender systems can greatly help users find proper items based on their contextual settings without much effort in the era of Big Data.

Marketplace is the one of business sectors that has the great potential growth in Indonesia. some Indonesian society is still often shop offline. Based on survey data on Indonesian people who shop for groceries, 63% still choose to shop offline and 36% state that convenience is the most important factor regardless of online and offline. Marketplace also has limitations which do not have staff who can help customers like in offline stores (Faizin & Surjandari, 2020). Customers can get complete information and get convenience at purchasing experience through assistance from staff. The marketplace also has difficulty managing large number of products in a product catalogue. These limits can be overcome using features such as search and directory, but that not efficient because requires extra effort from the customer.

### 1. 2 Statement of the Problem

Consumers spend a lot of time and money by visiting different shopping centers searching for particular products. In the process time is wasted and further, consumers are not able to establish the best affordable prices for the products. It's thus very important to develop a recommender system where a consumer can search for a particular product across various retail shops and be able to compare their prices, establish location and availability of the product.

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## 2.0 Literature Review and Recommender system modeling

### 2.1 Functional Architecture of Recommender Systems

A recommender system consists of cyclic functioning procedures that are divided in the following four steps: Data collection, data filtering, Rank the recommended items and Presentation of data. By the execution of the above-mentioned procedural steps a recommender system aims at two tasks. Firstly, the production of recommendations and secondly to use the users feedback after the delivery of the recommendations to them, so the process can be repeated and produce new recommendations as it presented in Figure 1.

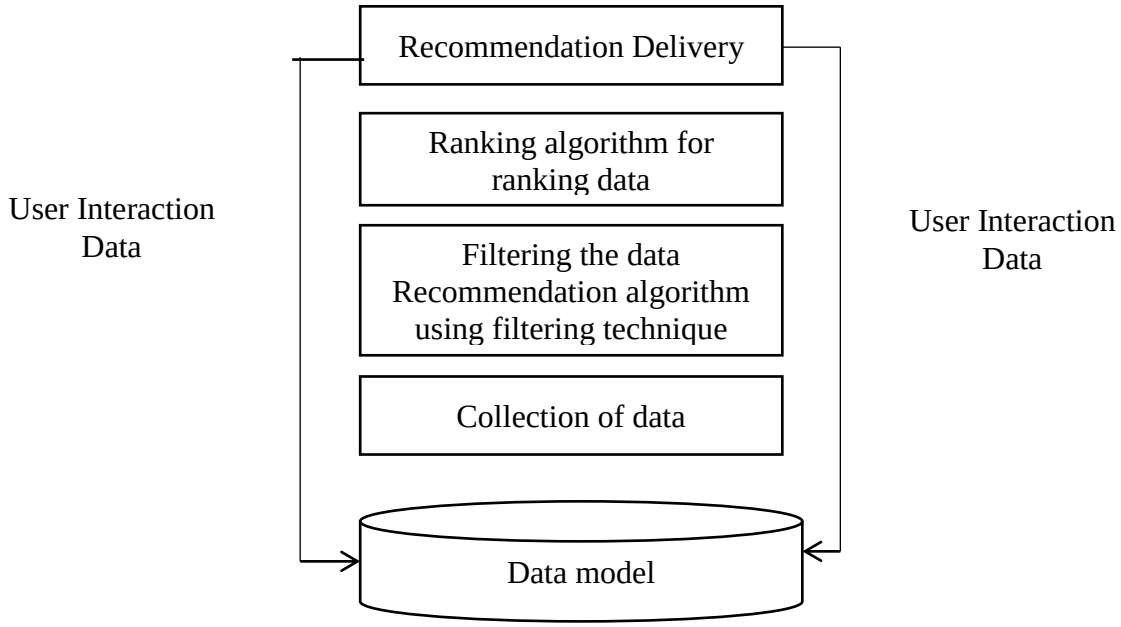


**Figure 1 Functional RS Architecture**

**Collection of data** - The collection of data is directly correlated to the data model that is used within a software application. The data is usually defined based on the overall design of a software application and based on the contextual information that a software application collects and processed into further computations. The data model usually depends on the domain that a recommender system is built for and the methods of storage and representation of the data (e.g. relational databases or semantic web representation methods).

**Recommendation filtering techniques** - As mentioned above the recommendation filtering techniques depend on the type of data that a RS is processing and the type of recommendations it plans to produce. The recommendation filtering techniques are divided in three categories according to the type of data they use for the computation of recommendations as well as the computational algorithm methods they use. The three categories are the Content-based Filtering (CBF), the Collaborative Filtering (CF) and the Hybrid Filtering (HF) techniques.

**Ranking Algorithms and Representation of recommendations** - The collection of data and its parsing through the recommendation filtering techniques generate a set of recommendations that fulfill the rules that a recommender system has to take into account during the computations. The next and final step that a RS has to complete is to present the generated set of recommendations to the final recipients, the users. Recommendations must be presented to the users ranked. The ranking of the recommendations is based on the preferences of each user and their personal interests. A recommendation is considered successful when the highest in priority recommendation offered to a user is closer to her interests and when this recommendation is actually accepted by the user.

### 2.2 Framework of Context-Aware Recommender Systems

The general framework of a typical context-aware recommender system is depicted in Figure 1.2 In this framework, firstly, users rating data as well as his/her context information are collected. Then, it is imperative to combine these two data's and generate either by adopting a hierarchical or a multidimensional rating model which captures the user-item interactions and the contextual information. Based on this rating model, the recommendation module is built to predict user interests and recommend related items. All these processes are elaborated as follows.

Data collection phase is the fundamental of the entire framework of context-aware recommender systems that mainly fall into two categories: user-item data and context data. The user-item data collection is related to collecting information regarding the preferences (e.g., ratings) of users for the items the system wishes to recommend. On the other hand, the context data collection is simply about capturing the contextual information of the users while expressing their preferences. Furthermore, the context data collection phase is categorized into Context Acquisition, Context Relevancy and Selection and Context Incorporation processes.

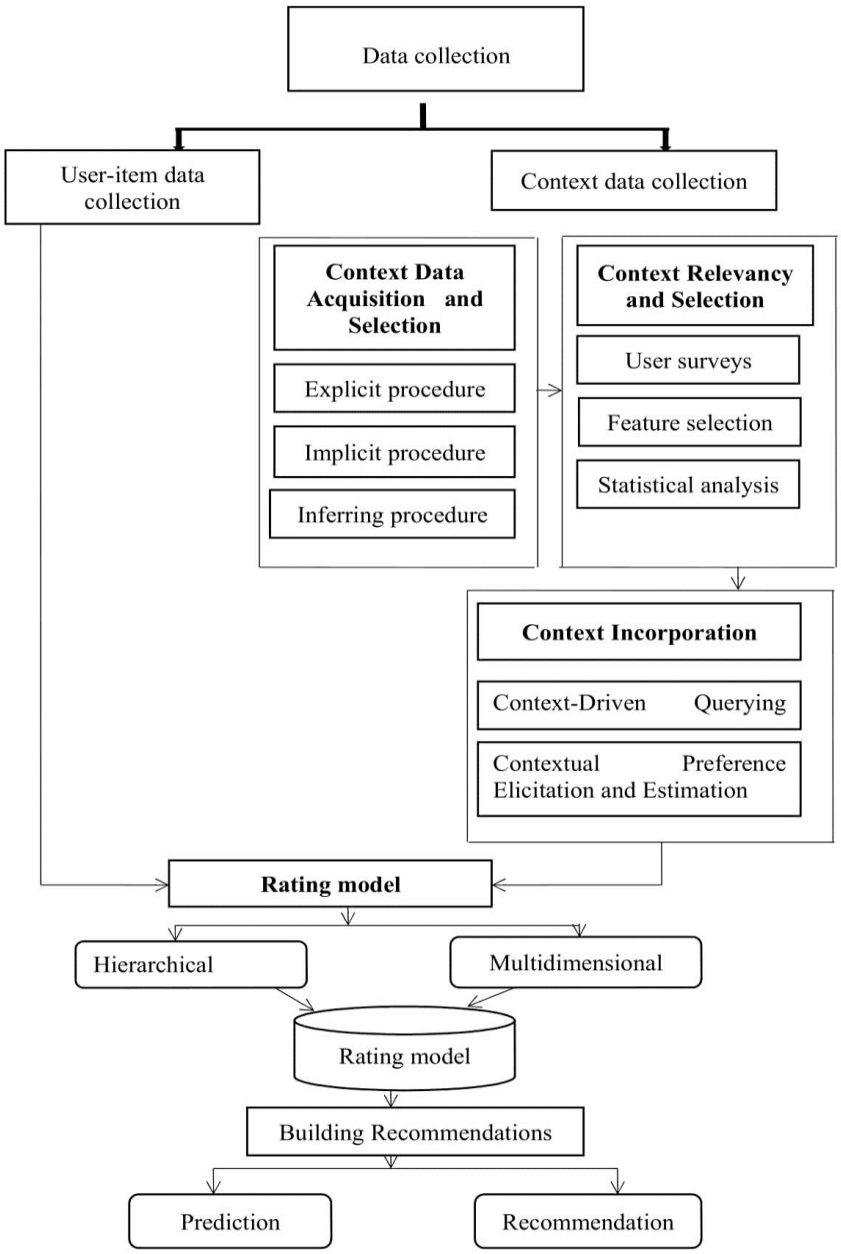


**Figure 2 Framework of Context Recommender Systems (CARS)**

In a context-aware recommender system, relevant contextual information's are collected to generate a context-aware user profile for the prediction tasks. The contextual user profiling is a new paradigm of user profiling, formally proposed by Adomavicus et al. (2011) that emerged from context-aware recommendation systems to address the limitations of the traditional user profiling techniques which focus only on the interests of users and how much they express it. The authors researched approaches where such traditional user/ item paradigm was extended to support additional dimensions capturing the context in which recommendations are made. Accordingly, context-aware profiling techniques consider a multidimensional approach to accommodate the user, his/her preferences and the context where user expresses such interests/preferences and this is represented as $R$: $User \times Items \times Context \rightarrow Rating$ where R is the rating function, *User* and *Items* are the domains of the user and items respectively, and *Context* specifies the contextual information that defines the

user and the item domains. In this paper, the authors gathered the common contextual information's utilized for context-aware recommender system and they divided them into the following categories.

**User Context** This category of contextual information represents the user's profile, location, their demography, current activity, emotions and the people nearby. **Physical Context** is the second category of contextual information that represents the time, position, and activity of the user. When the system performs the recommendation, the physical context also includes the weather, light, and temperature information's of the surroundings. **Social Context** This is the third category of contextual information that refers to interactions wherein people react to events differently, depending on their immediate situation. The social context information provides contents such as the presence and role of other people around the user, and whether the user is alone or in a group when using the recommender system.

## 3.0 Methodology

This paper relied much on literature review approach. The application of recommender systems was studied by reviewing empirical studies and conclusions by scholars. Conclusions and recommendations were based on past empirical findings of other studies.

## 4.0 Conclusion

When recommendation systems are applied to grocery stores, the sparsity of evaluation values can be a problem. Two major recommendations are made. Two-step recommendation is composed of product category recommendation by using a recommendation algorithm and product item recommendation by heuristic decision of store manager. The results show that recommendation according to the reconstructed evaluation value by singular value decomposition (SVD) is appropriate for direct recommendation and user-based collaborative filtering is appropriate for two step recommendation

## 5.0 Recommendation

It is argued in this study that consumer choices that include budget, location, time and product availability influence online shopping. Hence, the results of this study may be of use to the mobile applications developers providing apps services that may use the recommendations aimed at improving on consumer purchases. In that regard, it is important that a consumer can just log in online through a web based recommender system, choose a supermarket with better pricing, nearness and with varieties and go to shop there instead of moving from one to another. Affordability and availability of the product also matter much to the consumer. It is therefore important to consider these features when developing web based recommender system.

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