BIBLIOGRAPHY

ZENAIDA U. GARAMBAS, May 2007, Markov Chain Modeling and Forecasting of Saint Louis University Enrolment on Selected Degree Programs in the Tertiary Level

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ABSTRACT

This study aimed at building a Markov chain to model the enrolment of selected colleges in Saint Louis University. The average of the enrolment of the past ten years was used to form the initial state vector. In addition to the enrolment statistics, the total number of drop-outs, shifters and transferees were used to complete the transition matrix.

The analysis and interpretation of data resulted in the projection of enrolment for the next five years for the selected degree programs at Saint Louis University. Based on the computations made, there will be an increase in enrolment per year from school year 2007-2008 to school year 2011-2012. The increase, however, is not constant or the same for all the degree programs. The following degree programs will have a very little increase in the number of incoming first years, that is, less than 40 students increase in each school year: BS Computer Science, BS Social Work, Bachelor of Philosophy, BS Psychology, BS Industrial Engineering, AB Political Science, and BS Chemical Engineering. On the other hand, the following colleges have big number of additional incoming first years in the succeeding years after 2007-2008: BS in Accountancy, BS in Electronics and Communications Engineering, BS Architecture, BS Civil Engineering,

and BS Information Technology. The other degree programs will just have an average of additional one section per school year.

This would help administrators in their five-year plan pertaining, but not limited to, the number of new faculty members to be hired, availability of classrooms and budget.

It is recommended that further studies be conducted on forecasting student enrolment and include other variables such as number of students who have withdrawn, transferred to another school, and other pertinent data. Also, the probability that a student will graduate given that he is now in the fourth year could also be added in the transition matrix.

Other related studies such as finding the number of graduates employed in their respective field of specialization, employed in fields other than their specialization, or the number of graduates who go abroad may also be good areas of research studies.

Also, it is recommended that the other degree programs not included here be analyzed in the same manner.

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INTRODUCTION

Background of the Study

Education is the best legacy of parents to their children. Parents desire that their children choose a degree that would land them to a gainful employment. A high school graduate, therefore, who is contemplating to go to college uses forecasting in choosing a major field of specialization in line with what he wants to do when he graduates and what his career opportunities will be. His choice of a college major involves forecasts of how well he will do in his courses.

The desire to forecast the future is as old as the human race. In ancient times, people relied on prophets, soothsayers, and crystal balls. Today there are computers that have an impressive array of quantitative capabilities which are powerful tools used in predicting the future.

Many decisions are based on forecasts of one sort or another. A politician planning to run in a forthcoming election may forecast his probability of winning by using the past and present data. The demands for blood types in a blood-bank inventory model exhibit both seasonal and trend patterns which can be estimated by using statistical forecasting models. An investor relies on the help of financial analysts who forecast market trends. A businessman studies the history of demand for his product and make some forecasts on his revenue and sales.

Every start of the semester, the enrolment statistics are posted on a big bulletin board at the lobby of the school. The data are fascinating, yet they simply show numbers of enrollees for each college for the current semester. But as to the growth or decline compared to the previous years, one cannot know. Had there been a steady increase, say, for the last five years? Will this growth continue for the next five years? Or will there be a time for a plateau or even a decline in the enrolment for a particular college?

Certainly, it is the utmost concern of school administrators to attract students since students are their primary clientele. Thus, they should try to find out what courses attract high school graduates most, and thus serve them better. Furthermore, they are trying their best to find ways and means to improve their curriculum, to determine which courses are to be phased out and what new courses are needed to keep abreast with the changing times and the technologically-oriented society.

Saint Louis University is one of the big universities in Baguio City which was founded by the CICM missionaries in 1927. At present, it offers elementary, secondary, tertiary, and post-graduate education. In the tertiary level, there are sixty-two undergraduate degree offerings in the seven colleges. The colleges are as follows: College of Commerce and Accountancy, College of Engineering and Architecture, College of Education, College of Human Sciences, College of Information and Computing Sciences, College of Natural Sciences, and College of Nursing.

The researcher selected only some of the degree programs to be used in this study to analyze and forecast. College of Nursing, for instance, retains a definite number of students for the third and fourth year levels regardless of the number of enrollees accepted for the first year level. The College of Commerce and Accountancy has just phased out some courses and replaced by new ones. What other courses are likely to be phased out in the future due to eventual decline in the enrolment or due to very little increase in the forthcoming freshmen? Forecasting would help answer these questions.

At the time of this study, there are several new course offerings in Saint Louis University such as BS in Mechatronics Engineering, BS in Resort, Restaurant and Hotel Management, Bachelor in Library and Information Science, BS in Information Management, and BS in Human Resource Development. However, there are degree offerings being phased out.

There are many forecasting techniques but the researcher believes that Markov chain analysis is the best forecasting tool for this particular study because students can be classified as belonging to the different states (freshmen, sophomores, juniors, seniors, drop-outs, shifters or transferees). These are referred to as the current states or conditions and can be used to forecast the next state. Levin, et al (1979) described Markov analysis as a method of analyzing the current behavior of some variable in an effort to predict the future behavior of that same variable. They added further that Markov analysis has been successfully applied to a wide variety of decision situations.

This study utilized the past and the present enrolment data and used them to build a model which was used in forecasting future enrolment.

Statement of the Problem

The study aims to analyze and assess the enrolment statistics on selected degree programs in the tertiary level of Saint Louis University. Specifically, the researcher would like to answer the following questions:

1. What is the Markov chain model that fits the enrolment statistics for the last ten years on the selected degree programs?
2. Based on the enrolment data for the past ten years, what is the forecasted or projected enrollment pattern for the next five years on each of the selected degree programs?

Objectives of the Study

This study aims to determine the enrollment pattern on selected degree programs of the different colleges in Saint Louis University. Specifically, the study aims to:

1. Construct a Markov chain model that fits the enrolment data for the last ten years from school year 1997–1998 to school year 2006–2007 on the selected degree programs.

2. Forecast or project the enrolment pattern for the next five years on each of the selected degree programs based on the enrolment for the last ten years using Markov Chain Analysis.

Importance of the Study

The lifeblood of any educational institution is the number of enrollees. It is therefore imperative to study past and present enrolment trend so as to be able to project students' enrolment distribution for the next, say, five years for the preparation of a five-year development plan by the administration. This is an important aspect in the planning and allocation of annual operating and budget resources.

A problem that faces school administrators across the country is predicting student enrollments in the coming years. The ability to predict the number of current students that will be enrolled in future years is a critical factor in the determination of future enrolments. For that reason an administrator would like to know the probability that a currently enrolled freshman will be enrolled at the same university as a senior three years hence.

This study focused on determining the enrolment behavior of selected colleges in a university and consequently made forecasts. Results from this study may provide information to school administrators, planning officers, and researchers. Senior high school students could also utilize this study to help them in their decision-making and planning activities. This study will also help the administrators in deciding which offerings are to be phased out and how long will others be still offered. The forecasts may be used as benchmark for the Admission Office to regulate enrolment for new students, and also for faculty requirements.

Scope and Delimitation of the Study

Enrolment data on selected degree programs in Saint Louis University for SY 1997–1998 to SY 2006–2007 were gathered and utilized in this study. It also included the following: 1) the number of continuing students by year level, 2) the number of students who shift to another course, and 3) the number of students transferring to SLU from another school.

This study was limited to the enrolment data in Saint Louis University in the College of Engineering and Architecture, College of Information and Computing Sciences, the College of Human Sciences. There were eight degree programs selected from the College of Engineering and Architecture (BSME, BSChe, BSIE, BSCE, BSEE, BSECE, BSGE and BS Architecture), seven from the College of Human Sciences (AB Econ, AB English, Bachelor of Philosophy, AB Political Sciences, AB Communication, BS Psychology, and BS Social Work), three from the College of Information and Computing Sciences (BS Math, BSIT, BSCS), and one from the College of Accountancy and Commerce (BS Accountancy).

The forecasts were made on each degree program using Markov Chain Analysis. A chain was constructed by multiplying the initial state vector by the formulated transition matrix, and the resulting row vector would again be multiplied by the same transition matrix, and so on; thus forming a Markov chain.

This study was conducted from November 2006 to April 2007 at Saint Louis University, Baguio City.

REVIEW OF RELATED LITERATURE

Forecasting and Modeling

The selection and implementation of the proper forecast methodology have always been important in planning and decision-making for most firms, institutions, and agencies.

The need to obtain a forecast has to be identified at the appropriate management level. The historical data required must be compiled and by studying these data, an appropriate model can be structured. A forecasting procedure that behaves well under the model should be selected.

Forecasting, as defined by Freud (1977), is the process of arriving at the values that some variables may take on the specific future time. Anderson (1971) considered forecasting as a process of predicting the future with the knowledge of the past occurrence. Pindick (1981) stated that forecasting is the prediction of future observations of time series. Lee (1971) stated that the individual business man, the farmer, officers of a union responsible for negotiating appropriate labor-management relations and all the rest of the community in one way or another should have heavy stake in the making of economic forecasts. Anderson (1971) stated that most companies can forecast total demand for all products with errors of less than 5%.

Smith (1985) stated that businesses routinely make forecasts of their sales, materials costs, interest rates, and a dizzying array of other things. He added that government policymakers forecast output, unemployment, inflation, interest rates, and so on.

Hillier and Lieberman (1986) asserted that forecasting is an essential component of a successful inventory system. They added that forecasting also plays an important role in industry in the areas of marketing, financial planning, and production. A forecast, however, is not the final product itself; it is to be used as a tool in making a managerial decision.

Anderson, et al (1971), stated that an essential aspect of managing any organization is planning for the future, and indeed, long-run success of an organization is closely related to how well management is able to anticipate the future and develop appropriate strategies. He added however, that a forecast is simply a prediction of what will happen in the future. Managers must learn to accept the fact that regardless of the technique used, they will not be able to develop perfect forecasts. Good judgment, intuition, and an awareness of the state of the economy may give a manager a rough idea or "feeling" of what is likely to happen in the future.

According to Galliers (1987), descriptive information attempted to replace the real world of objects of rules and events by a set of symbols which map the real world on one-to-one basis information systems included on the basis of assumptions of statistical distribution and behavior.

Kerliger (1973) pointed out that one can predict from an independent to a dependent variable. Further, the author stressed the existence or non-existence of relation can be predicted and can even tell something that happened in the past.

Aczel (1989) also noted that many variables, such as sales and other business variables, can be forecast, and the use of statistics plays an important role in forecasting these variables.

Management needs a clear picture of the nature of trends and the sort of thing that are likely to happen in the economy. The decision-maker seeks to shape the future but he works in the context of a broad network of economic forces. Forecasting is used in planning and decision–making that involve individual products. The nature of the demand curve for a product can be vital for a firm to know yet hard to calculate (Lynn, 1974).

Pankratz (1981) cited three examples of how forecasting can aid in planning:

1. A business firm manufactures computerized television games for retail sale. If the firm does not manufacture and keep in inventory enough units of its product to meet demand, it could lose sales to a competitor and thus have lower profits. On the other hand, keeping an inventory is costly. If the inventory of finished goods is too large, the firm will have higher carrying costs and lower profits than otherwise. This firm can maximize profits (other things equal) by properly balancing the benefits of holding inventory (avoiding lost sales) against costs (interest charges). Clearly, the

inventory level the firm should aim for depends partly on the anticipated amount of future sales. Unfortunately, future sales can rarely be known with certainty so decisions about production and inventory levels must be based on sales forecasts.

2. A nonprofit organization provides temporary room and board for indigent transients in a large city in the northern part of the United States. The number of individuals requesting the aid each month follows a complex seasonal pattern. The directors of the organization could better plan their fund-raising efforts and their ordering of food and clothing if they had reliable forecasts of the seasonal variation in aid requests.
3. A specialty foods wholesaler knows from experience that sales are usually sufficient to warrant delivery runs into a given geographic region if population density exceeds a critical minimum number. Forecasting the exact amount of sales is not necessary for this decision. The wholesaler uses census information about population density to choose which regions to serve.

Pankratz added that forecasts can be formed in many different ways, depending on the purpose and importance of the forecasts as well as the costs of the alternative forecasting methods. The food wholesaler in the example above combines his or her experience and judgment with a few minutes looking up census data. But the television game manufacturer might employ a trained statistician or economist to develop sophisticated mathematical and statistical models in an effort to achieve close control over inventory levels.

Santos et. al. (1975) applied forecasting method in projecting the student's enrollment to three secondary institutions through the use of linear regression analysis which served as a basis for educational planners to provide accommodation for school children who seek admission to the school system in the future.

Carino (2002) conducted a study aimed to forecast fish prices in Benguet to help fish producers in deciding on the right kind of fish to produce, when to culture, and how to gain more yield. Gannapao (1997) made a study aimed to forecast market retail prices of selected fruit vegetables using time series analysis and was able to come up with the predicted market retail prices of selected fruit vegetables for the next five years.

Hillier and Lieberman (1986) stated that forecasts can be obtained by using qualitative and quantitative techniques. In the former case, a forecast is usually the result of an expression of one or more experts' personal judgment or opinion, and it is often called a judgmental technique. They further cited the following examples whereby forecasting is applied: (1) a major research university calls in its leading economists every September to obtain their judgment on what to expect as an inflation rate for the next academic year – number crucial to the budgeting process. This number is generally arrived at by consensus after prolonged discussion by the economists, (2) the daily market closing prices of a particular stock over the period of a year constitute a time series. Time series analysis exploits techniques that utilize these data for forecasting the values that the variable of interest will take on in a future time, (3) the West Coast distributor of 10-speed bicycles wants to make quarterly sales forecasts for planning purposes; he wants to forecast the sales that will occur during the next quarter; and (4) forecasting the total sales of a textbook in a given period may be functionally related to the mail order sales during the same period. Data on mail order sales and total sales over previous periods may be used to forecast total sales in a future period given the mail order sales for that period.

Anderson (1971) classified forecasting methods as quantitative or qualitative. Quantitative forecasting methods can be used when (1) past information about the variable being forecast is available, (2) the information can be quantified, and (3) a reasonable assumption is that the pattern of the past will continue into the future. Furthermore, Glichist (1976) enumerated three methods of forecasting such as (1)intuitive methods, (2) the causal methods, and (3) the extrapolative methods. These extrapolative methods are based on the extrapolation into the future of the features shown by relevant data in the past; these are statistical as well as mathematical in nature. Some widely used methods under this are the moving averages, exponential smoothing, trend projection, and the stepwise autoregressive.

In decision-making problems we are often faced with making decisions based on phenomena that have uncertainty associated with them. Hillier and Lieberman (1986) pointed out that this uncertainty is caused by inherent variation due to sources of variation that elude control or due to the inconsistency of natural phenomena. They suggest that rather than treat this variability qualitatively, it can be incorporated into the mathematical model and thus handle it quantitatively. They added that this generally can be accomplished if the natural phenomena exhibit some degree of regularity, so that their variation can be described by a probability model.

Some basic models for forecasting are the following: 1) constant mean models; 2) linear trend models; 3) regression models; 4) stochastic models; 5) seasonal models; 6) growth models; and 7) multivariate models.

Stochastic models are used when random elements play dominant part in determining the structure of the model. Time series models are classified into two classes namely: stationary time series and non-stationary time series. A stationary series is one whose graph exhibits no trend and the series remains in equilibrium. The data cluster about a constant mean. A series not satisfying these conditions are known to be non- stationary. A non-stationary series is usually transformed to a stationary state before modeling because it is quite difficult to build models on non-stationary series. The study on how a random variable evolves over time includes stochastic processes.

Dinkel, et al (1978) defined stochastic process as a collection of random variables whose values are observed at certain points in time. Also, Hillier and Lieberman (1986) defined stochastic process to be simply an indexed collection of random variables (X_t) where the index t runs through a given set T, where T is taken to be the set of non-negative integers, and X_t represents a measurable characteristic of interest at time *t*. They added further that a consideration of the behavior of a system operating for some period of time often leads to the analysis of a stochastic process.

A stochastic process made up of an infinite sequence of trials is called a Markov chain, named after the Russian mathematician Andrei Andreevich Markov (1856 – 1922) who developed much of the modern theory of stochastic processes. Levin, et al (1979) stated that Andrei Markov first used this process to describe the behavior of particles of gas in a closed container.

Markov Chain Application

Markov chains have been applied in areas such as education, marketing, health services, finance, accounting, and production. Markov processes present one of the best-known and most useful classes of stochastic processes.

Budnick, Mojena, and Vollmann (1977) defined Markov chain as a stochastic process with the following properties: (1) discrete state space, (2) Markovian property, and (3) one-step transition probabilities which remain constant over time (termed as stationary transition probabilities). And they further characterized Markovian property as follows:

Given that the present (or most recent) state is known, the conditional probability of the next state is independent of states prior to the present (or most recent) state, that is,

$$P(X_{t+1} = x_{t+1} \mid X_0 = x_0, X_1 = x_1, \ldots, X_t = x_t) = P(X_{t+1} = x_{t+1} \mid X_t = x_t)$$

for t = 0, 1, …. and all possible sequences for state values. Note that an upper-case letter represents the random variable and a lower-case letter represents a specific value of the random variable (termed as random variate).

According to Hillier and Lieberman (1986), the Markovian property can be shown to be equivalent to stating that the conditional probability of any future "event", given any past "event" and the present state $X_t = i$, is independent of the past event and depends only upon the present state of the process.

Gallin (1984) paraphrased the Markov process, that is, if the system is in state *i* at a given time *n*, there is a fixed probability P_{ij} that it will be in the state *j* at time *n+1*. In other words, P_{ij} represents the probability of going from state to state or unit time period. The fact that P_{ij} does not depend on *n* means that we can calculate the probability of the next state of the system, if we know the current state.

According to Mizrahi and Sullivan (1976), the Markov chain model is a theory that can be used to characterize a series of experiments, in which the result of each experiment will depend only on the result of the immediately preceding experiment and not on other prior experiments. Furthermore, Markov chains and other stochastic models can be applied to genetics, the science of heredity. They added that Markov chains are useful in controlling breeding experiments wherein we are interested in what happens to the genotype of the offspring after several generations.

Budnick, et al (1977), cited many situations where Markov models have been used. It has been used to study the behavior of gas particles in a container, to model the development of biological populations, and to forecast weather patterns in meteorology. They added that managerial applications include analyses of inventory and queuing systems; replacement and maintenance policies for machines; brand loyalty in marketing; time series of economic data such as price movements of stocks; accounts receivable in accounting; hospital systems such as the movements of coronary and geriatric patient; management of resources such as water and wildlife; and expected payout of life insurance policies. Specific examples cited by Budnick, et al are: (a) Markov chains of brand switching behavior for 500 consumers used as diagnostic tools for suggesting marketing strategies such as prediction of market shares at specific future points in time, assessment of rates of change in market shares over time, prediction of market share equilibriums (if they exist), assessment of the specific effects of marketing strategies in changing undesirable market shares, and evaluation of the process for introducing new products; (b) Markov model for analyzing the flow of patients in the geriatric ward of a state hospital wherein the patients are classified in one of the four states in any given month., and (c) A simplified Markovian scenario concerned with predicting the future behavior of prices of securities (stocks, bonds, treasury bills, and the like) for the purpose of formulating investment strategy. The closing daily prices and the differences in closing prices from one day to the next are stochastic processes over time. Based on these price movements, a discrete three-state and discrete parameter stochastic process $\{X_t\}$ can now be defined with respect to actual changes in price of a stock from one day to the next.

Examination of the given data from the Government Secondary School in Victoria revealed that prior to 1975, promotion and repeated rates were fairly stable, whereas post 1974, the majority of the rates took on some specific patterns (Johnston et. al., 1973). However Williams (1982) cited that in the analysis undertaken, important matters should be borne in mind. First, the transition rates themselves, pre-1975, had a substantially different pattern of behavior compared to post 1974. There is no reason to suggest that the behavior will not occur again in the future, hence the behavior of the transition rates should be carefully monitored. Second, the small sample size for the calculation of the function forms of rates although compensated for by increased tightness of significance tests, cause some concern regarding the general applicability of the patterns of change over time.

Winston (1991) illustrated the use of Markov chain in his example "The Gambler's Ruin". He asserted that since the amount of money one player has after $t + 1$ plays of the game depends on the past history of the game only through the amount of money he has after t plays, there is definitely a Markov chain. And since the rules of the game don't change over time, then it is a stationary Markov chain. Moreover, he cited the Cola example where each person's purchases are viewed as a Markov chain with the state at any given time being the type of cola the person last purchased. Hence, each person's cola purchases may be represented by a two-state Markov chain. Another example cited by Winston is about the accounts receivable situation of a firm modeled as an absorbing Markov chain. His example "Work Force Planning" used absorbing Markov chain to answer the following questions regarding the law firm: (1) What is the probability that a newly hired lawyer will leave the firm before becoming a partner? (2) On the average, how long does a newly hired junior lawyer stay with the firm? (3) What is the average length of time that a partner spends with the firm?

As cited by Williams (1982), Stone (1972) postulated a Markov model that allowed for changing promotion and repeated rates over time, although nowhere did the author indicate how this might be effected. A Markov chain model capable of coping with changing promotion and repeated rates is developed and applied to Victorian Secondary School system where separate account is taken from Government and Non-Government schools, and males and females.

Fraleigh (1990) applied Markov chain model through his example on predicting population distribution at income categorized as poor, middle, and rich consecutively; a Markov chain dealing with the distribution of a population among states measured over evenly spaced time intervals wherein a *n x n* transition matrix T describes the movement of the population (income) among states (poor, middle, and rich).

Salda (1998) conducted a study on "Forecasting Benguet State University Enrolment" using Markov Chain and forecasted the enrolment distribution for the next five years.

These studies are related to the present study because they made use of Markov Chain models. The researcher used a Markov Chain model in forecasting future enrolment on selected degree programs in Saint Louis University.

<u>Theoretical Framework</u>

In every educational institution the trend of the mobility of the students' enrolment seems not to be stable on the population growth. The assumptions are as follows:

1. A student in the freshmen level could only be promoted to the sophomore level, or could be a drop-out or a repeater.
2. A sophomore student could only be promoted to the junior level, maybe retained in the level or could be dropped-out.

3. A junior student could be promoted to the senior level, or could be retained or could be a drop-out.
4. A senior student could be retained, dropped or moved out through graduation.
5. Students retained in a certain year level do not leave the educational system.

Harden and Tcheng (1971) illustrated the flow of students in Figure 1.

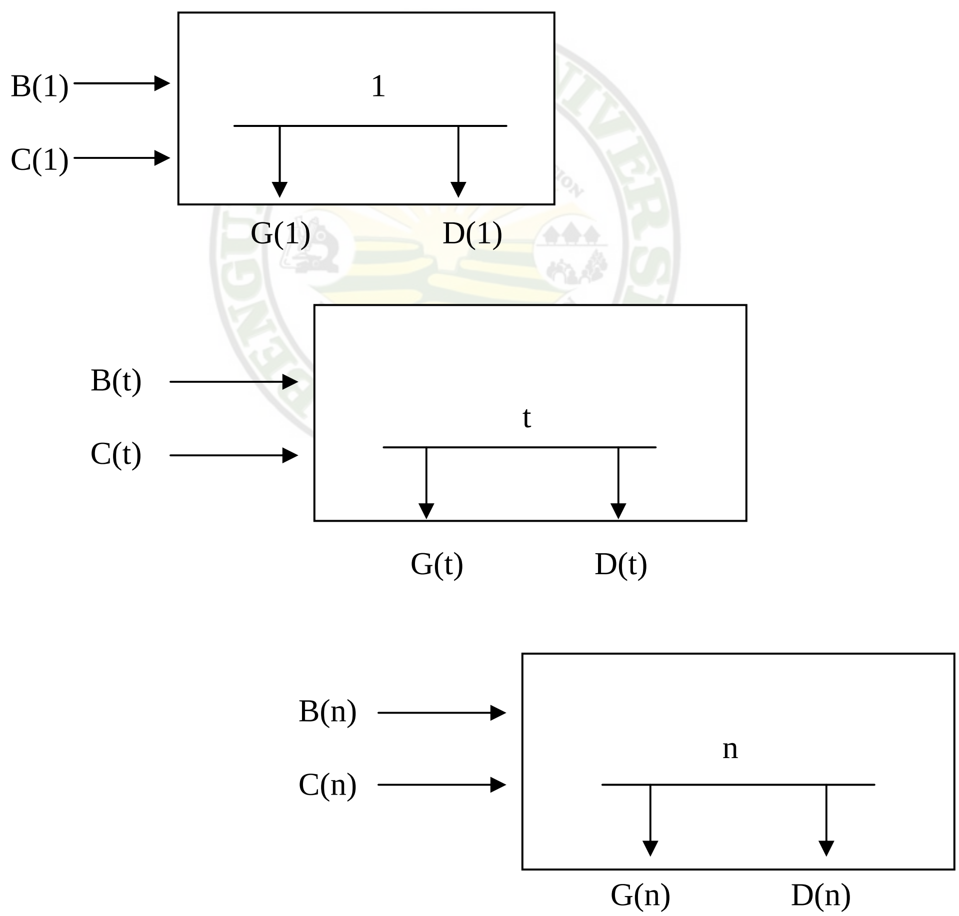

Figure 1: Model of the flow of students in an educational institution where t =1, 2, 3, …., *n* are the indices for the various academic years.

The following legend was used for Figure 1:

B(t) – new students entering the school at the beginning of the academic year t.
C(t) – students during the academic year (t-1) continuing to year t.
D(t) – students leaving the school as drop-outs.
G(t) – students leaving school as graduates.

In order to analyze such problem in determining the enrolment distribution, the Markov process is used. A Markov chain is a special type of stochastic process. According to Larson et. al. (1991), at each transition, each member in the given state must either stay in that state or change to another state. Since the entries in the i^{th} column of the matrix represents the probabilities that a member of the population will change from the j^{th} state, it follows that the sum of the entries in each column must be one. In a Markov chain, the outcomes on the i^{th} trial maybe influenced by the outcome on the trial by the outcome on the *(t-1)* trial. The outcome S_1, S_2, S_3,…, Sn are called states. And the probability of being in one state to another during an increment of time is termed as the transition probability.

Let P_{ij} the transition probability that a member of a population will change from the j^{th} state to the i^{th} state where $0< P_{ij} <1$.

In particular, P_{ij} the probability that a member of the population will remain in the i^{th} state. A probability of P_{ij} means that the members certain to the change from the j^{th} state to the i^{th} state.

Collection of all probabilities P_{ij} where $1< i <n$ and $1< j <n$, is represented by an $n\ x\ n$ transition matrix P as follows:

	S_1	S_2	S_3	………S_n
S_1	P_{11}	P_{12}	P_{13}	……...P_{1n}
S_2	P_{21}	P_{22}	P_{23}	………P_{2n}
S_3	P_{31}	P_{32}	P_{33}	………P_{3n}
.	.	.	.	
.	.	.	.	
.	.	.	.	
S_n	P_{n1}	P_{n2}	P_{n3}	……….P_{nn}

The above matrix shows the flow from one state to another. For instance P_n is the probability of moving from S_1 to S_2. It is square matrix P with non-negative elements, since $P_{ij} = 0$ for all i and j.

The matrix of transition probabilities is computed from the available data and enrolment projections are determined by repetitive multiplication of given enrolment distribution and the transition probability matrix.

Considering the Markov chain with n different states (S_1, S_2, S_3, S_n), the i^{th} state is called absorbing $P_{ij} = 1$. Moreover, the Markov chain is called absorbing if it has at least an absorbing state, and it is possible for a member of the population to move from any non-absorbing state to an absorbing one in a finite number of transition. In other words Markov chain is called an absorbing state if it is impossible to leave it once it is entered (Gallin, 1984).

Winston (1991) classified and defined the states in a Markov chain as follows:

1) Given two states *i* and *j*, a **path** from i to j is a sequence of transitions that begins in *i* and ends in *j*, such that each transition in the sequence has a positive probability of occurring.

2) A state *j* is r**eachable** from a state *i* if there is a path leading from *i* to *j*.

3) Two states *i* and *j* are said to **communicate** if j is reachable from *i*, and *i* is reachable from *j*.

4) A set of states S in a Markov chain is a **closed set** if no state outside of S is reachable from any state in S.

5) A state *i* is an **absorbing state** if $p_{ii} = i$

6) A state *i* is a **transient state** if there exists a state *j* that is reachable from *i*, but the state *i* is not reachable from state *j*.

7) If a state is not transient, it is called a **recurrent state**.

8) A state *i* is **periodic** with period $k > i$ if *k* is the smallest number such that all paths leading from state *i* back to state *i* have a length that is a multiple of *k*. If a recurrent state is not periodic, it is referred to as **aperiodic**.

Definition of Terms

The following terms have been defined in their operational context.

Trials of the process are the events that trigger transitions of the system from one state to another. The enrolling of a student to a particular year level is a trial of the process.

State of the system is the condition of the system at any particular time period.

Freshmen are the students in the first year level of college.

Sophomores are the students in the second year of college and has an academic standing of passing the first year level.

Juniors are students in the third year of college with an academic standing of passing in the first and in the second year level.

Seniors are students in the fourth year of college with an academic standing of passing in the first, second, and third year of college.

Drop-out or Quitter refers to a student who leaves school before the end of the school year.

Shifter refers to a student who changes a degree to another at a certain year level.

Transferee refers to a student who comes from one school and enrolled to another school.

State probability is the probability that a system will be in any particular state. For instance, the probability that a student is a freshman, a sophomore, a junior, or a senior is referred to as a state probability.

Transition is the movement from one state to another. When a student moves from one year during the current school year to another year level in the following school year, then a transition has occurred.

Transition probabilities are probabilities of the movement from one state to another, say, the probability that a freshman now will become a sophomore next school year.

Absorbing state. A state is said to be absorbing if the probability of making a transition out of that state is zero. Thus once the system has made a transition into an absorbing state, it will remain there forever.

A Markov process is a stochastic system for which the occurrence of future states depends on the immediate preceding state.

A Markov chain is a probabilistic model that describes the random movement over time of some activity.

Markov analysis is a method of analyzing the current behavior of some variable in an effort to predict the future behavior of that variable.

Fundamental matrix is a matrix necessary for the computation of probabilities associated with absorbing states of a Markov process.

Degree offering refers to the degree programs offered by the different colleges in Saint Louis University. The different degree offerings used in this study are the eight degree programs in the College of Engineering and Architecture namely: BSME, BSChe, BSIE, BSCE, BSEE, BSECE, BSGE, and BS Arch; seven degree programs in the College of Human Sciences which are AB Econ, AB Engl, Bachelor of Philosophy, AB Pol Sci, AB Comm, BS Psychology, and BSSW, and three from the College of Information and Computing Sciences which are BS Math, BSIT, and BSCS; and BSAc in the College of Accountancy and Commerce. The acronyms used for the degree offerings are as follows:

BSChe – Bachelor of Science in Chemical Engineering

BSCE – Bachelor of Science in Civil Engineering

BSEE – Bachelor of Science in Electrical Engineering

BSECE – Bachelor of Science in Electrical Engineering

BSIE – Bachelor of Science in Industrial Engineering

BSME – Bachelor of Science in Mechanical Engineering

BSGE – Bachelor of Science in Geodetic Engineering

BSArch – Bachelor of Science in Architecture

AB Econ – Bachelor of Arts major in Economics

AB Engl – Bachelor of Arts major in English

AB Pol. Sci. – Bachelor of Arts major in Political Science

AB Comm – Bachelor of Arts major in Mass Communication

BS Psycho – Bachelor of Science in Psychology

BSSW – Bachelor of Science in Social Work

BSAc – Bachelor of Science in Accountancy

BS Math – Bachelor of Science in Mathematics

BSIT – Bachelor of Science in Information Technology

BSCS – Bachelor of Science in Computer Science

METHODS AND PROCEDURES

Research Design and Methodology

The data on the tertiary enrolment at the Saint Louis University were gathered. The enrolment data utilized in this study is a ten-year period which started from the school year 1997 – 1998 to school year 2006 – 2007.

In this study, a discrete time Markov chain was considered. Karlin et. al. (1975) defined a discrete time Markov chain S_n as a Markov process whose state space is countable or finite set and for which t = 0, 1, 2, 3,…., *n*, that is, a jump of more than one steps occurred.

Harshbarger (1989) and Larson (1991) added that Markov chain is a study of repeated trials in which the outcome on any trial depends only on the outcome of the previous trials. Typically, each experiment has a finite fixed number of outcomes called states.

Specifically, five states were considered: the freshmen, sophomore, junior and senior levels and quit or drop-out. For the sake of simplicity each level was coded correspondingly as 1, 2, 3, 4 and Q for the four-year degree programs and 1, 2, 3, 4, 5, and Q for the five-year engineering programs. These are referred to as the S_n states. From the gathered data, the transition probabilities were computed and comprise the transition matrix. Forecast values on the number of students for the next five years were computed based on the average of the recent ten years, that is, from school-year 1997-1998 to school year 2006-2007.

Transition Probabilities

The matrices which show the flow of students was computed in a one-year interval, starting from school-year 1997–1998 to school-year 2006–2007 for the following degree courses: seven from the College of Engineering and Architecture namely: BSME, BSChe, BSIE, BSCE, BSEE, BSECE, and BS Architecture; seven degree offerings in the College of Human Sciences which are: AB Econ, AB English, Bachelor of Philosophy, AB Political Sciences, AB Communication, BS Psychology, and BS Social Work; three degree offerings in the College of Information and Computing Sciences, and BS Accountancy in the College of Accountancy and Commerce.

In computing the transition probabilities, the number of students continuing to the next level was derived by subtracting from each year level the number of students coming from another course (shifter) or from another school (transferee).

Population of the Study

The population comprises the students from the College of Human Sciences, College of Engineering and Architecture, College of Information and Computing Sciences, and BS Accountancy. The exact enrolment statistics from the stated colleges form school year 1997-98 to school year 2006-2007 was utilized. Specifically, those taking up courses leading to the following degrees: BS in Chemical Engineering, BS in Civil Engineering, BS in Electrical Engineering, BS in Electronics and Communications Engineering, BS in Industrial Engineering, BS in Geodetic

Engineering, BS in Mechanical Engineering, BS in Architecture, AB in Economics, AB in English, AB in Political Science, Bachelor of Philosophy, BS in Psychology, BS in Social Work, BS in Information Technology, BS in Mathematics, and BS in Computer Science.

Data Gathering Tools

The researcher made use of secondary sources of data in gathering relevant information for this study. These data were acquired from the Management Information Systems Office of Saint Louis University.

Statistical Tool

The average of the ten-year enrolment data was computed and used as a basis for the computation of the transition probabilities. It is also used to derive the initial state vector. The average is computed as follows:

$$\bar{x} = \frac{\sum_{1}^{10} y_n}{10}$$

where $\bar{x}$ = average enrolment for the year level, y_n= total enrolment for the nth year (n = 1 to 10 years)

Markov Chain Analysis was used to assess and analyze the enrolment statistics and other pertinent data. From the gathered data, a Markov Chain model was constructed. Consequently, the enrolment distribution for the next five years was forecasted using the resulting Markov Chain model.

Projection of the Number of Students

Forecast values on the number of students for the next five years were computed based on the average of the recent ten years, that is, from school-year 1997-1998 to school-year 2006-2007.

The projection for each year level was arrived at by multiplying the matrix P by the row vector representing the recent ten years of the students' distribution.

Taking the average of school-year 1997-1998 to school-year 2006-2007 as t = 0, the row vector which is the initial enrolment was multiplied by the matrix P (transition matix) to come up with the row vector of enrolment for the year t = 1. Further, the enrolment distribution at t = 1 was multiplied by the matrix P and the resulting vector denotes the enrolment distribution at t = 2. Repetitive use of the above procedure enables one to project the number of students for the succeeding years.

In notation, let the row vector of enrolment be S_n. To determine the enrolment distribution at $t = n$, the formula $S_n = S_{n-1}*P$ will be used where S_n represents the current or present state, S_{n-1} the previous state vector, and P the transition matrix.

Farlow and Haggard (1987) suggested the following formula for finding the new state vector:

Let P be the transition matrix of a Markov chain with present state vector

$$p = (p_1, p_2, p_3, \ldots\ldots, p_m)$$

The new state vector

$p' = (p_1', p_2', \ldots\ldots, p_m')$ is found by computing the matrix

product

$$\underset{\substack{\textit{Pesent State}\\ \textit{Vector, } S_{n-1}}}{(p_1, p_2, \ldots, p_m)} \underset{\textit{Transition Matrix}}{\begin{vmatrix} p_{11} & p_{12} \ldots\ldots p_{1m} \\ p_{21} & p_{22} \ldots\ldots p_{2m} \\ & . \\ & . \\ p_{m1} & p_{m2} \ldots\ldots p_{mn} \end{vmatrix}} = \underset{\substack{\textit{New State}\\ \textit{Vector, } S_{n}}}{(p_1', p_2', \ldots, p_m')}$$

In matrix language the above relationship can be written as $pP = p'$ where P is the transition matrix. The limiting vector, called the steady state vector of the Markov chain, of the above sequence of state vectors will give the proportion or fraction of students that will ultimately be in each of the levels or states.

The flowchart on the research design for the Markov Chain is shown in Figure 2 on the next page.

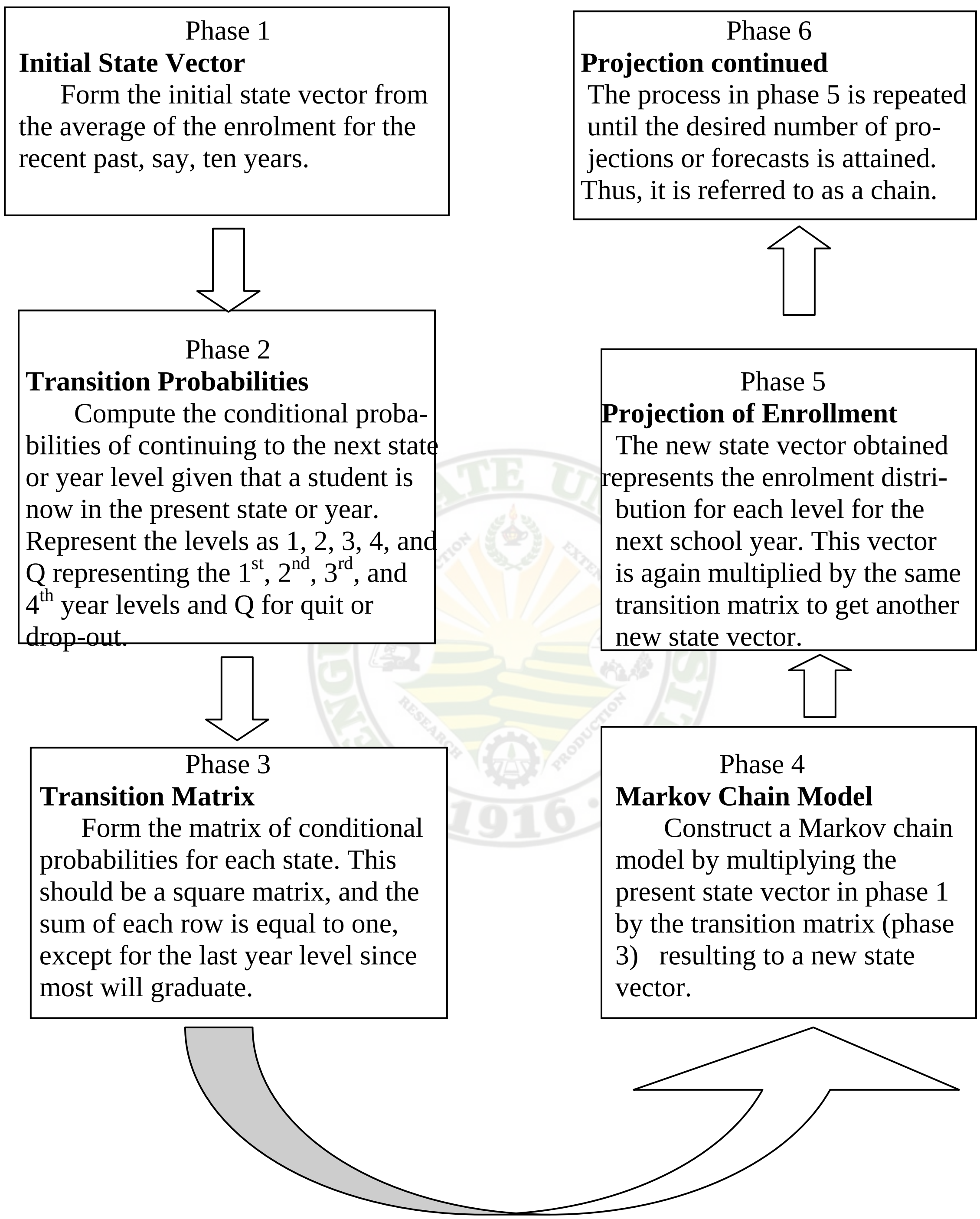

Figure 2 Flowchart on the research design for the Markov Chain

RESULTS AND DISCUSSION

Preliminary Analysis

The following data were gathered from the Management Information Systems Office of Saint Louis University: a) enrolment statistics for each year level in each degree program for the last ten years, b) number of shifters in each year level for each degree program for the last ten years, and c) transferees in each year level for each degree program for the last ten years. From these data, the initial state vector was constructed. The total enrolment per year level for each degree program for the last ten years is shown in Table 1.

It was observed that among the 19 degree programs used in this study, BS Accountancy has the biggest population in the first year level, whereas the least populated program is BS Geodetic Engineering.

Transition Probabilities

The conditional probabilities or transition probabilities indicate the chance or likelihood of moving from one state to another, or stated in another way, from one year level to the next level. These probabilities were used to obtain the transition matrices. Each matrix was used as a multiplier to the present state row vector to arrive at the new state vector.

Table 1. Total enrolment from school year 1997-98 to 2006-07 by degree program

	Year Level			
Degree Program	First	Second	Third	Fourth
AB English	667	450	470	490
AB Economics	447	296	260	270
Bachelor of Philosophy	631	570	640	680
AB Political Science	3522	3319	3063	2899
AB Communication	3638	3215	2594	2289
BS Psychology	3593	3570	3096	2148
BS Social Work	1528	1527	1550	1418
BC Computer Science*	363	99	9	5
BS Information Technology**	5258	4117	3352	2592
BS Mathematics	526	275	289	256

For the five-year degree programs	First	Second	Third	Fourth	Fifth
BS Accountancy*	5798	4682	1797	2009	1928
BS Chemical Engineering	1770	1640	1650	1640	1775
BS Civil Engineering	5027	3779	3606	2961	2725
BS Electrical Engineering	2009	1743	2711	2247	2301
BS ECE	13429	12220	9113	7730	7700
BS Industrial Engineering	1314	1217	1280	1330	1420
BS Mechanical Engineering	3127	2537	2533	2170	2160
BS Geodetic Engineering	206	156	174	156	228
BS Architecture	3347	2252	2161	1998	1685

* For the previous three years
** For the previous seven years

Table 2 shows the computed transition probabilities for AB English corresponding to the conditional probabilities of the first, second, third and fourth years as they move from one state (year level) to another state (next year level) given that they are now in the present state. Also presented in the same matrix of conditional probabilities are the probabilities that a student will not move on to the next state given that he is in the present state, that is, he may have dropped out or retained in the same year level.

Using the past ten years enrolment statistics for AB English, the probability that a student will be promoted to second year (t + 1) given that he is presently enrolled as a first year is 0.60, and the probability of being retained in the first year level is 0.35, while the probability that a freshman is likely to drop or quit is 0.05. Likewise, the probability of the continuing second year students to be promoted to the third year level (t + 2) is 0.97 and the probability of being retained in the second year is 0.01, whereas the probability of quitting or leaving the system is 0.02. Furthermore, the probability of the continuing third students to be promoted to the fourth year level (t + 3) is 0.98 and the probability of quitting is 0.02. Moreover, there is a probability of 0.01 that a fourth year student quits or drops. It is plainly observed that the highest retention rate is in the first year level, that is, 35%, and it has also the highest probability of students who drop or quit. Furthermore, 1% of the seniors are likely to quit, thus it is presumed that 99% will graduate.

Table 2. Transition probabilities for AB English

Level	1	2	3	4	Q
1	0.35	0.60	0	0	0.05
2	0	0.01	0.97	0	0.02
3	0	0	0.00	0.98	0.02
4	0	0	0	0	0.01
Q	0	0	0	0	1

Table 3. Transition probabilities for Bachelor of Philosophy

Level	1	2	3	4	Q
1	0.09	0.87	0	0	0.04
2	0	0	0.98	0	0.02
3	0	0	0.01	0.97	0.02
4	0	0	0	0	0.02
Q	0	0	0	0	1

Table 3, on the other hand, shows the conditional probabilities for Bachelor of Philosophy. There is a probability of 0.87 that a freshman will be moving to the second year level given that he is now in the first year, 0.09 chance of being retained, and 0.04 probability of quitting. Moreover, there is a 0.98 probability that a sophomore will be promoted to the third year level and a 0.97 probability for a junior to be promoted to the fourth year.

Table 4 shows the transition probabilities for AB Economics. It is observed that there is a 62% chance of a continuing student to be promoted to the second year level given that he is now in the first year level and the percentage that a student will be retained in the first year is 34%, and about 4% of the freshmen are likely to drop or quit. Moreover, there is an 87% chance that a second year student will move to the third year and 96% chance that a third year

Table 4. Transition probabilities for AB Economics

Level	1	2	3	4	Q
1	0.34	0.62	0	0	0.04
2	0	0.09	0.87	0	0.04
3	0	0	0.01	0.96	0.03
4	0	0	0	0	0.01
Q	0	0	0	0	1

Table 5. Transition probabilities for AB Political Science

Level	1	2	3	4	Q
1	0.07	0.89	0	0	0.03
2	0	0.06	0.92	0	0.03
3	0	0	0.04	0.94	0.01
4	0	0	0	0	0.01
Q	0	0	0	0	1

will move to the fourth years.

Table 5 shows the transition matrix for AB Political Science. It depicts an 89% chance that a first year student moves to the second year level and a 92% chance of moving to the third year level given that a student is now in the second year. Whereas, a junior has a 94% chance of being promoted to the fourth year level.

Likewise, the conditional probabilities for AB Communications in Table 6 show that there is an 84% chance that a first year student will move to the second year level and an 80% chance of moving to the third year level given that a student is now in the second year. Whereas, a junior has an 88% chance of being promoted to the fourth year level.

Table 6. Transition probabilities for AB Communication

Level	1	2	3	4	Q
1	0.12	0.84	0	0	0.04
2	0	0.18	0.80	0	0.02
3	0	0	0.09	0.88	0.03
4	0	0	0	0	0.02
Q	0	0	0	0	1

Table 7. Transition probabilities for BS Psychology

Level	1	2	3	4	Q
1	0.01	0.95	0	0	0.04
2	0	0.12	0.85	0	0.03
3	0	0	0.29	0.69	0.02
4	0	0	0	0	0.01
Q	0	0	0	0	1

Shown in Table 7 are the transition probabilities for BS Psychology where it is observed that there is a probability of 0.95 that a student will be moving to the second year level given that he is now in the first year; a 0.85 probability that a sophomore will be promoted to the third year level; a 0.69 probability that a junior will be promoted to the fourth year level. The highest retention rate is in the third year level.

Based on the computed conditional probabilities shown in Table 8 for BS Social Work, there is a probability of 0.95 that a student will be moving to the second year level given that he is now in the first year; a 0.98 probability that a sophomore will be promoted to the third year level; a 0.93 probability for a junior to be promoted to the fourth year level.

Table 8. Transition probabilities for BS Social Work

Level	1	2	3	4	Q
1	0.01	0.95	0	0	0.04
2	0	0.01	0.98	0	0.01
3	0	0	0.06	0.93	0.01
4	0	0	0	0	0.02
Q	0	0	0	0	1

Table 9. Transition probabilities for BS Computer Science

Level	1	2	3	4	Q
1	0.02	0.92	0	0	0.06
2	0	0.05	0.93	0	0.02
3	0	0	0.03	0.94	0.03
4	0	0	0	0	0.03
Q	0	0	0	0	1

As for BS Computer Science, there is a probability of 0.92 that a student will be moving to the second year level given that he is now in the first year; a 0.93 probability that a second year student will be promoted to the third year; a 0.94 probability for a junior to be promoted to the fourth year level. Table 9 shows these results.

For BSIT shown in Table 10, there is a 76% chance that a first year student moves to the second year level and an 81% chance of moving to the third year level given that a student is now in the second year. Whereas, a junior has a 77% chance of being promoted to the fourth year level. It is also observed that the highest rate of retention is in the third year, and the highest percentage of dropping students is in the first year.

Table 10. Transition probabilities for BS Information Technology

Level	1	2	3	4	Q
1	0.17	0.76	0	0	0.07
2	0	0.16	0.81	0	0.03
3	0	0	0.21	0.77	0.02
4	0	0	0	0	0.01
Q	0	0	0	0	1

Table 11. Transition probabilities for BS Math

Level	1	2	3	4	Q
1	0.33	0.62	0	0	0.05
2	0	0.01	0.96	0	0.03
3	0	0	0.07	0.90	0.03
4	0	0	0	0	0.01
Q	0	0	0	0	1

Table 11 shows the conditional probabilities for BS Math. There is a 62% chance that a first year student is promoted to the second year level and a 96% chance to be promoted to the third year level given that a student is now in the second year. Whereas, a junior has a 90% chance of being promoted to the fourth year level.

For BS Accountancy, there is a probability of 0.80 that a student will be moving to the second year level given that he is now in the first year; a 0.44 probability for a sophomore to be promoted to the third year level, 0.88 probability for a junior to be promoted to the fourth year, and 0.99 probability for a fourth year student to be promoted to the fifth year. Table 12 further shows that the retention rate in the second year level is very high.

Table 12. Transition probabilities for BS Accountancy

Level	1	2	3	4	5	Q
1	0.18	0.80	0	0	0	0.04
2	0	0.55	0.44	0	0	0.01
3	0	0	0.11	0.88	0	0.01
4	0	0	0	0	0.99	0.01
5	0	0	0	0	0	0.01
Q	0	0	0	0	0	1

This is due to the cut-off grade prescribed by the college in order for a sophomore to move to the third level in the same course.

For BS Chemical Engineering, there is a 91% chance that a first year student moves to the second year level and a 98% chance of moving to the third year level given that a student is now in the second year. Whereas, a junior has a 98% chance of being promoted to the fourth year level, and also 98% to be promoted to the fifth year level given that a student is now in the fourth year. Table 13 shows the above-stated probabilities.

As for BSCE, there is a probability of 0.26 that a freshman will be retained or will not move to the second year level, a probability of 0.74 that a student will be moving to the second year level given that he is now in the first year; 0.95 probability for a sophomore to be promoted to the third year level, 0.82 probability for a junior to be promoted to the fourth year, and 0.92 probability for a fourth year to be promoted to the fifth year. It is further observed that a freshman is not likely to drop or quit. These results are shown in table 14.

Table 13. Transition probabilities for BS Chemical Engineering

Level	1	2	3	4	5	Q
1	0.09	0.91	0	0	0.00	0.004
2	0	0.01	0.98	0	0.00	0.01
3	0	0	0.01	0.98	0.00	0.01
4	0	0	0	0.00	0.98	0.02
5	0	0	0	0	0	0.01
Q	0	0	0	0	0.00	1.00

Table 14. Transition probabilities for BS Civil Engineering

Level	1	2	3	4	5	Q
1	0.26	0.74	0	0	0.00	0.004
2	0	0.02	0.95	0	0.00	0.03
3	0	0	0.15	0.82	0.00	0.03
4	0	0	0	0.07	0.92	0.01
5	0	0	0	0	0	0.01
Q	0	0	0	0	0.00	1.00

Table 15 shows the transition probabilities for BSEE. There is an 86% chance that a first year student moves to the second year level and a 96% chance of moving to the third year level given that a student is now in the second year. Whereas, a junior has a 97% chance of being promoted to the fourth year level, and also 98% to be promoted to the fifth year level given that a student is now in the fourth year.

For BSECE, Table 16 shows that there is a 90% chance that a first year student moves to the second year level and a 74% chance of moving to the third year level given that a student is now in the second year. Whereas, a junior has a 85% chance of being promoted to the fourth year level, and also 99% to be promoted to the fifth year level given that a student is now in the fourth year.

Table 15. Transition probabilities for BS Electrical Engineering

Level	1	2	3	4	5	Q
1	0.14	0.86	0	0	0.00	0.004
2	0	0.00	0.96	0	0.00	0.04
3	0	0	0.01	0.97	0.00	0.02
4	0	0	0	0.00	0.98	0.02
5	0	0	0	0	0	0.01
Q	0	0	0	0	0	1.00

Table 16. Transition probabilities for BS Electronics and Communications Engineering

Level	1	2	3	4	5	Q
1	0.10	0.90	0	0	0.00	0.003
2	0	0.23	0.74	0	0.00	0.03
3	0	0	0.13	0.85	0.00	0.02
4	0	0	0	0.00	0.990	0.01
5	0	0	0	0	0	0.01
Q	0	0	0	0	0.00	1.00

As for BS Industrial Engineering, there is a probability of 0.83 that a student will be moving to the second year level given that he is now in the first year; 0.96 probability for a sophomore to be promoted to the third year level, 0.96 probability for a junior to be promoted to the fourth year, and 0.97 probability for a fourth year to be promoted to the fifth year. These are shown in Table 17.

In Table 18 are the conditional probabilities for BS Mechanical Engineering. It is shown that there is a probability of 0.80 that a student will be moving to the second year level given that he is now in the first year; 0.97 probability for a sophomore to be promoted to the third year level, 0.86 probability for a junior to be promoted to the fourth year, and 0.98 probability for

Table 17. Transition probabilities for BS Industrial Engineering

Level	1	2	3	4	5	Q
1	0.17	0.83	0	0	0.00	0.04
2	0	0.01	0.96	0	0.00	0.03
3	0	0	0.01	0.96	0.00	0.03
4	0	0	0	0.00	0.972	0.03
5	0	0	0	0	0	0.01
Q	0	0	0	0	0.00	1.00

Table 18. Transition probabilities for BS Mechanical Engineering

Level	1	2	3	4	5	Q
1	0.20	0.80	0	0	0.00	0.04
2	0	0.01	0.97	0	0.00	0.03
3	0	0	0.12	0.86	0.00	0.02
4	0	0	0	0.01	0.979	0.01
5	0	0	0	0	0	0.01
Q	0	0	0	0	0.00	1.00

a fourth year to be promoted to the fifth year.

As for BS Geodetic Engineering, in Table 19 there is a 67% chance that a student will be moving to the second year level given that he is now in the first year, 97% chance for a sophomore to be promoted to the third year level, 89% chance for a junior to be promoted to the fourth year, and 96% for a fourth year to be promoted to the fifth year. It is observed further that a freshman is less likely to drop or quit. However, as compared to the other engineering courses, BS Geodetic Engineering has the highest retention rate in the first year level which is 33%, leaving only 67% of the freshmen to continue to the second year level.

Table 20 shows that there is a 0.66 probability that a current freshman in BS Architecture will continue to the second year level, and 34% are likely to be retained. Furthermore, there is a probability of 0.95 for a sophomore to be promoted to the third year level, a probability of 0.92 for a third year student to move to the fourth year level, and a probability of 0.84 for a student in the fourth year to move to the fifth year.

Table 19. Transition probabilities for BS Geodetic Engineering

Level	1	2	3	4	5	Q
1	0.33	0.67	0	0	0.00	0.003
2	0	0.01	0.97	0	0.00	0.02
3	0	0	0.09	0.89	0.00	0.02
4	0	0	0	0.03	0.962	0.01
5	0	0	0	0	0	0.02
Q	0	0	0	0	0	1.00

Table 20. Transition probabilities for BS Architecture

Level	1	2	3	4	5	Q
1	0.34	0.66	0	0	0.00	0.003
2	0	0.02	0.95	0	0.00	0.02
3	0	0	0.06	0.92	0.00	0.02
4	0	0	0	0.14	0.84	0.01
5	0	0	0	0	0	0.02
Q	0	0	0	0	0	1.00

Projected Number of Students for the Next Five Years (School Year 2007-2008 to SY 2011-2012)

Corresponding to the derived transition matrix, projections on the enrolment pattern for the year were made for each degree program by multiplying the current state vector with the transition matrix. This process was repeated for four times (iterations) to arrive at the forecasted number of enrollees for each school-year on the next five years. This process results to a chain which is referred to as the Markov chain model.

Table 21. Projected number of students for AB English for the next five years

	Year Level			
School Year	First	Second	Third	Fourth
2007-2008	67	45	47	49
2008-2009	90	41	44	46
2009-2010	122	55	39	43
2010-2011	165	74	53	39
2011-2012	223	100	72	52

For the program AB English, it is projected that there will be around 67, 90, 122, 165, and 223 incoming freshmen for the school years 2007-2008, 2008-2009, 2009-2010, 2010-2011, and 2011-2012 respectively. The computed values for each year level are shown in Table 21.

Likewise, a projection on the enrolment distribution for the next five years for Bachelor of Philosophy is summarized in Table 22. Based on the computed results, there is much lower additional number of incoming freshmen (ten or less) for each school year in the course Bachelor of Philosophy as compared to that of AB English. There will be around 63, 69, 75, 82, and 89 enrollees for the first year in the next five school years.

Table 22. Projected number of students for Bachelor of Philosophy

	Year Level			
School Year	First	Second	Third	Fourth
2007-2008	63	57	64	68
2008-2009	69	55	57	62
2009-2010	75	60	54	55
2010-2011	82	65	59	53
2011-2012	89	71	64	57

Table 23. Projected number of students for AB Economics

	Year Level			
School Year	First	Second	Third	Fourth
2007-2008	45	30	26	27
2008-2009	60	31	26	25
2009-2010	81	40	27	25
2010-2011	108	54	35	26
2011-2012	145	72	47	34

Projections on the enrolment pattern for the next five years in AB Economics are shown in Table 23. Based on the results, it is observed that there is a less increase in the number of incoming freshmen in AB Economics than in AB English, but a little higher than in Bachelor of Philosophy. Furthermore, a significant decrease is noted in the number of continuing second year students (from the first year level) which means that many students may be retained, dropped out, shift to another course or transfer.

As observed in Table 24 the projections are quite big but a closer look at the first year level conveys just an average of less than thirty students added every year for the next five years in AB Political Science.

Table 24. Projected number of students for AB Political Science

	Year Level			
School Year	First	Second	Third	Fourth
2007-2008	352	332	306	290
2008-2009	377	333	318	288
2009-2010	403	355	319	299
2010-2011	431	380	340	300
2011-2012	461	407	363	319

Table 25. Projected number of students for AB Communication

School Year	Year Level First	Second	Third	Fourth
2007-2008	364	322	259	229
2008-2009	408	364	281	228
2009-2010	457	408	316	247
2010-2011	511	457	335	278
2011-2012	573	512	398	312

Likewise, Table 25 shows the projected enrolment distribution in the next five years for Bachelor of Arts in Communications. About one section of freshmen will be added each year.

Projections made on the enrolment distribution for the next five years for BS Psychology are shown in Table 26. Based on the results, big numbers are seen but the projected yearly increase in the incoming freshmen is just about 3 to 4 students; there is no significant increase.

Table 27 shows the projected enrolment distribution for BS Social Work for the next five years. It is observed that there is a very little increase, about one or two students, in the number of incoming freshmen for the next five years. There is, however, a high rate of continuing students to the next year level.

Table 26. Projected number of students for BS Psychology

School Year	Year Level First	Second	Third	Fourth
2007-2008	359	357	310	215
2008-2009	363	384	393	214
2009-2010	366	391	440	271
2010-2011	370	395	460	304
2011-2012	374	399	469	317

Table 27. Projected number of students for BS Social Work

	Year Level			
School Year	First	Second	Third	Fourth
2007-2008	153	153	155	142
2008-2009	155	147	159	144
2009-2010	156	148	153	148
2010-2011	158	150	155	143
2011-2012	159	151	156	144

The corresponding projected enrolment distribution for BSCS for the next five years is shown in Table 2. The number of students in the third and fourth year levels in school year 2007-2008 is very alarming. Most of the students most probably shifted to BSIT or any related new course. Based on the present demand, BS Information Technology and BS Information Management (BSIM) have higher demand than BSCS. Despite the projected increase in the enrolment for the next five years, there is a great possibility of being phased out since BSIT and BSIM are already offered. Saint Louis University just started to offer BSIM this school year 2006-2007. This could be a good alternative program.

Table 28. Projected number of students for BS Computer Science

	Year Level			
School Year	First	Second	Third	Fourth
2007-2008	121	33	3	2
2008-2009	123	113	31	3
2009-2010	126	119	106	29
2010-2011	128	122	114	100
2011-2012	131	124	117	107

Table 29. Projected number of students for BSIT

	Year Level			
School Year	First	Second	Third	Fourth
2007-2008	751	588	479	370
2008-2009	879	665	577	369
2009-2010	1028	774	660	444
2010-2011	1203	905	766	508
2011-2012	1407	1059	894	590

Table 29 shows large populations indicating that many students are attracted to the course BSIT. It is known for a fact that our society is becoming technology-based and industries, companies, large firms and institutions cannot survive without computer technology since large array of information could be stored in them.

Table 30 shows the projected enrolment distribution for BS Math for the next five years. A perusal of the results reveals that there is a high mortality rate in the first year level. There is a very low chance for a freshman to continue to the second year level. Furthermore, there is a gradual increase in the number of forthcoming freshmen.

Table 30. Projected number of students for BS Math

	Year Level			
School Year	First	Second	Third	Fourth
2007-2008	53	28	29	26
2008-2009	70	33	29	26
2009-2010	94	44	34	26
2010-2011	125	59	45	30
2011-2012	166	78	59	40

Table 31. Projected number of students for BS Accountancy

			Year Level		
School Year	First	Second	Third	Fourth	Fifth
2007-2008	1933	1561	599	670	643
2008-2009	2281	2405	753	527	663
2009-2010	2692	3147	1141	662	522
2010-2011	3176	3884	1510	1004	656
2011-2012	3748	4677	1875	1329	994

In Table 31, it is observed that BS Accountancy has a very large population, almost 40 sections of freshmen. However, the chance of continuing until the third level is quite low. The college conducts departmental examinations for major (accounting) subjects so that the screening will be impartial. In this regard, many students obtain deficiencies, thus, they cannot go to the next year level. Many of them shift to another major or course.

Table 32 summarizes the enrolment pattern for the next five years in BS Chemical Engineering. It is observed that there are more or less twenty students added each year in the first year for the next five years.

Table 32. Projected number of students for BS Chemical Engineering

			Year Level		
School Year	First	Second	Third	Fourth	Fifth
2007-2008	177	164	165	164	162
2008-2009	193	163	162	162	161
2009-2010	210	177	161	159	159
2010-2011	229	193	175	158	156
2011-2012	250	211	191	172	155

Table 33. Projected number of students for BS Civil Engineering

	Year Level				
School Year	First	Second	Third	Fourth	Fifth
2007-2008	503	378	361	296	273
2008-2009	634	380	413	317	272
2009-2010	799	477	423	361	291
2010-2011	1006	600	516	372	332
2011-2012	1268	757	648	449	342

Likewise, the projected enrolment distribution for the next five years in BS Civil Engineering is shown on Table 33. It is observed that the number of students who reach the last year level is very few compared to the initial number of freshmen. This may be due to difficult major subjects that may lead students to shift to another course or be retained. This, however, is a general observation for all the engineering programs.

Table 34 shows the projected enrolment distribution for the next five years for BSEE. About one section is added each year for the next five years in the first year level.

Table 34. Projected number of students for BS Electrical Engineering

	Year Level				
School Year	First	Second	Third	Fourth	Fifth
2007-2008	201	174	271	225	230
2008-2009	229	173	170	263	221
2009-2010	261	197	168	165	258
2010-2011	298	225	191	163	161
2011-2012	339	256	218	185	159

Table 35. Projected number of students for BS Electronics and Communications Engineering

School Year	First	Second	Year Level Third	Fourth	Fifth
2007-2008	1343	1222	911	773	770
2008-2009	1477	1490	1023	774	765
2009-2010	1625	1672	1235	869	767
2010-2011	1788	1847	1398	1050	861
2011-2012	1966	2034	1549	1188	1040

It is noted that BSECE has the highest number of enrollees in the College of Engineering and Architecture. Consequently, it produces the most number of graduates in the same college. In the projections made as shown in Table 35, it will still be the most populated department among the Engineering departments, with about three sections of freshmen added each year for the next five years. Saint Louis University addressed this concern by creating a related course, BS Mechatronics Engineering, which is now in its first year of operation.

Table 36 displays the projected enrolment distribution for the next five years in BSIE. In contrast to BSECE, there will be a very little increase in the

Table 36. Projected number of students for BS Industrial Engineering.

School Year	First	Second	Year Level Third	Fourth	Fifth
2007-2008	131	122	128	133	142
2008-2009	153	110	118	123	129
2009-2010	179	128	107	114	119
2010-2011	210	150	124	102	110
2011-2012	245	176	145	119	100

Table 37. Projected number of students for BS Mechanical Engineering

School Year	Year Level First	Second	Third	Fourth	Fifth
2007-2008	313	254	253	217	216
2008-2009	376	253	277	220	212
2009-2010	451	303	279	240	215
2010-2011	541	364	327	242	235
2011-2012	649	436	392	284	237

number of incoming freshmen for the next five years in BSIE.

Table 37, likewise, shows the projected enrolment distribution for the next five years in BS Mechanical Engineering. It is projected that one to two sections of freshmen will be added for the next five years.

Table 38 shows the projection on the enrolment pattern for the next five years in BS Geodetic Engineering. It is observed that at present, the number of freshmen is below the normal one section and that the increase in the incoming freshmen for the next five years is an average of ten students.

Table 38. Projected number of students for BS Geodetic Engineering

School Year	Year Level First	Second	Third	Fourth	Fifth
2007-2008	21	16	17	16	23
2008-2009	28	14	17	16	15
2009-2010	37	19	15	16	15
2010-2011	49	25	20	14	15
2011-2012	66	33	26	18	14

Table 39. Projected number of students for BS Architecture

	Year Level				
School Year	First	Second	Third	Fourth	Fifth
2007-2008	335	225	216	200	169
2008-2009	449	226	227	227	168
2009-2010	602	301	228	240	190
2010-2011	806	403	299	243	202
2011-2012	1080	540	401	310	204

The projections on the enrolment pattern for BS Architecture are shown in Table 39. It is projected that two to three sections are added each year for the next five years.

Based on the over-all projected values, it has been observed that the following degree programs will have a very little increase each year in the next five years on the number of incoming first years, that is, less than 40 students for each school year: BS Computer Science, BS Social Work, Bachelor of Philosophy, BS Psychology and BS Industrial Engineering. On the other hand, the following colleges have big number of additional incoming first years in the succeeding years after 2007-2008: AB Economics, AB English, BS Mathematics, BS in Accountancy, BS in Electronics and Communications Engineering, BS Architecture, BS Civil Engineering, and BS Information Technology. The other degree programs have an average of just one additional section of incoming first years per school year for the next five years.

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

School administrators regularly prepare, among others, a budget plan for the coming years, say, for the next five years. The forecasted number of enrolment for each year level and each school year is of utmost importance in the plan.

The researcher was determined to pursue this study because of the relevance in today's competitive condition in schools. The assessment and analysis of the present enrolment statistics would assist school administrators in the planning and decision-making.

The enrolment statistics for the past ten years was used to form transition matrices for the conditional probabilities of the movement of students from one year level to the next. The average number of drop-outs, transferees and shifters were also gathered and subtracted from the average enrolment to derive the conditional probabilities. Nineteen matrices were formed to correspond to the nineteen degree programs. Furthermore, an initial state row vector was derived from the average enrolment for the past ten years.

The projected numbers of students for the next school year (SY 2007-2008) were arrived at by multiplying the initial state vector by the transition matrix; the resulting row matrix would again be multiplied by the same transition matrix to arrive at the next set of projected number of students (for SY 2008-2009); and this process went on until five groups of data were gathered corresponding to the next five school years.

Summary of Findings

The analysis and interpretation of data resulted in the projection of enrolment for the next five years for the selected degree programs at Saint Louis University. Based on the computations made, there will be an increase in enrolment per year from school year 2007-2008 to SY 20111-2012. The increase, however, is not constant or the same for all the degree programs. The following degree programs will have a very little increase in the number of incoming first years, that is, less than 40 students increase in each school year: BS Computer Science, BS Social Work, Bachelor of Philosophy, BS Psychology and BS Industrial Engineering, AB Political Science, and BS Chemical Engineering. On the other hand, the following colleges have big number of additional incoming first years in the succeeding years after 2007-2008: BS in Accountancy, BS in Electronics and Communications Engineering, BS Architecture, BS Civil Engineering, and BS Information Technology. The other degree programs have just an average of additional one section per school year.

This would help administrators in their five-year plan pertaining to, but not limited to, number of new faculty members to be hired, availability of classrooms and budget.

Conclusion

The Markov Chain Analysis is one of the best tools used in predicting behavior of future events on the condition that prior events have occurred. This process does not need too much historical data. It deals with the present state to predict behavior of the future state. There are many applications in industry, in education, in business, in government, and in medical fields.

From this study, it is concluded that the degree with the highest projected increase in enrolment is BS Electronics and Communications Engineering.

The values obtained in this study, however, should not be taken as final and accurate since there are still other intervening factors that affect enrolment like parents' income, inflation, demand for a certain skill, employability rate, line of interest of the student, accessibility of school and the like.

Recommendation

It is recommended that further studies be conducted on forecasting student enrolment and include other variables such as number of students who have withdrawn, transferred to another school, and other pertinent data. Also, the probability that a student will graduate given that he is now in the fourth year could be added in the transition matrix. Further studies such as the employability of graduates from each degree program could also be made using the same statistical analysis. One could project the answers to the following questions: (a) how many of the graduates get employed in their own field, (b) How many get employed in fields other than their field of specialization? (c) How many of them leave the country?

Also, it is recommended that the other degree programs not included here be analyzed in the same manner.

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APPENDIX A

LETTER REQUEST TO THE MANAGEMENT INFORMATION SYSTEMS SAINT LOUIS UNIVERSITY BAGUIO CITY

APPENDIX A

Saint Louis University
College of Information and Computing Sciences
Department of Mathematics
Bonifacio Street, Baguio City

March 26, 2007

MR. ANGELITO PERALTA
Director, MIS Office
Saint Louis University

Thru: Ms Cynthia Arceo
OIC

Dear Sir;

Greetings!

I, the undersigned, am presently conducting a study on MARKOV MODELING AND FORECASTING OF SAINT LOUIS UNIVERSITY ENROLMENT IN THE TERTIARY LEVEL as a partial fulfillment for the degree Master of Arts in Applied Statistics. My study is limited to the data from school year 1997-1998 to school year 2006-2007 pertaining to the following colleges: College of Engineering and Architecture, College of Human Sciences, College of Information and Computing Sciences, College of Accountancy and Commerce (BS in Accountancy only).

In this connection, may I respectfully request from your office the following data:

a. Enrolment statistics per semester by degree program.
b. Number of drop-outs per semester by degree program.
c. Number of students who shifted from one program to another.
d. Number of transferees from other schools by year and by degree program.

Your favorable action on this request is highly appreciated.

Thank you very much.

Truly yours,

Zenaida Garambas

APPENDIX B

TOTAL ENROLLMENT FROM SCHOOL YEAR 1997-1998

TO 2006-2007 BY DEGREE PROGRAM

Appendix B-1. College of Human Sciences

COURSE	SCHOOL YR	YEAR LEVEL 1	2	3	4
AB Economics	1997-1998	105	30	47	42
	1998-1999	84	59	23	38
	1999-2000	44	48	34	27
	2000-2001	79	34	31	37
	2001-2002	34	33	33	32
	2002-2003	45	32	21	30
	2003-2004	24	25	30	17
	2004-2005	18	25	20	25
	2005-2006	14	10	22	17
	2006-2007	-	-		
AB English	1997-1998	56	37	42	51
	1998-1999	30	38	51	65
	1999-2000	79	13	43	62
	2000-2001	51	63	32	27
	2001-2002	40	31	52	60
	2002-2003	50	32	44	52
	2003-2004	61	50	50	61
	2004-2005	52	48	32	40
	2005-2006	123	49	49	40
	2006-2007	125	89	77	32
Bachelor of Philo	1997-1998	62	54	93	91
	1998-1999	25	34	60	70
	1999-2000	49	37	44	53
	2000-2001	101	42	43	52
	2001-2002	80	102	52	57
	2002-2003	82	66	77	61
	2003-2004	48	82	85	85
	2004-2005	79	42	75	80
	2005-2006	49	65	52	65
	2006-2007	56	46	61	63

Appendix B-1. Continued …

COURSE	SCHOOL YR	YEAR LEVEL 1	2	3	4
AB Pol Sci	1997-1998	432	397	267	222
	1998-1999	431	452	335	224
	1999-2000	471	353	442	318
	2000-2001	383	438	330	400
	2001-2002	364	347	413	339
	2002-2003	305	316	357	407
	2003-2004	344	259	263	340
	2004-2005	283	283	206	264
	2005-2006	294	248	228	187
	2006-2007	215	226	222	198
AB Comm	1997-1998	499	519	289	234
	1998-1999	462	452	335	224
	1999-2000	369	331	490	264
	2000-2001	354	268	288	359
	2001-2002	356	249	255	272
	2002-2003	301	326	232	223
	2003-2004	256	257	225	206
	2004-2005	345	197	130	187
	2005-2006	406	291	149	176
	2006-2007	290	325	201	144
BS Psychology	1997-1998	453	514	258	133
	1998-1999	411	582	273	197
	1999-2000	436	423	364	233
	2000-2001	425	398	388	243
	2001-2002	374	325	443	227
	2002-2003	343	365	356	272
	2003-2004	279	370	270	209
	2004-2005	253	311	261	227
	2005-2006	349	276	234	215
	2006-2007	270	322	249	192
BS Social Work	1997-1998	146	148	195	146
	1998-1999	115	188	139	153
	1999-2000	139	179	199	91
	2000-2001	165	193	168	167
	2001-2002	127	163	217	164
	2002-2003	132	137	180	181
	2003-2004	145	119	156	177
	2004-2005	189	126	117	144
	2005-2006	214	116	117	100
	2006-2007	156	158	112	95

Appendix B-2 College of Engineering and Architecture

COURSE	SCH YR	YEAR LEVEL 1	2	3	4	5
BS Che	1997-1998	197	232	193	153	154
	1998-1999	213	174	190	169	167
	1999-2000	196	211	188	152	170
	2000-2001	226	180	214	197	167
	2001-2002	224	199	213	161	207
	2002-2003	195	194	233	164	199
	2003-2004	121	162	194	219	173
	2004-2005	150	87	205	179	202
	2005-2006	120	108	138	165	176
	2006-2007	128	93	130	139	160
BSCE	1997-1998	499	304	359	224	233
	1998-1999	440	361	312	269	245
	1999-2000	511	375	385	344	260
	2000-2001	514	451	368	357	235
	001-2002	393	385	357	333	321
	2002-2003	476	342	364	308	355
	2003-2004	487	374	340	284	277
	2004-2005	577	367	385	230	310
	2005-2006	600	403	372	284	256
	2006-2007	530	417	364	328	233
BSEE	1997-1998	226	229	269	212	206
	1998-1999	155	194	220	241	230
	1999-2000	212	144	232	190	266
	2000-2001	191	207	236	156	207
	2001-2002	148	160	300	239	170
	2002-2003	182	121	260	297	225
	2003-2004	186	145	273	230	297
	2004-2005	242	168	276	224	276
	2005-2006	247	192	336	216	202
	2006-2007	220	183	309	242	222
BSECE	1997-1998	1897	1483	1093	726	528
	1998-1999	1434	1584	1314	852	660
	1999-2000	1418	1406	1329	972	793
	2000-2001	1575	1266	1093	876	1011
	2001-2002	1452	1379	929	819	1010
	2002-2003	1251	1445	888	848	909
	2003-2004	1071	1126	840	791	937
	2004-2005	1092	889	648	759	925
	2005-2006	1109	801	477	610	868
	2006-2007	1130	841	502	477	659

Appendix B-2. Continued…

		YEAR LEVEL				
COURSE	SCH YR	1	2	3	4	5
BSIE	1997-1998	206	197	252	172	78
	1998-1999	184	180	234	194	153
	1999-2000	170	156	257	208	198
	2000-2001	160	163	238	257	207
	2001-2002	125	121	233	229	243
	2002-2003	97	129	152	233	220
	2003-2004	93	72	159	183	216
	2004-2005	90	77	58	153	189
	2005-2006	88	55	79	53	165
	2006-2007	101	67	119	62	62
BSME	1997-1998	297	377	354	252	301
	1998-1999	265	240	319	290	309
	1999-2000	315	225	240	241	373
	2000-2001	239	273	229	189	355
	2001-2002	257	196	270	186	243
	2002-2003	251	243	194	233	220
	2003-2004	286	212	266	158	259
	2004-2005	338	206	210	195	186
	2005-2006	512	222	210	225	146
	2006-2007	367	343	241	201	200
BSGE	1997-1998	16	9	18	15	17
	1998-1999	22	9	10	17	24
	1999-2000	23	18	15	16	21
	2000-2001	23	20	18	18	21
	2001-2002	18	18	11	15	30
	2002-2003	35	11	24	6	24
	2003-2004	24	27	22	20	13
	2004-2005	15	24	22	20	23
	2005-2006	18	11	20	18	31
	2006-2007	12	9	14	11	24
BS Arch	1997-1998	395	223	232	171	134
	1998-1999	306	285	176	250	134
	1999-2000	319	234	232	206	171
	2000-2001	279	218	227	232	187
	2001-2002	252	201	203	206	188
	2002-2003	259	141	188	205	173
	2003-2004	269	183	168	159	193
	2004-2005	324	149	190	163	137
	2005-2006	333	169	181	141	134
	2006-2007	277	175	193	139	136

Appendix B-3 College of Information and Computing Sciences

COURSE	SCHOOL YR	YEAR LEVEL 1	2	3	4
BSCS	1996-1997	933	500	391	447
	1997-1998	8	659	473	416
	1998-1999	1	16	499	526
	1999-2000	-	-	90	487
	2000-2001	-	-	10	260
	2001-2002	-	-	20	14
	2002-2003	-	-	1	1
	2003-2004	-	-	1	4
	2004-2005	89	1	1	1
	2005-2006	178	52	2	2
	2006-2007	95	46	15	1
BSMath	1996-1997	67	35	12	7
	1997-1998	64	47	28	15
	1998-1999	60	31	48	23
	1999-2000	68	31	29	41
	2000-2001	76	37	34	29
	2001-2002	56	39	46	26
	2002-2003	38	17	38	35
	2003-2004	26	11	16	35
	2004-2005	28	5	17	20
	2005-2006	26	11	16	15
	2006-2007	17	12	17	10
BSIT	1996-1997	-	-	-	-
	1997-1998	-	-	-	-
	1998-1999	-	-	-	-
	1999-2000	-	-	-	-
	2000-2001	1006	688	598	431
	2001-2002	1175	711	621	474
	2002-2003	776	692	565	492
	2003-2004	596	461	518	366
	2004-2005	578	323	437	391
	2005-2006	527	365	321	230
	2006-2007	600	877	292	208

Appendix B-4 College of Commerce and Accountancy

		YEAR LEVEL				
COURSE	SCH YR	1	2	3	4	5
BS Ac	1996-1997	1262	1346	486	360	-
	1997- 1998	1454	1150	580	354	-
	1998-1999	1467	1086	528	422	-
	1999-2000	2184	1246	543	463	-
	2000-2001	2079	1742	536	501	-
	2001-2002	1969	1781	862	459	-
	2002-2003	1844	1613	951	824	-
	2003-2004	1983	1467	818	894	-
	2004-2005	1940	1528	571	744	794
	2005-2006	2104	1511	695	605	817
	2006-2007	1754	1643	531	660	767

APPENDIX C

TOTAL DROP-OUTS FROM SCH00L YEAR 1997-1998

BY DEGREE PROGRAM

Appendix C-1 College of Human Sciences

COURSE	SCHOOL YR	YEAR LEVEL 1	2	3	4
AB Econ	1997-1998	5	3	4	0
	1998-1999	5	2	0	0
	1999-2000	0	1	0	0
	2000-2001	2	0	1	0
	2001-2002	1	1	1	1
	2002-2003	1	2	0	1
	2003-2004	0	1	0	0
	2004-2005	1	1	1	0
	2005-2006	1	0	0	0
	2006-2007	0	0	0	0
AB English	1997-1998	1	1	1	1
	1998-1999	0	0	0	0
	1999-2000	3	0	1	0
	2000-2001	3	0	0	1
	2001-2002	3	0	1	0
	2002-2003	6	1	2	0
	2003-2004	4	2	4	0
	2004-2005	2	2	0	0
	2005-2006	4	2	0	0
	2006-2007	12	1	2	2
Bachelor of Philo	1997-1998	3	3	2	1
	1998-1999	2	0	1	3
	1999-2000	1	0	2	0
	2000-2001	4	1	1	1
	2001-2002	3	1	0	1
	2002-2003	1	4	3	0
	2003-2004	1	0	5	1
	2004-2005	5	2	0	4
	2005-2006	2	2	1	0
	2006-2007	3	1	0	1

Appendix C-1. Continued…

COURSE	SCHOOL YR	YEAR LEVEL 1	2	3	4
AB Pol. Sci.	1997-1998	11	12	7	3
	1998-1999	13	9	5	4
	1999-2000	8	10	5	1
	2000-2001	11	5	1	3
	2001-2002	10	3	6	2
	2002-2003	9	10	6	4
	2003-2004	19	20	4	4
	2004-2005	18	10	4	4
	2005-2006	11	10	3	4
	2006-2007	7	6	2	0
AB Comm	1997-1998	19	15	9	8
	1998-1999	11	12	9	8
	1999-2000	11	4	9	3
	2000-2001	20	10	8	6
	2001-2002	20	7	5	3
	2002-2003	12	10	7	6
	2003-2004	11	6	5	1
	2004-2005	14	5	7	2
	2005-2006	7	6	5	3
	2006-2007	8	5	3	1
BS Psychology	1997-1998	12	7	2	1
	1998-1999	7	12	3	2
	1999-2000	6	9	3	3
	2000-2001	23	5	6	1
	2001-2002	21	5	6	1
	2002-2003	16	7	5	1
	2003-2004	16	11	5	1
	2004-2005	23	10	7	0
	2005-2006	11	11	4	3
	2006-2007	9	9	2	1
BS Social Work	1997-1998	5	3	2	3
	1998-1999	3	4	3	1
	1999-2000	6	1	4	6
	2000-2001	3	1	1	1
	2001-2002	2	4	1	3
	2002-2003	4	2	2	3
	2003-2004	6	0	2	3
	2004-2005	11	1	0	2
	2005-2006	8	4	1	2
	2006-2007	6	6	1	0

Appendix C-2. College of Engineering and Architecture

COURSE	SCH YR	YEAR LEVEL 1	2	3	4	5
BS ChE	1997-1998	4	4	1	0	1
	1998-1999	7	6	6	3	2
	1999-2000	8	1	0	0	2
	2000-2001	2	2	4	4	2
	2001-2002	5	4	2	4	1
	2002-2003	7	5	3	4	1
	2003-2004	0	3	5	3	0
	2004-2005	4	1	4	4	0
	2005-2006	4	0	2	1	1
	2006-2007	2	1	1	3	3
BSCE	1997-1998	9	6	7	1	5
	1998-1999	16	13	11	3	7
	1999-2000	14	6	5	1	3
	2000-2001	15	14	3	5	3
	2001-2002	18	10	13	3	1
	2002-2003	30	14	13	5	4
	2003-2004	22	10	9	8	2
	2004-2005	22	11	10	4	4
	2005-2006	20	12	7	3	3
	2006-2007	19	12	13	3	2
BSEE	1997-1998	13	5	4	1	2
	1998-1999	2	8	1	3	0
	1999-2000	4	5	4	2	5
	2000-2001	5	6	2	3	2
	2001-2002	5	6	7	4	2
	2002-2003	13	7	1	0	3
	2003-2004	11	6	3	6	0
	2004-2005	9	7	5	4	6
	2005-2006	11	10	7	4	0
	2006-2007	6	7	6	2	1
BSECE	1997-1998	50	33	19	4	5
	1998-1999	47	37	20	8	3
	1999-2000	40	39	25	5	4
	2000-2001	53	39	18	6	8
	2001-2002	39	47	45	11	4
	2002-2003	53	45	21	7	6
	2003-2004	61	67	17	12	9
	2004-2005	46	41	12	8	9
	2005-2006	40	22	6	9	6
	2006-2007	27	20	10	3	6

Appendix C-2. Continued…

COURSE	SCH YR	YEAR LEVEL 1	2	3	4	5
BSIE	1997-1998	4	5	6	5	1
	1998-1999	11	7	5	5	1
	1999-2000	5	6	6	2	0
	2000-2001	5	4	10	6	1
	2001-2002	4	3	5	8	1
	2002-2003	6	3	2	1	1
	2003-2004	5	1	2	2	1
	2004-2005	8	5	1	2	3
	2005-2006	0	1	2	2	1
	2006-2007	2	1	5	3	1
BSME	1997-1998	14	8	8	0	2
	1998-1999	14	6	7	3	7
	1999-2000	10	4	6	2	4
	2000-2001	5	7	7	1	3
	2001-2002	10	6	7	3	2
	2002-2003	6	6	8	1	1
	2003-2004	11	9	3	2	0
	2004-2005	18	15	6	3	5
	2005-2006	17	3	6	4	0
	2006-2007	13	7	3	3	3
BSGE	1997-1998	1	0	3	0	0
	1998-1999	1	0	0	0	0
	1999-2000	2	0	0	0	0
	2000-2001	2	2	0	0	1
	2001-2002	0	0	1	0	1
	2002-2003	0	0	0	0	0
	2003-2004	0	0	0	0	0
	2004-2005	0	1	0	0	0
	2005-2006	0	0	1	0	0
	2006-2007	0	0	0	1	1
BS Arch	1997-1998	7	3	3	3	1
	1998-1999	13	13	7	10	3
	1999-2000	15	0	9	2	1
	2000-2001	11	13	8	2	3
	2001-2002	14	4	2	7	5
	2002-2003	11	6	4	5	3
	2003-2004	13	10	5	5	3
	2004-2005	15	5	7	2	6
	2005-2006	19	0	4	0	7
	2006-2007	14	5	3	2	0

Appendix C-3. College of Information and Computing Sciences

COURSE	SCHOOL YR	YEAR LEVEL 1	2	3	4
BSCS	1997-1998	0	4	4	4
	1998-1999	0	0	8	3
	1999-2000	0	0	1	3
	2000-2001	0	0	0	4
	2001-2002				
	2002-2003	0	0	0	1
	2003-2004				
	2004-2005	6	0	0	0
	2005-2006	11	1	0	0
	2006-2007	13	2	1	0
BS Math	1997-1998	0	1	0	2
	1998-1999	4	0	1	0
	1999-2000	3	1	1	0
	2000-2001	2	1	1	0
	2001-2002	4	0	2	0
	2002-2003	1	1	3	0
	2003-2004	2	0	1	0
	2004-2005	2	0	1	0
	2005-2006	1	1	0	0
	2006-2007	0	1	0	0
BSIT	1997-1998	15	0	0	0
	1998-1999	24	7	0	0
	1999-2000	42	12	5	0
	2000-2001	49	17	5	4
	2001-2002	45	23	3	2
	2002-2003	41	26	12	3
	2003-2004	46	21	5	4
	2004-2005	63	8	6	1
	2005-2006	35	6	3	1
	2006-2007	25	14	6	3

Appendix C-4. College of Commerce and Accountancy

		YEAR LEVEL			
COURSE	SCHOOL YR	1	2	3	4
BS Accountancy	1997-1998	15	6	6	3
	1998-1999	18	10	3	1
	1999-2000	31	11	6	4
	2000-2001	38	13	3	2
	2001-2002	35	16	7	2
	2002-2003	49	16	6	2
	2003-2004	48	26	9	2
	2004-2005	55	14	0	3
	2005-2006	50	22	7	5
	2006-2007	28	23	8	

APPENDIX D

TOTAL SHIFTERS FROM SCHOOL YEAR 1997-1998

TO 2006-2007 BY DEGREE PROGRAM

Appendix D-1. College of Human Sciences

COURSE	SCHOOL YR	YEAR LEVEL 1	2	3	4
ABEcon	1997-1998	11	2	1	0
	1998-1999	3	1	1	0
	1999-2000	3	1	1	0
	2000-2001	2	1	0	1
	2001-2002	2	1	0	1
	2002-2003	1	0	0	0
	2003-2004	1	0	0	0
	2004-2005	0	0	0	0
	2005-2006	2	1	0	0
	2006-2007	0	0	0	0
AB English	1997-1998	8	5	1	0
	1998-1999	5	6	1	1
	1999-2000	3	2	0	0
	2000-2001	4	4	0	0
	2001-2002	4	4	0	0
	2002-2003	5	4	0	1
	2003-2004	8	2	2	0
	2004-2005	8	5	0	0
	2005-2006	8	2	1	0
	2006-2007	11	5	0	0
Bachelor of Philosophy					
	1997-1998	9	0	0	0
	1998-1999	2	2	0	0
	1999-2000	3	1	1	0
	2000-2001	1	2	0	0
	2001-2002	1	2	0	0
	2002-2003	2	1	1	1
	2003-2004	1	1	0	0
	2004-2005	3	3	2	0
	2005-2006	3	1	1	0
	2006-2007	1	2	0	0

Appendix D-1. Continued

COURSE	SCHOOL YR	YEAR LEVEL 1	2	3	4
AB Pol. Sci.	1997-1998	49	17	2	0
	1998-1999	34	13	1	0
	1999-2000	36	9	1	1
	2000-2001	31	19	2	0
	2001-2002	31	19	2	0
	2002-2003	14	10	0	0
	2003-2004	25	7	1	0
	2004-2005	18	17	1	0
	2005-2006	20	11	3	1
	2006-2007	9	10	0	0
AB Comm	1997-1998	71	12	3	0
	1998-1999	31	16	0	0
	1999-2000	21	9	0	0
	2000-2001	38	7	2	0
	2001-2002	38	7	2	0
	2002-2003	19	23	1	0
	2003-2004	11	10	0	0
	2004-2005	21	5	0	0
	2005-2006	20	7	0	0
	2006-2007	17	6	0	0
BS Psycho	1997-1998	46	17	1	0
	1998-1999	23	7	0	0
	1999-2000	20	3	0	0
	2000-2001	60	9	0	0
	2001-2002	60	9	0	0
	2002-2003	17	26	1	0
	2003-2004	18	15	1	0
	2004-2005	15	8	0	0
	2005-2006	27	25	0	0
	2006-2007	19	10	6	1
BSSW	1997-1998	14	10	0	0
	1998-1999	14	7	0	0
	1999-2000	14	5	0	0
	2000-2001	11	7	1	0
	2001-2002	15	5	1	0
	2002-2003	11	5	0	0
	2003-2004	9	6	0	1
	2004-2005	6	5	0	0
	2005-2006	9	4	1	1
	2006-2007	9	8	1	0

Appendix D-2. College of Engineering and Architecture

COURSE	SCHOOL YR	YEAR LEVEL 1	2	3	4	5
BS ChE	1997-1998	2	6	0	0	0
	1998-1999	2	1	0	0	0
	1999-2000	4	1	0	0	0
	2000-2001	3	1	1	0	0
	2001-2002	5	3	1	0	0
	2002-2003	5	1	0	0	0
	2003-2004	1	1	1	0	0
	2004-2005	4	0	1	0	0
	2005-2006	4	0	0	0	0
	2006-2007	3	2	0	0	0
BSCE	1997-1998	14	1	0	0	0
	1998-1999	9	2	1	0	0
	1999-2000	11	3	1	0	0
	2000-2001	11	7	0	0	0
	2001-2002	5	4	0	0	0
	2002-2003	9	2	0	0	0
	2003-2004	9	5	1	0	0
	2004-2005	9	1	0	0	0
	2005-2006	13	3	0	0	0
	2006-2007	8	4	0	0	0
BSEE	1997-1998	8	2	0	0	0
	1998-1999	5	1	0	0	0
	1999-2000	2	1	0	0	0
	2000-2001	4	0	0	0	0
	2001-2002	1	1	0	0	0
	2002-2003	4	2	0	0	0
	2003-2004	6	0	1	1	0
	2004-2005	3	3	0	0	0
	2005-2006	2	2	0	0	0
	2006-2007	0	1	0	0	0
BSECE	1997-1998	31	6	2	0	1
	1998-1999	22	10	3	0	0
	1999-2000	25	16	0	0	0
	2000-2001	18	5	3	0	0
	2001-2002	20	10	3	0	0
	2002-2003	20	17	4	0	0
	2003-2004	11	5	1	0	0
	2004-2005	16	3	0	0	0
	2005-2006	11	3	1	0	0
	2006-2007	16	4	0	0	0

Appendix D-2. Continued…

COURSE	SCHOOL YR	YEAR LEVEL 1	2	3	4	5
BSIE	1997-1998	7	1	1	1	0
	1998-1999	7	1	1	0	0
	1999-2000	9	1	0	0	0
	2000-2001	7	4	0	0	0
	2001-2002	5	2	0	1	0
	2002-2003	3	4	2	0	0
	2003-2004	2	2	2	0	0
	2004-2005	1	1	0	0	0
	2005-2006	2	1	0	0	0
	2006-2007	5	1	4	0	0
BSME	1997-1998	6	0	0	0	0
	1998-1999	3	1	0	0	0
	1999-2000	4	2	0	0	0
	2000-2001	7	0	1	0	0
	2001-2002	6	0	0	0	0
	2002-2003	3	5	1	0	0
	2003-2004	2	1	1	0	0
	2004-2005	3	0	0	0	0
	2005-2006	5	0	0	0	0
	2006-2007	5	5	1	0	0
BSGE	1997-1998	2	1	0	0	0
	1998-1999	0	2	0	0	0
	1999-2000	0	2	0	0	0
	2000-2001	0	1	0	0	0
	2001-2002	0	1	0	0	0
	2002-2003	1	1	0	0	0
	2003-2004	0	0	0	0	0
	2004-2005	0	0	0	0	0
	2005-2006	0	0	0	0	0
	2006-2007	0	0	0	0	0
BSArch	1997-1998	9	1	0	0	1
	1998-1999	12	0	0	0	0
	1999-2000	9	1	0	0	0
	2000-2001	7	0	2	0	0
	2001-2002	7	1	0	0	0
	2002-2003	14	1	0	0	0
	2003-2004	7	0	1	0	0
	2004-2005	6	0	1	0	0
	2005-2006	9	0	0	0	0
	2006-2007	8	0	1	0	0

Appendix D-3. College of Information and Computing Sciences

COURSE	SCHOOL YR	YEAR LEVEL 1	2	3	4
BSCS	1997-1998	2	6	0	0
	1998-1999	0	0	0	0
	1999-2000	0	0	0	0
	2000-2001	0	0	0	0
	2001-2002	0	0	0	0
	2002-2003	0	0	0	0
	2003-2004	0	0	0	0
	2004-2005	7	0	0	0
	2005-2006	3	2	0	0
	2006-2007	8	8	0	0
BS Math	1997-1998	0	1	1	1
	1998-1999	0	1	1	0
	1999-2000	1	1	5	0
	2000-2001	0	1	0	1
	2001-2002	2	0	1	0
	2002-2003	0	0	0	0
	2003-2004	0	0	0	0
	2004-2005	2	0	2	0
	2005-2006	3	0	2	0
	2006-2007	1	0	1	0
BSIT	1997-1998	25	1	0	0
	1998-1999	31	3	0	0
	1999-2000	26	12	1	0
	2000-2001	43	5	2	0
	2001-2002	35	6	1	0
	2002-2003	12	5	0	0
	2003-2004	24	10	0	0
	2004-2005	37	12	0	0
	2005-2006	29	12	2	0
	2006-2007	37	12	1	0

Appendix D-4. College of Commerce and Accountancy

		YEAR LEVEL			
COURSE	SCHOOL YR	1	2	3	4
BS Ac	1997-1998	13	5	0	0
	1998-1999	19	11	0	0
	1999-2000	6	1	0	0
	2000-2001	0	0	0	0
	2001-2002	1	2	1	0
	2002-2003	1	0	0	0
	2003-2004	2	1	0	0
	2004-2005	1	1	0	1
	2005-2006	1	0	0	0
	2006-2007	1	0	0	0

BIOGRAPHICAL SKETCH

The author, Zenaida Ulpindo Garambas, is a native of Tagudin, the first town of Ilocos Sur. Born on the eighth day of the eighth month in the year 1960 to Mauricio Somera Ulpindo and Avelina Luque Fajardo, both from Tagudin, Ilocos Sur, she happens to be their fifth child among seven.

The author studied at Saint Augustine's School at her hometown from kindergarten to second year high school, then moved to San Jose High School, La Trinidad, Benguet to finish her high school studies where she graduated in 1976 as the class salutatorian.

For her tertiary education, she studied at Saint Louis University, Baguio City and took up a course leading to the degree Bachelor of Science in Mathematics (minor in Physics), which she successfully hurdled as the lone graduate in BS Math in 1981.

After graduation, she was hired to teach Mathematics and Physics at Saint Louis University Laboratory High School and while teaching there, she was invited by SLU-RSTC/RSDC-DOST to be one of the trainers to train teachers from Regions I, III, and CAR in the fields of Mathematics and Physics, which she considers to be the best test of her career. These were conducted during Saturdays and during the summer.

Married to Alfonso Lang-ay Garambas of Sablan, Benguet, they were blessed with six wonderful children: Alny Gerald, Alfonso Sammy, Angelicus Christopher, Avelmar Renan, Audrey Bella, and Adralin Phil.

At present, the author teaches at Saint Louis University in the College of Information and Computing Science, Mathematics Department.