Application of Forecasting Technique for Students Enrollment

Norhaidah Abu Haris¹, Munaisyah Abdullah², Abu Talib Othman³ and Fauziah Abdul Rahman⁴

¹Universiti Kuala Lumpur (UNIKL), Malaysia, norhaidah@unikl.edu.my
²Universiti Kuala Lumpur (UNIKL), Malaysia, munaisyah@unikl.edu.my
³Universiti Kuala Lumpur (UNIKL), Malaysia, abutalib@unikl.edu.my
⁴Universiti Kuala Lumpur (UNIKL), Malaysia, fauziahar@unikl.edu.my

ABSTRACT

Students enrollment forecasting provides information for management in decision making and planning for the Higher Education Institutions (HEI). Due to that, many forecasting techniques have been proposed to improve the accuracy in the predictions. This study discussed the factors that influence the students’ enrollment and various forecasting techniques that have been applied in several studies. The understanding of forecasting techniques is important to find which techniques could give the best result and could contribute informative knowledge, especially for management to make decisions in HEI students’ enrollment area.

Keywords: enrollment, forecasting, decision making.

I INTRODUCTION

Forecasting is an important tool for both strategic and tactical decision making that is considered as an essential part for efficient and effective management. The reasons for management to consider forecasting are to study the current, historical and the continuance of data relationships for certain situations, where that forecasting techniques that will provide high level of accuracy with less cost, the quantity of the historical data in which the relevancy of the information can be measured for reliable decision making and lastly, the time frame to formulate the forecast. (Dianne & Amrik S., 1994)

Forecasting will help management to make further assumptions based on data collected. Enrollment forecasting is related to analyzing current trends, understanding the significant impact on the enrollment and revenue outcomes. This information could be used to influence the future strategy and resource decisions. (Ward, 2007)

Student enrollment forecasting provides important information for management decision making and planning in Higher Education Institution (HEI). The significance of this study is to understand various factors that influence students to enroll in HEI. Two forecasting techniques are identified in this study – Statistical and Data Mining shows that each technique has their own strengths and weaknesses to produce forecast accuracy. Some of the influential factors have been used by the researchers to forecast the students’ enrollment decisions in HEI. The selection of HEI for students’ enrollment could be varied between different HEI and different countries. Therefore, factors contribute in influencing the students to enroll also could be deferred.

Therefore, some of the knowledge contribute from the chosen forecast techniques is dependent on the selection factors of the particular HEI.

II FACTORS INFLUENCE STUDENTS ENROLLMENT IN HEI

Studies on students’ decisions have attracted many researchers. The influencing factors that lead to a conclusion on the student enrollment decisions can be divided into three main factors that can be further categorized into eleven sub-factors. The factors are: (Farhan et al, 2012)

a. Internal Factors – Aspiration, Aptitude and Career
b. External Factors – Courses, Cost Location, Reputation, Promotion and Facilities.

The factors influencing the students’ choice to study in HEI are important because HEI will be able to understand the reasons why a student chooses a particular institution over others. The information obtained can be used by universities to assist in the development of a marketing plan. (Mahsood & Chemicheri, 2010) Therefore the management
could layout strategic planning to promote their HEI to potential students’.

Other factors that could influence the students’ enrollment decisions in a particular HEI are:

a. Financial Aid - financial aid merit awards provided by the HEI.(Klaauw, 2002)(James, 2009)(Eric et al., 2009), the availability of financial aid can affect enrollment and completion(Deland & Cochrane, 2008). The importance of financial aid is an effective tool to compete with other colleges to obtain students.(Klaauw, 2002) The types of financial aid – merit based scholarships, need based scholarship and educational loan(Janet, 2007). The choice of public or private depends on the financial aid offered for students from low income families.(Hashem & John A., 2010)

b. Information Satisfaction - the information regarding product or service provided by the HEI (Farhan et al., 2012). Students’ enquiry on the institutions can also predict the enrollment decision(Monks, 2009).

c. Employment Opportunities – employment opportunities upon completion of studies. (Klaauw, 2002).

d. University or College choice – depends on the facilities, procedures and policies, entry requirement and extra-curricular activities.(Samsinar et al., 2003)(Wagner & Pooyan, 2009) and quality of services provided.(Wagner & Pooyan, 2009)

e. Tuition fee - Cost of education and degree (content and structure) (Wagner & Pooyan, 2009)

f. Institution Prominence – The reputation of the HEI and desired programmes(Fernandez, 2010), quality of education and also pecuniary factors. (Fernandez, 2010)

g. Student Characteristics, External Influences and College Attributes(Ming, 2010)

h. Location - Geographic and demographic factors also influence the students’ enrollment decision in HEI. (Monks, 2009)

Besides all the factors mentioned above, the main reasons students pursue higher education were to improve job prospects, gain knowledge and experience. (Fernandez, 2010). Other factors that could influence student’s decisions are facilities and infrastructure (Ward, 2007). The student inquiries in choosing the HEI of their choice can also be used as a predictor.(Cullen F. & Kenton, 2006). (Ming, 2011) in his studies emphasize that students from different countries have different criteria in selecting HEI. He also introduces a conceptual framework which shows the factors that influencing student decision to enroll in HEI in Malaysia.(Ming, 2010)

In figure 1, the conceptual framework consists of independent variables and dependent variables. The independent variables are divided into two: Fixed College Characteristics and College Effort to Communicate with students.

III FORECASTING TECHNIQUES ON STUDENT ENROLLMENT

Forecasting techniques can be classified as either extrapolation– extend present trends or normative – look backward for a desired future. Technology for forecasting techniques can be categorized into:(Roper et al., 2011)

a. Direct – forecast parameters that measure functional capacity or relevant characteristics.

b. Correlative – correlate parameters that measure technology with parameters of other technologies or other background parameters.

c. Structural – interaction between technology and context that must be explicit.

The enrollment forecasting methods are critically important for the HEI to determine short and long term forecasts for capital improvement and facilities planning. Accurate forecasts are important in times of change. The increasing and decreasing number of students will not only affect planning decisions, but could give management perceived quality of instructions.(Sweeney & Middleton, 2005)

Various techniques used by HEI to forecast enrollment. The forecasting techniques are divided into a few categories: (Ahrens, 1979) (i) quantitative techniques based on historical data (ii) contribution models that incorporate the historical data and rely on a relationship between enrollments with other parameters, or using techniques that integrate subjective judgment instead of using quantitative measures; (iii) modification or suggestions for
adjustments or comparisons to previously developed forecasting techniques (iv) qualitative techniques using surveys to determine potential students’ enrollment (Nurlida, Faridah, & Nooraini, 2013). However the selection of appropriate forecast techniques is dependent on the availability of the HEI data. The techniques involved in each forecasting will give input on the long and short term range planning of the HEI.

The field areas that are identified for HEI forecast: 
(Ward, 2007)

a. Size Scope – number of students projection for particular year or semester, target goal achievement for HEI, influence on student credit and tuition revenue.
b. Profile on the Students Enrollment – the number of students that pursuing degree and completion.
c. New Student academic profile ability - entrance exam scores, grade point average and etc.
d. Enrollment Mix – gender, ethnicity, international status, registration status (full time vs part time), lodging status (residential vs commuter)
e. Enrollment Outcome – persistence rate for first time student enrollment enhancement, student retention sustained or improved.
f. Financial Aid and Revenue – can support the size, enrollment mix and enrollment outcomes.

The need for forecasting as explained by (Huang & Yu, 2013) for situations such as:
a. Difficult for decision makers to evaluate the complexity of organizational and environmental factors without systematic assistance.
b. The organization's relationship could be not reliable, therefore, need forecasts to identify new relationship.
c. Organizations could be moving toward systematic decision making therefore need formal forecasting to support and assess their activities.
d. Practitioners could have developed and directly applied formal forecasting methods.

Therefore, forecasting will enable decision makers to focus on the variety and complexity of the problem. The selection of the correct technology forecasting techniques for a particular problem will help decision makers to understand better possibilities. The following methods have been identified to forecast on the student enrollment in HEI and the results were dependent on HEI forecasting criteria.

A. Statistical
A few statistical methods have been used to forecast the student enrollment in HEI with varying results.

Structural Equation Modelling (SEM) is used to identify the factors that are responsible for student choice in private HEI - experienced or qualified or knowledgeable lecturers, suitable syllabus. The finding has shown that the academician’s expertise and promotion medium will attract students to choose HEI for their educational studies. (Osman M. Zain et al, 2013)

Forecasting using Regression Analysis was applied to the number of students enrolled by semester and level, freshman and senior as well as student demand for theme courses seats in the general education program in Grand Valley State University. The results on the forecasted historical data has been used to change on the academic policy. (Shabbir Choudhuri et al, 2007)

Institutional Research Intelligence (IRI) uses SAS Logistic Regression to predict the students that were offered admissions to HEI but turned down the offer. (Djunaidi, 2012)

The Monte Carlo method is used to forecast the enrollment for KIMEP University, Kazakhstan. In the studies, the findings mention that the student choice satisfaction depends on the information satisfaction and the information satisfaction has no direct impact on institution choice satisfaction. (Quinn, 2013)

Multiple Regression Analysis was used in the study had focused on the Internal, External and Social factors that influence students' choice decisions to enroll in HEI in Pakistan. The objective of the study is to explore factors that influence students' decisions by applying multiple statistical techniques to find out association between them. (Farhan et al, 2012)

The study conducted by (Shuqin, 2002) examined three enrollment projection methods and tested on six community colleges and compared using Mean Absolute Percent Error (MAPE). These methods are Linear Regression, Auto-Regression and Three Component Model that was applied using different variables and which results is lesser percentage of error. Linear Regression was applied to student population, college budget and student fees. Auto-Regression was applied to population of ages 16 to 55, college budget and student fees. The Three Component Model was tested on four groups of new students (first time and non-credit students) with the age population that are between the ages of 18-19, 20-24, 25-34 and 35-55. The results of the studies
show that the three methods did quite well and the error rate is low.

Mindanao State University (MSU-IIT) used students’ data to forecast the number of courses to be opened before the enrollment commences. This study was conducted using statistical time series models – Simple Moving Average, Single Exponential Smoothing and Double Exponential Smoothing. The results of the time series models were compared with naïve model used by the university and the projected data yields less error using MAPE with 20.5% difference in favor of the time series models. (Rabby Q. & Mary Jane, 2012)

All these methods were used to forecast the enrollment of students in HEI with different criteria and variables. These methods are satisfied for certain conditions only.

B. Data Mining

Data Mining (DM) can also be used for forecasting. A few of data mining techniques has been identified to forecast the student enrollment in HEI.

The techniques of DM as described by (Fadzillah & Mansour Ali, 2011) could be either predictive and descriptive. The predictive techniques is to forecast about values of data values using known results found from different data sources while descriptive techniques identify patterns or relationships in data. The Predictive techniques consist of Classification, Prediction, Regression and Time Series analysis. The Descriptive techniques comprise of Clustering, Summarizations, Association Rules and Sequence Analysis.

In the study for student enrollment at Sebha University in Libya, the cluster analysis is used to group the analyzed data of the undergraduate student enrollment into clusters based on similarities consists of genders, Libyan students, courses and etc. The result of is used as a predictor experiment to the predictive Analysis encompass of Neural Network, Logistics Regression and Decision Tree which are applied on student enrollment. The outcomes of the studies show that Neural Network has given better prediction accuracy on the student enrollment. (Fadzillah & Mansour, 2009)

In other research conducted by a private university in Thailand, Bayesian Network of DM methods had been applied to predict student course registration in a private university in Thailand. The data were obtained from student enrollments together with a GPA and grades of the subjects. The results were used to advise students in planning to register courses in each semester. (Pathom et al, 2008) The study later was further enhanced by comparing Bayesian Network with 3 other types of classifying algorithms- C4.5, Decision Forest and NBTree using the same variables GPA and grades of the subjects. NBTree was concluded to give highest prediction power. (Pathom et al, 2008)

Other DM methods which are used to predict on the enrollment of students in the California State University are Support Vector Machine and Rule-based predictive techniques. The students are grouped into three categories: new students include freshman and transfer, continued and returned students. The analyzed student’s data include population, employment, tuition and fees. The result was analyzed by Cubist a tool to better understand the enrollment projection. (Svetlana et al, 2006)

The research conducted by University of Lima, Peru is to find the impact on the academic performance based on the students’ enrollment. Two synthetic attributes were used – course difficulty and potential (grades in related course). C4.5, K-Nearest Neighbor (K-NN), Naïve Bayes, Bagging and Boosting were applied to the data. The result suggests that Boosting is the best accuracy predictor methods which was further tested on the Student Performance Recommender System with a learning engine with proven outcomes. (Vialardi, et al., 2011)

Another DM technique to forecast on the academic performance using enrollment data is Decision Tree. The studied result focuses on the students’ strength at the time of enrollment, therefore after the enrollment process; HEI will attempt to improve the quality of the student. The input will help the instructors to take necessary actions for the slow learners to improve in the university examinations. (M Narayana & M., 2012)

(Borah et al, 2011) had proposed a new attribute Selection Measure Function (heuristic) on existing C4.5 Decision Tree algorithm. The C4.5 gives promising solution on the split information of the enrollment process at the engineering college in India. Another approach in the studies is to find the accuracy rate between C5.0 Decision Tree algorithm, and back propagation algorithm of the Artificial Neural Network (ANN). The result showed that the ANN has given the highest forecasting accuracy.

The study that was conducted at the University of California suggested that DM techniques are much better than statistical methods to assist HEI in achieving enrollment goals. SAS Enterprise Miner software is applied to test the DM techniques, Neural Network, Decision Tree, Logistic Regression and
Ensemble Models. From this study Neural Network method is better than other methods (Tongshan).

Studies on enrollment forecasting also has been conducted using Fuzzy Time Series methods. These methods are: High Order Fuzzy Time Series. (Chen & Hsu, 2004), Fuzzy Time Series and Genetic Algorithms (Chen & Chung, 2006), Fuzzy Time Series and Clustering Techniques (Kurniawan & Chen, 2009), Adaptive Time Variant Fuzzy Time Series (Wong, Enjian, & Chu, 2010), High Order Fuzzy Time Series (S.M.Chen, 2002), First-Order Fuzzy Time Series (Melike & Konstantin, 2005), Heuristic Time Variant Fuzzy Time Series (Melike & Konstantin, 2005), Cardinality Fuzzy Time Series (Chang et al, 2007) were applied to find highest forecasting accuracy. Another method is Weight Fuzzy Time Series with additional data from University Teknologi Malaysia (UTM). (Z. Ismail & R.Efendi, 2011)

These Fuzzy Time Series techniques have been conducted using enrollment data of the University, Alabama, which was originally introduced by Song and Chissom. (Q. Song & B.S. Chissom, 1993)

Various DM forecasting techniques explained above show that DM could be applied to improve the accuracy in forecasting. The researchers have proposed various techniques with different factors and variables to suit with their forecast criteria. The accuracy of each of the techniques is dependent on various factors chosen for particular studies.

The studies are further categorized into the table as shown in Table 1 - the list of the Statistical methods and Table 2 - the list of DM methods that was used to forecast on student enrollment in HEI.

### Table 1: Statistics

<table>
<thead>
<tr>
<th>Statistical Methods</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Equation Modelling(SEM)</td>
<td>Academicians, Lecturers, promotions</td>
</tr>
<tr>
<td>Regression Analysis</td>
<td>New+ existing students, courses</td>
</tr>
<tr>
<td>Monte Carlo</td>
<td>Information satisfaction</td>
</tr>
<tr>
<td>Multiple Regression</td>
<td>Internal, External &amp; Social factors</td>
</tr>
<tr>
<td>Linear Regression</td>
<td>Student population, budget, fees</td>
</tr>
</tbody>
</table>

### Table 2: Data Mining

<table>
<thead>
<tr>
<th>Data Mining Methods</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neural Network</td>
<td>Undergraduate students cluster (genders, etc)</td>
</tr>
<tr>
<td>Logistic Regression</td>
<td></td>
</tr>
<tr>
<td>Decision Tree</td>
<td></td>
</tr>
<tr>
<td>Bayesian Network</td>
<td>GPA &amp; grades, subjects – course register</td>
</tr>
<tr>
<td>C4.5</td>
<td></td>
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<tr>
<td>Decision Forest</td>
<td></td>
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<tr>
<td>NB Tree</td>
<td></td>
</tr>
<tr>
<td>Support Vector Machine (SVM)</td>
<td></td>
</tr>
<tr>
<td>Selection Measure Function (Heuristics) – C4.5, Decision Tree</td>
<td>Students Enrollment process</td>
</tr>
<tr>
<td>Artificial Neural Network – Back propagation Algorithm</td>
<td>Students Enrollment process</td>
</tr>
<tr>
<td>SAS Enterprise Miner – Neural Network, Decision Tree, Logistic</td>
<td>Students Enrollment process</td>
</tr>
</tbody>
</table>
### IV  THE IMPORTANCE OF FORECASTING ON THE STUDENTS ENROLLMENT

The knowledge learned from the forecasting techniques could be important to explore the potential of the organization’s historical data and could be used to deal with management decisions of the present situation (Jing, 2002). Knowledge Management (KM) forecasting technologies could also give significant impact on supporting the technology of forecasting. These technologies are: (Marc et al, 2006)

<table>
<thead>
<tr>
<th>Technique</th>
<th>Number of student enrollments per year</th>
<th>Course difficulty &amp; Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression, Ensemble Model</td>
<td>Students’ Strengths</td>
<td></td>
</tr>
<tr>
<td>Decision Tree</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuzzy Time Series (FTS), High Order FTS, FTS &amp; Genetic Algorithm, FTS &amp; Clustering Algorithm, Adaptive Time Variant FTS, First Order FTS, Heuristic Time Variant FTS, Cardinality FTS, Weight FTS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4.5, K- Nearest neighbor, Naïve Bayes, Bagging &amp; Boosting</td>
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</tbody>
</table>

d. Topic Maps – provide methods to navigate associative across large amounts of available information in a conscious manner, enabling systematic identification of information and creation of new knowledge by the user.

e. Ontologies – related to meta-context approach in which the explicit contextual information and specific references have added to the information resources.

These KM forecasting can be supported by one or more technology, which is part of strategic innovation management.

The problem of forecasting the data is very time consuming and usually involves various steps to define, extracted, cleaned, harmonized and prepared data. The reasons several techniques applied to these data is to produce a high quality forecast with best result. Understanding the factors that could drive the enrollment demand will help the HEI to derive ways to leverage numerous resources into actionable strategies that can directly impact profitability.

The choice of a good forecast technology could either be quantitative, qualitative or mixture of both. The rationale for selecting many different approaches as practical within resource limitations is to support the decision makers to make good decision based on the forecast information from a range of desirable futures or avoid the less desirable ones. This forecast technique will give impact on the forecast assessment and at the same time could affect new developments on the technologies, processes, policies, organizations and other factors in which forecaster can identify areas that would give significant impacts that will occur, likelihood and their consequences in future. (Roper et al, 2011)

### V  CONCLUSION

In this paper, a few methods are presented and described in the literature studies on various research that are related to forecasting on the student enrollment in HEI. The forecasting techniques are critical components for analyzing the consequences and necessary to be applied in future works. Finally, the ability to understand some of the forecasting techniques is important in finding the best and suitable approach that could contribute knowledgeable information especially in HEI students’ enrollment area.

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