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An Intelligent Recommendation System Framework for Student Relationship Management

Kanokwan Kongsakun, Chun Che Fung, Sirilak Borirug and Wudhijaya philuek

Abstract—In order to enhance student satisfaction, many services have been provided in order to meet student needs. A recommendation system is a significant service which can be used to assist students in several ways. This paper proposes a conceptual framework of an Intelligent Recommendation System in order to support Student Relationship Management (SRM) for a Thai private university. This article proposed the system architecture of an Intelligent Recommendation System (IRS) which aims to assist students to choose an appropriate course for their studies. Moreover, this study intends to compare different data mining techniques in various recommendation systems and to determine appropriate algorithms for the proposed electronic Intelligent Recommendation System (IRS). The IRS also aims to support Student Relationship Management (SRM) in the university. The IRS has been designed using data mining and artificial intelligent techniques such as clustering, association rule and classification.

Keywords— Intelligent Recommendation System, Student Relationship Management, Customer Relationship, Management, Data Mining, Fuzzy Logic, Rough Set.

I. INTRODUCTION

In order to meet the challenges of producing graduates ready for the job market and to excel in the higher education sector, many universities in Thailand are providing various student services in order to support student learning, enhance student satisfaction and to improve student performance. With limited resources and increasing competition for students in the education sector, higher education institutes are focusing on efforts to increase the rate of student retention and completion. One of the important aspects is the enrolment process during such time a student has to select or receive recommendations for courses or majors that are most suitable for the student. In addition, a university's performance is also increasingly being used to measure its quality and "reputation" [2]. An aspect of such measurement is based on factors that affect a student's satisfaction. For instance, Gatfield [3] has concluded that it is significant for higher education institutes to concentrate on the issue of quality, through accreditation processes and various aspects of quality services from the students' perspectives.

Another aspect of student services is counselling. Archer and Cooper [1] confirmed that provision of counselling services is an important factor contributing to students' academic success. In addition, Urata and Takano [4] stated that the essence of the student counselling should include advices on career guidance, identification of learning strategies, handling of inter-personal relation, along with self understanding of the mind and body. It can be said that a key aspect of student services is to provide counselling on course guidance as this will assist the students in their decision and future university experience. Many students choose particular courses of study just because of perceived job opportunities. However, issues may arise if a student is not interested in the career, or if the course is not suitably matched with the student's capability[5]. In the tertiary education sector, teaching staff may have insufficient time to counsel the students due to workload and there are inadequate tools to support them. Hence, it is desirable that some forms of intelligent recommendation tools could be developed to assist students in their enrolment. This forms the motivation of this research.

In order to establish successful and long lasting relationship between students and university, Student Relationship Management (SRM) is a means to promote and nurture such relationship [6]. The idea of SRM has

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been evolved from the concept of the Customer Relationship Management (CRM), which aims to solicit the customers and gain their royalty [7]. Thus, understanding the needs of students will contribute towards gaining student satisfaction and achieve the goals of SRM.

The remaining sections of this paper are organized as follows. The next section discusses SRM in universities. Section III discusses various Data Mining (DM) techniques used by Recommendation Systems. Section IV then focuses on the proposed framework, which presents the main idea and the research methodology. This paper concludes with discussions on the work to be undertaken and future development.

II. STUDENT RELATIONSHIP MANAGEMENT IN UNIVERSITY

Nowadays, the problem of student retention in higher education could be attributed to low student satisfaction, student transfer and drop-outs [8]. This issue leads to lose of students and revenue, and increasing cost of replacement. On the other hand, it was found that the quality and convenience of support services are other factors that influence students to change educational institutes [9]. Consequently, the concept of SRM has been implemented in various universities so as to assist the improvement of the quality of learning processes and student activities.

Definitions of SRM have been adopted from CRM which focuses on the customers and aims to establish effective competition and new strategy in order to improve the performance of a firm [10]. In the case of SRM, the education sector is considered. Although there have been many research focusing on CRM, few research studies have focused on SRM. In addition, the technological supports are still inadequate to sustain SRM in universities. For instance, a SRM system's architecture has been proposed so as to support the SRM concepts and techniques that assist the university's Business Intelligent System. This project provided a tool to aid the tertiary student for the decision-making process. The SRM strategy also provided the institution with SRM practices, including the planned activities to be developed for the students, as well other relevant participants. The study was verified that the technological support to the SRM concepts and practices were insufficient at the time of writing [6].

In the context of educational institutes, the students may be considered having a role as "customers" (although it is arguable that whether this is acceptable from education perspectives) and the objective of Student Relationship Management is to increase their satisfaction and loyalty for the benefits of the institute. SRM may be defined under a similar view as CRM and aims at developing and maintaining a close relationship between the institute and the students by supporting the management processes and monitoring the students' academic activities and behavior. Piedade and Santos [6] explained that SRM involves the identification of performance indicators and behavioral patterns that characterize the students and different situations under which they are supervised. In addition, the concept of SRM is "*understood as a process based on the student acquired knowledge, whose main purpose is to keep a close and effective students institution relationship through the closely monitoring of their academic activities along their academic path*". SRM can be utilized as an important means to support and enhance a student's satisfaction[11].

Understanding the needs of the students is essential for their satisfaction. It is necessary to prepare strategies in both teaching and related services to support Student Relationship Management. The significance of developing a strong relationship between university and student is a long term strategy. Hence, this paper proposed an innovative information system to assist students in universities in order to support the SRM concept.

III. ISSUES FACED BY UNIVERSITY STUDENTS

Prior studies have investigated issues faced by students during their times in the universities. The causes of the problems and issues are many. For example, depression is common among some tertiary students. It impacts the student behaviours as regard to their experience and affects the student's motivation, concentration, feeling of self-worth, and mood [12]. From the perspective of the university, the issues are related to allocation of resources and how to recruit students of high calibre and who have high probability of completion. If decisions are not made appropriately, this could lead to unfulfilled number places and lost of potential tuition fees. The problem of student retention in higher education could be attributed to low student satisfaction, student transfer and drop-out [8]. This issue leads to lose of students and revenue, and increasing cost of replacement. Moreover, it was found that the quality and convenience of support services are other factors that influence students to change educational institutes in higher education [9].

Therefore, in the recruitment and enrolment of students in the university, it is necessary to meet the student's needs and to match their capability. Understanding the student's needs will enhance the student's learning experience and increase their chances of success, and reduce wastage of resources due to dropouts, and change of programs.

IV. CURRENT SOLUTIONS

An understanding of the existing information systems can assist student management, student services and market

operation for the participants. It is important to develop strategy to maintain and enhance student satisfaction which is the key role in SRM. Among the researches and papers concerning SRM, there are a number of proposals on solutions for the university management and students. Some examples of such proposals are as shown below.

Piedade and Santos [6] proposed a SRM architecture which supports the SRM concepts and techniques that assist the university's Business Intelligent System. Moreover, the project provided a tool to aid the tertiary students in the decision-making process. The SRM strategy also provides the institution with SRM practices, including planned activities to be developed for the students, as well as other relevant participants. The study found that the technological support to the SRM concepts and practices were insufficient at the time of writing.

Another solution focused on the provision of counselling and careers services, which has been adopted by many universities. To enhance the university's mission, the prominent services provided by universities are psychological counselling, careers and work-placement advice and financial assistance. In addition, feedback from students is vital in the process.

In business, focusing on customer retention is significant [13, 14]. In terms of education systems, Ackerman and Schibrowsky [15] have applied the concept of business relationships and proposed a business relationship marketing framework. The framework provided a different view on retention strategies and an economic justification on the need for implementing retention programs. The prominent result is the improvement of graduation rates by 65% by simply retaining one additional student out of every ten. The researcher added that this framework is appropriate both on the issues of places on quality of services. Although some problems could not be solved directly, it is recognised that Information and communication technologies can be used and contributes towards maintaining a stronger relationship with students in the educational systems [6].

V. RECOMMENDATION SYSTEM AND DATA MINING

The electronic systems have changed the traditional user behaviors. For example, e-commerce is an essential and modern process in today's business[16], e-mail has become the important role in communication system; moreover, e-learning has been prominent in learning system. Similarly, the intelligent Recommendation System can become a significant supporting system in universities. There are some prior studies focusing on recommendation systems, which used the several data mining techniques as shown below.

A. Association Rule

Association Rule, like classification rule, is used to establish the relationships or associations between values of categorical variables in large data sets[17]. For instance, Liao, Zou and Chang[18] proposed an association rules and sequential rules based recommendation system. The experimental result showed that recommendation system outperform better than algorithm which generated by customer automatically. Their research also showed that the method provided more reliable recommendation and sufficient and integrated information.

B. Collaborative Filtering

Using Collaborative Filtering, the Collaborative Recommendation is made by finding a group of similar customers based on preferences of other customers. For example, GroupLens[19], Shardanand and Maes[20], proposed the earliest recommendation system using Collaborative Filtering algorithms. However, the system suffers from the sparseness and scalability issues. On the other hand, Ringo focuses on the personalized recommendations for music albums and artists, and GroupLens focuses on helping the users to find available articles as required.

C. Hybrid System

An integration of multiple techniques may result in better accuracy of the recommendation. Qiu, Xu and Qiu [21] proposed a hybrid recommender system, which integrated a multi-agent system and collaborative filtering. In order to classify customers into different profitability levels, the objectives of study were to solve two problems; feebleness of the use of a particular recommendation strategy with all customers, and the weakness of undifferentiated customer service for different groups of customers. The result showed that hybrid system may address some of the problems. Moreover, the implementation of an agent-based strategy selector can adapt to the various methods, and the strategy of market segmentation assists the business to clarify the profit of investment.

D. Neural Networks

Takagi [22]explained the characteristic of neural networks (NNs) is based on the concept of "*a biological neuron consists of dendrite, a cell body, and an axon. The connections between dendrite and the axons of other neurons are called synapses.*" On the other hand, Lawrence[23] explained that NNs were capable to discover non-linear associations between the training input and output sets, and create function to model non-linear dynamic systems. For instance, in recommendation systems, the researches have shown that NNs are capable to

predict the market direction more accuracy than the other techniques [24].

E. Fuzzy Rule and Rough Set

The concept of rough set is a new mathematical approach in order to represent and process vagueness and uncertainty in data analysis. Rough Set technology has been applied to various applications; in addition, it has produced significant results in machine learning, knowledge discovery, decision analysis, expert systems and other applications[25]. Another application was focused on an intelligent recommendation in virtual mall for products selection. The study was based on machine learning using rough set and fuzzy set[16].

VI. PROPOSED ARCHITECTURE OF RECOMMENDATION SYSTEM

To service student, an Intelligent Recommendation System plays the important role to support students in various ways. There have been several solutions supporting SRM for university students; however, no system has focused on the recommendation system for students using historical data. A recommendation system could apply statistical, artificial intelligence and data mining techniques to the problem of making appropriate recommendation for the students.

Figure 1 illustrates the proposed recommendation system framework. The proposal aims to analyse student background such as student preference, previous results, scores of each subject from each semester and the overall GPA from the enterprise database. The result will then be used to compare the profile of the new students. The recommendation system will then provide the most appropriate courses and subjects for students based on past records.

A. Data Preparation

After data collection, the data will be re-formatted in the stage of data transformation. In the cleaning process, the parameters used in the data analysis will be identified and the missing data will be handled [26].

B. Data Analysis

Next, Clustering Techniques such as K-Means Clustering Algorithm will be applied to group the data [27]. The process of clustering is used to describe target customer's behavior in marketing and CRM [18]. In this research, clustering is used to classify the target student's performance into the meaningful subgroups based on historic data. The set of data items from the clustering process will be applied in this process. Association rule will then be used to examine the relationships between the subgroups [18, 28]. For instance, this process will be applied to identify the student features that appear most often. The coverage of Association Rule is the number of instances that it predicts correctly [27]. The most common output will be analyzed and compared with the clustering output to ensure the prediction more correctly.

Next, the classification based on Fuzzy set theory and Rough Set will be applied [29]. Fuzzy set will be used for knowledge representation, system control and decision making.

To validate the accuracy of the rules from the training data set, an independent testing data set will be applied. The important point in this stage is the need to gather efficient training set to create classified rules. Rough set will also be used to find the minimal subsets of attributes and they will be applied to the data with categorical values.

C. Prediction Model

The prediction model is an integrated process which evaluates the outputs from the previous stage and applies a weighted formula to determine the final recommendation. The weights will be determined or learnt from previous historic data and subject to human intervention based on the experience of the counselor or advisor.

VII. CONCLUSION

The article describes a proposal on a recommendation system in support of SRM and to address issues related to the problem of course advice or counseling for university students. The recent work is focusing on the development and implementation of each process in the framework. Once developed, the system will be tested and the prediction model will be refined. The recommendation system will provide a useful service for students supporting Student Relationship Management strategy in Thai private universities.
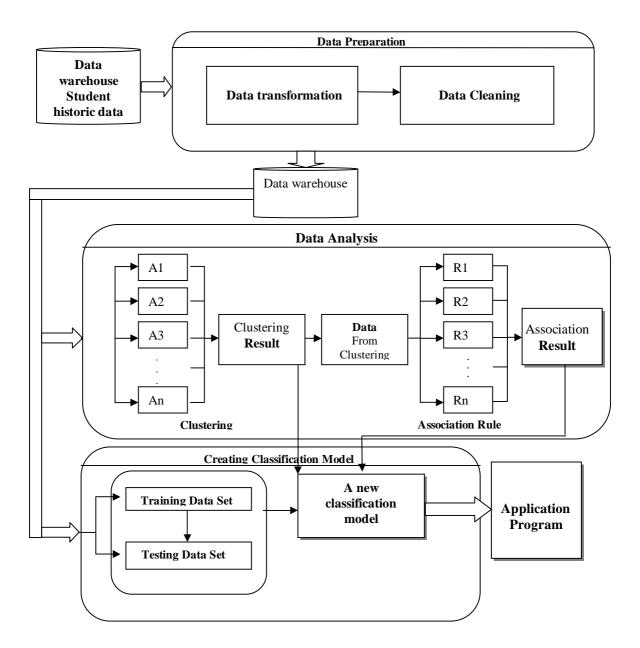
Figure 1: Proposed Recommendation System Framework in Support of Student Relationship Management (SRM)

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