TRACER STUDY ON AIMST UNIVERSITY STUDENTS USING DATA MINING

A project submitted to the Faculty of Information Technology in partial

fulfillment of the requirement for the degree Master of Science

(Information Technology)

Universiti Utara Malaysia

by

LOGA VIJAINDRAN DAMOTHARAN

(a) Loga Vijaindran Damotharan, 2012. All rights reserved.



KOLEJ SASTERA DAN SAINS (College of Arts and Sciences) Universiti Utara Malaysia

PERAKUAN KERJA KERTAS PROJEK (Certificate of Project Paper)

Saya, yang bertandatangan, memperakukan bahawa (I, the undersigned, certifies that)

LOGA VIJAINDRAN A/L DAMOTHARAN (804762)

calon untuk Ijazah (candidate for the degree of) <u>MSc. (Information Technology)</u>

telah mengemukakan kertas projek yang bertajuk (has presented his/her project of the following title)

TRACER STUDY ON AIMST UNIVERSITY STUDENTS USING DATA MINING

seperti yang tercatat di muka surat tajuk dan kulit kertas projek (as it appears on the title page and front cover of project)

bahawa kertas projek tersebut boleh diterima dari segi bentuk serta kandungan dan meliputi bidang ilmu dengan memuaskan.

(that this project is in acceptable form and content, and that a satisfactory knowledge of the field is covered by the project).

Nama Penyelia Utama: : ASSOC. PROF. FADZILAH SIRAJ (Main Supervisor) Tandatangan (Signature) Nama Penyelia Kedua: : MRS. NUR AZZAH ABU BAKAR (Co-Supervisor) تعریض (Date) : <u>۱۹/۱/۲۵/۲</u> Tandatangan (Signature) Nama Penilai : MISS JUHAIDA ABU BAKAR (Name of Evaluator) _______ Tarikh (Date) : _______ Tandatangan (Signature)

PERMISSION TO USE

In presenting this project in partial fulfillment of the requirements for a postgraduate degree from the Universiti Utara Malaysia, I agree that the University Library may make it freely available for inspection. I further agree that permission for copying of this project in any manner, in whole or in part, for scholar purposes may be granted by my supervisor(s) or, in their absent, by the Dean of Centre for Graduate Studies. It is understood that any copying or publication or use of this project or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and Universiti Utara Malaysia for any scholar use which may be made of any material from my project.

Request for permission to copy or make other use of the material in this project in whole or part should be addressed to:

Dean Centre for Graduate Studies Universiti Utara Malaysia 06010 Sintok Kedah Darul Aman

i

ABSTRAK (BAHASA MALAYSIA)

Kajian pengesanan graduan merupakan salah satu pendekatan yang digunakan secara meluas di pelbagai bidang pengurusan terutamanya dalam bidang pengajian tinggi. Sedemikian, kajian seumpama adalah yang terkini serta amat efektif dalam kalangan para penyelidik untuk mendapatkan satu reka model yang menyimpulkan keberkesananan institusi pengajian tinggi dalam usaha melahirkan graduan-graduan yang berkualiti tinggi dan diterima masyarakat. Selain itu, kajian ini turut meramal bilangan graduan yang akan dilahirkan oleh sesebuah institusi pengajian tinggi berdasarkan data-data statistik yang sedia ada. Maka dengan cara yang sama, kajian pengesanan graduan untuk Universiti AIMST turut dijalankan dengan menganalisis datadata yang telah yang diperoleh dari bahagian kemasukan pelajar, Universiti AIMST untuk meramal bilangan siswazah yang akan menamatkan pengajian pada tahun-tahun akan datang berdasarkan bilangan para siswazah dari tahun-tahun sebelumnya. Set data yang diperolehi dari bahagian kemasukan pelajar Universiti AIMST merupakan set data mentah iaitu ianya mengandungi data – data yang hilang yang harus diperbaiki dahulu. Maka set data tersebut harus melalui pelbagai fasa dalam kaedah CRISP untuk memperbaiki data yang hilang dan seterusnya membolehkan ianya dapat digunakan dalam pelombongan data. Walaubagaimanapun, data tersebut harus melalui pra pemprosesan dalam fasa persediaan data dalam kaedah CRISP untuk menjadikan set data yang berkualiti serta boleh digunakan dalam pelombongan data.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my both supervisors, Associate Professor Fadzilah Siraj and Puan Nor Azzah Abu Bakar for their invaluable guidance, encouragement and knowledge-sharing in completing my project work.

Herewith I also would like to extend my appreciation to my late father Mr Damotharan Sarathy, who had given me the education and support till his last breath.

Next would be my mom, Madam Ramu Damotharan for her sacrifice and continuous support throughout my life.

This followed the most wonderful and important person in my entire life, who none other than my wife Ms Bavani Loga Vijaindran who has been by my side in all my life achievements and undertakings.

Next is my loving son, Neesshant Loga Vijaindran who silently and patiently supported me in this career achievement.

Also, my appreciation is to the management of AIMST University especially Students and Records Division, Registry and School of General and Foundation Studies for trusting and allowing me to do the tracer study.

Lastly, I would like to thank those who have supported me directly and indirectly to make this research a success.

By:

Loga Vijaindran Damotharan School of Computing College of Arts & Sciences Universiti Utara Malaysia 2012.

iv

Table of Content

Permission to	o Use	i
Abstract (En	glish)	ii
Abstract (Bahasa Malaysia)		iii
Acknowledgement		iv
List of Table	25	viii
List of Figur	res	xi
CHAPTER 1	I: INTRODUCTION	1
	D 11 Outer and	3
1.1	Problem Statement	
1.2	Research Questions	4
1.3	Objectives	4
1.4	Scope	4
1.5	Significance	5
1.6	Summary	5
CHAPTER	2: LITERATURE REVIEW	6
2.1	Tracer Study	6
2.2	Data Mining	8
2.3	Data Mining in Education	11
2.4	Tracer Study in Education	13
2.5	Summary	18

СН	APTER 3: N	IETHODOLOGY		19
	3.1	Introduction		19
	3.2	Phase 1: Business Understanding	7	21
	3.3	Phase 2: Data Understanding		22
	3.4	Phase 3: Data Preparation		23
	3.4.1	Mean Calculation Proc	ress	27
	3.5	Phase 4: Modeling		28
	3.6	Phase 5: Evaluation		29
	3.7	Phase 6: Deployment		30
	3.8	Summary		31
СН	APTER 4: J	RESULTS		32
	4.1	DATA SUMMARY		32
	4.2	FREQUENCY ANALYSIS		35
	4.2.1	Gender		36
	4.2.2	Race		37
	4.2.3	State		38
	4.2.4	Program Level		39
	4.2.5	Entry Requirement		41
	4.2.6	Financial Resources		42
	4.3	CROSS TABULATION WITH	RESPECT TO PROGRAM	43
	4.3.1	Gender		43
	4.3.2	Race		50
	4.3.3	Financial Resources		58

Financial Resources

4.3.3

	4.3.4	Entry Requirements	65
	4.4	Summary	70
CHAF	PTER 5: C	ONCLUSIONS	71
6	REFERE	ENCES	73
APPE	NDIXES		80

List of Tables

Table 2.1	Cluster Characteristics between Variables	13
Table 3.1	Data sets with missing values	24
Table 3.2	Data sets without missing values	24
Table 3.3	Mean Value to replace the Missing Values	25
Table 3.4	Mean calculation for Bumiputera status	27
Table 4.1	Students Profile	34
Table 4.2	Datasets with missing values	35
Table 4.3	Cross Tabulation between Degree Courses with Gender	43
Table 4.4	Cross Tabulation between Diploma Courses with Gender	47
Table 4.5	Cross Tabulation between Degree Courses with Race	50
Table 4.6	Cross Tabulation between Diploma Courses with Race	55
Table 4.7	Cross Tabulation between Degree Courses with Financial Resources	59
Table 4.8	Cross Tabulation between Diploma Courses with Financial Resources	62
Table 4.9	Cross Tabulation between Degree Courses Entry Requirement	65
Table 4.10	Cross Tabulation between Diploma Courses Entry Requirement	69
Table 4.11	Correlation Coefficient	71
Table 1	Cross Tabulation between Courses and Gender	80
Table 2	Cross Tabulation between Diploma and Gender	80
Table 3	Cross Tabulation between Degree and Gender	81
Table 4	Cross Tabulation between Courses and Race	81
Table 5	Cross Tabulation between Diploma and Race	82
Table 6	Cross Tabulation between Degree and Race	82

Frequency Analysis for Gender	83
Frequency Analysis for Race	83
Frequency Analysis for State	83
Frequency Analysis for Bumiputera Status	84
Frequency Analysis for Number of Semesters	84
Frequency Analysis for Intake Month/Year	85
Frequency Analysis for Estimated Finishing	85
Frequency Analysis for Course Name	86
Frequency Analysis for Course Type	87
Frequency Analysis for Course Code	87
Frequency Analysis for Study Scheme	88
Frequency Analysis for Offering Method	88
Frequency Analysis for Program Level	88
Frequency Analysis for Requirement	88
Frequency Analysis for OKU_Status	89
Frequency Analysis for Handicapped Type	89
Frequency Analysis for Financial Resources	89
Frequency Analysis for Student Status	89
Frequency Analysis for Gender	90
Frequency Analysis for Race	90
Frequency Analysis for State	90
Frequency Analysis for Bumiputera Status	91
Frequency Analysis for Number of Semesters	91
	 Frequency Analysis for Race Frequency Analysis for State Frequency Analysis for Bumiputera Status Frequency Analysis for Number of Semesters Frequency Analysis for Intake Month/Year Frequency Analysis for Estimated Finishing Frequency Analysis for Course Name Frequency Analysis for Course Type Frequency Analysis for Course Code Frequency Analysis for Study Scheme Frequency Analysis for Program Level Frequency Analysis for OKU_Status Frequency Analysis for Financial Resources Frequency Analysis for Student Status Frequency Analysis for Student Status Frequency Analysis for Student Status Frequency Analysis for State Frequency Analysis for Requiremet Frequency Analysis for State

Table 30	Frequency Analysis for Intake Month/Year	92
Table 31	Frequency Analysis for Estimated Finishing	92
Table 32	Frequency Analysis for Course Name	93
Table 33	Frequency Analysis for Course Type	94
Table 34	Frequency Analysis for Course Code	94
Table 35	Frequency Analysis for Study Scheme	94
Table 36	Frequency Analysis for Offering Method	95
Table 37	Frequency Analysis for Program Level	95
Table 38	Frequency Analysis for Requirement	95
Table 39	Frequency Analysis for OKU Status	96
Table 40	Frequency Analysis for Handicapped Type	96
Table 41	Frequency Analysis for Financial Resources	96
Table 42	Frequency Analysis for Student Status	96

List of Figures

Figure 3.1	Phases of the CRISP-DM Process Model	20
Figure 3.2	Value label for Bumiputera status variable	27
Figure 4.1	Population based on Gender	36
Figure 4.2	Population based on Race	37
Figure 4.3	Students breakdown based on States	38
Figure 4.4	Students breakdown based on Degree Programs	39
Figure 4.5	Students breakdown based on Diploma Programs	40
Figure 4.6	Population based on Entry Requirement	41
Figure 4.7	Population based on Financial Resources	42
Figure 4.8	Cross tabulation Course_Name (Degree) with Gender	44
Figure 4.9	Male students with respect to the Degree courses	45
Figure 4.10	Female students with respect to the Degree courses	46
Figure 4.11	Cross tabulation Course_Name (Diploma) with Gender	48
Figure 4.12	Female students with respect to the Diploma courses	48
Figure 4.13	Male students with respect to the Diploma courses	49
Figure 4.14	Cross tabulation Course_Name (Degree) with Race	51
Figure 4.15	Distribution of Indian students undertaking Degree program	52
Figure 4.16	Distribution of Chinese students undertaking Degree program	52
Figure 4.17	Distribution of Malay students undertaking Degree program	54
Figure 4.18	Cross tabulation Course_Name (Diploma) with Race	55
Figure 4.19	Distribution of Indian students undertaking Diploma program	57
Figure 4.20	Distribution of Chinese students undertaking Diploma program	57

Figure 4.21	Distribution of Malay students undertaking Diploma program	57
Figure 4.22	Cross tabulation Course_Name (Degree) with Financial_Resources	60
Figure 4.23	PTPTN support with respect to Degree courses	61
Figure 4.24	Personal support with respect to Degree courses	62
Figure 4.25	Cross tabulation Course_Name (Diploma) with Financial_Resources	63
Figure 4.26	PTPTN support with respect to Diploma	64
Figure 4.27	Personal support with respect to Diploma	64
Figure 4.28	Cross tabulation Course_Name (Degree) with Entry_Requirement	67
Figure 4.29	Cross tabulation Course_Name (Diploma) with Entry_Requirement	69

CHAPTER ONE INTRODUCTION

Education has become an essential part of everyone's life in which it gives added values to each individual, in particular, those who excel in their studies. There are several reputable education providers namely that are playing a vital role in producing high performance graduates. Regardless of whether the institution is a public or a private institution, students' performance always is the major concern.

A small number of students are performing well in their institutions despite numerous efforts given by the education provider and the government. Only handfuls of students are able to obtain excellent results and awarded with Deans' List as well as other recognitions. According to Emmanuel (2007), students' performance can be influenced by factors such as gender, family background, attitudes, previous academic background, location as well as the type of the course they enrolled. This study investigates the relationship between these factors (attributes) against students' performance in tertiary education.

The contents of the thesis is for internal user only

6. **REFERENCES**

- Al-Radaideh, Q. A., Al-Shawakfa, E. M. & Al-Najjar M. I. (2006). *Mining Student Data* Using Decision Trees, 1 - 5. International Arab Conference on Information Technology.
- Blood, D. (2010). Tracer Study Report: Winrock Moldova Entrepreneurship Grant and Training Programs. Retrieved from <u>http://www.winrock.org.md/wp-content/uploads/2011/04/Moldova-Tracer-Study-Final-Report-FINAL-2.pdf</u>
- Bolaane, B., Chuma, J. M. & Toteng, B. & Molwane, O. B. (2010). Tracer Study on the Employment Outcomes of the Vocational Training Graduate. Retrieved from http://www.botswanalmo.org.bw/docs/Documents/BOTA.pdf
- Cristian, M. M. (2010). Building Personalizes Interfaces by Data Mining Integration, 729-734. Proceedings of the International Multiconference on Computer Science and Information Technology.
- Devalari, N., Beikzadeh, M.R. & Phon-Amnuaisuk, S. (2005). Application of Enhanced Analysis Model for Data Mining Processes in Higher Educational System, F4B/1
 - F4B/6. 6th Annual International Conference: ITEHT, Juan Dolio, Dominican Republic.
- Ermeling, B. A., (2010). Tracing the Effects of Teacher Inquiry on Classroom Practice. Teaching and Teacher Education, 26, 377 – 388. University of California, Los Angeles, CA.
- Freitas, A. A. (2007). A Survey of Evolutionary Algorithms for Data Mining and Knowledge Discovery, 61 – 93. Postgraduate Programmes in Computer Science, Pontificia Universidade, Brazil.

- Gargano, M. L., Raggad, B. G. (1999). Data Mining A Powerful Information Creating Tool, 15, 81 – 90. Pace University, New York City, New York, USA.
- Hao, X. & Li, M. (2008). Application of Improved Algorithm of Data Reduction to Knowledge Discovery of Information Security Management, 5, 526 – 530. Fifth International Conference on Fuzzy Systems and Knowledge Discovery.
- Harrell, F. E. Jr. (2001). Regression Modeling Strategies: With Applications to Linear Models, Logistic Regression and Survival Analysis. New York, NY: Springer-Verlag.
- He, C. & Chen, Q. (2010). The Method for Data Reduction Based on Evaluation of Attributes Significance, 1 – 4. Second International Workshop on Intelligent Systems and Applications (ISA).
- Hluchy, L., Habala, O., Ciglan, M. & Tran, V.D. (2008). Mining and Integration of Environmental Data, 247 – 252. IEEE International Conference on Computational Cybernetics.
- Huang, Y. (2009). Study of College Human Resources Data Mining Based on the SOM Algorithm, 1, 324-327. Asia – Pacific Conference on Information Processing.
- Hyysalo, S. (2009). Learning for Learning Economy and Social Learning, 38, 726 73. Research Policy.
- Ibrahim, Z. & Rusli, D. (2007). Predicting Students' Academic Performance: comparing Artificial Neural Network, Decision Tree and Linear Regression, 1 – 6. 21st Annual SAS Malaysia Forum.
- Irawati, I. & Bastaman, B. (2011). Tracer study: Capturing the soft skills competency of FMUI'S medical graduates. Medicine & Health, 6 (1 Supplement). p. 100. ISSN 1823-2140.

- Jackson, J. (2002). Data Mining: A Conceptual Overview. Communications of the Association for Information System, 8, 267-296. Management Science Department, University of South Carolina.
- Jirapanthong, W. (2009). Classification Model for Selecting Undergraduate Programs, 89-95. Eighth International Symposium on Natural Language Processing.
- Jamir, A. (2008). The IDRC Tracer Study on NEPED 'Empowering Through Knowledge'. Retrieved from http://idlbnc.idrc.ca/dspace/bitstream/10625/40618/1/128922.pdf
- Kadzamira, E. C. (2003). Where has All the Education Gone in Malawi? Retrieved from <u>http://www.queensu.ca/samp/migrationresources/Documents/MALAWI_COMPL</u> <u>ETE.pdf</u>
- Kishor, P. (2007). Tracer Study on Training Graduates of Media Centre Programme. Panos South Asia. Retrieved from http://www.bcoalliance.org/system/files/PSA+Media+Centre+Programme+Tracer +Study+Report-6+Feb+'07.pdf
- Khemphila, A. & Boonjing, V. (2010). Comparing Performances of Logistics Regression, Decision Trees and Neural Networks for Classifying Heart Disease Patients, 193 – 198. International Conference on Computer Information Systems and Industrial Management Applications (CISIM).
- Kovacevic, A., Devedzic, V. & Pocajt, V. (2010). Using Data Mining to Improve Digital Library Services, 28, 829-843. The Electronic Library.
- Laokietkul, J., Utakrit, N. & Meesad, P. (2009). A Forecasting Model to Evaluate a Freshman's Ability to Succeed by Using Particular Full Scaled Class Association Rules (PFSCAR), 40 – 44. International Association of Computer Science and Information Technology – Spring Conference.

- Latif, L. A. & Baharom, R. (2010). OUM's Tracer Study: A Testimony to a Quality Open and Distance Education, 2, No.1. ASEAN Journal of Open and Distance Learning. Centre for Student Management, OUM Malaysia.
- Li, L. & Zhang, K. (2009). A Privacy Preserving Clustering Technique Using Hybrid Data Transformation Method, 1502 – 1506. IEEE International Conference on Grey Systems and Intelligent Services. Nanjing, China.
- Mabila, T.E., Malatje, S.E., Bediako, A.A, Kazeni, M.M.M. & Mathabatha, S.S. (2006).
 The Role of Foundation Programmes in Science Education: The UNIFY Programme at the University of Limpopo, South Africa, 26, 295 – 304.
 International Journal of Education Development.
- Mayanja, K. M. (2002). Graduate Employment: Investing In The service Mandate of The African University. Symposium on the African Universities in the 21st Century. Retrieved from <u>http://www.codesria.org/IMG/article_PDF/article_a580.pdf</u>
- Mohamed, F. (2003). Interim Report on Alumni Tracer Study Programme, 1-5. Retrieved from http://www.mche.edu.mv/assets/images/fmc/articles_online/tracer_fazna.pdf
- Millington, C. The Use of Tracer Studies for Enhancing Relevance and Marketability in Online and Distance Education. Barbados Community College. Retrieved from http://wikieducator.org/images/e/e1/PID_424.pdf
- Minaei Bidgoli, B. (2004). Data Mining for A Web Based Educational System, PhD Thesis Report, Department of Computer Science and Engineering, Michigan State University.
- Nadali, A., Kakhky, E. N. & Nosratabadi, H. E. (2011). Evaluating the Success Level of Data Mining Projects Based on CRISP – DM Methodology by a Fuzzy Expert System, 6, 161 – 165. Department of Information Technology Management, Science and Research Branch, Islamic Azad University, Tehran, Iran.

- Nghe, N. T., Janecek, P. & Haddawy, P. (2007). A Comparative Analysis of Techniques for Predicting Academic Performance, T2G-7 – T2G-12. 37th ASEE/IEEE Frontiers in Education Conference.
- Norris, D.(2005). Bloor Research. Clementine Data Mining Workbench. Retrieved from http://www.spss.ch/upload./1114004551_Clementine%209%20BloorReport%20L R.pdf
- Ogor, E. N. (2007). Student Academic Performance Monitoring and Evaluation Using Data Mining Techniques, 354 35. 4th Congress of Electronics, Robotics and Automotive Mechanics.
- Ooi, M. P. L., Chan, C., Lee, S -L, Mohanan, A. A., Goh, L.Y. & Kuang, Y. C. (2009). Towards Identification of Latent Defects: Yield Mining Using Defect Characteristic Model and Clustering, 194 - 199. Monash University, Bandar Sunway, Petaling Jaya, Selangor.
- Parco, G. F. & Kanzler, A. (2005). Engineered Reed Bed Treatment System as a Low Cost Sanitation Option for the Philippines. Hands – on Workshop on Sanitation and Wastewater Management.
- Rai, D., Gong, Y. & Beck, J. E. (2009). Using Dirichlet Priors to Improve Model Parameter Plausibility, 141 – 150. EDM Proceeding (2009).
- Rao, S. J. (2003). Regression Modeling Strategies: With Applications to Linear Models, Logistic Regression and Survival Analysis, 98(461), 257 – 258. Journal of American Statistical Association.
- Regmi, P. P., Mohanty, B. & Bista, S. (2006). Tracer Study: Urban Environmental Management Graduates 1998 - 2005. CIDA – AIT Partnership Project. Urban Environment Management (UEM) Field of Study.

- Richardson, B. D., Davis, K. C. & Beach, M. D. (2008). Introducing Data Mining Techniques and Software Engineering to High School Science Students, F2D - 1 - F2D - 6. 38th ASEE/IEEE Frontiers in Education Conference.
- Sapaat, M. A., Musthapha, A., Ahmad, J., Chamili, K. & Muhamad, R. (2011). A Data Mining Approach to Construct Graduates Employability Model in Malaysia, 1111
 1124. International Journal on New Computer Architectures and Their Applications. University Putra Malaysia, Malaysia.
- Servaas, V.D.B. (2008). How Effective are Poor Schools? Poverty and Educational Outcomes in South Africa, 34, 145 – 154. Studies in Educational Evaluation.
- Shongwe, M. & Ocholla, D. (2011). A Tracer Study of LIS graduates at the University of Zululand, 2000 – 2009, 1 – 14. Retrieved from <u>http://uzulu.academia.edu/MzwandileShongwe/Papers/731208/A_tracer_study_of</u> <u>LIS_graduates_at_the_University_of_Zululand_2000-2009</u>
- Shrestha, B. Chapter XIII: Tracer Study of School Leavers. Study on Student Performance in SLC. SLC study Team.
- Siraj, F. & Abdoulha, M. A. (2009). Uncovering Hidden Information within University's Student Enrolment Data Using Data Mining, 413 - 418. 3rd Asia International Conference on Modelling & Simulation.
- Siraj, F. & Abdoulha, M. A. (2011). Mining Enrolment Data Using Descriptive and Predictive Approaches, Knowledge – Oriented Applications in Data Mining, Kimito Funatsu (Ed.), ISBN: 978-953-307-154-1,53 - 72.
- Tovar, E. & Soto, O. (2010). The Use of Competences Assessment to Predict the Performance of First Year Students, F3J-1 – F3J-4. 40th ASEE/IEEE Frontiers in Education Conference.

- Ugwuonah, G. E. & Omeje, K. C. (1998). Higher Education and the Demands of Manpower Development in the Nigerian Manufacturing Sector; An Empirical Study of Enugu and Anambra States. Institute of Development Studies, University of Nigeria, Enugu Campus, Nigeria.
- Vandamme, J. P., Meskens, N. & Superby, J. F (2007). Predicting Academic Performance by Data Mining Methods, 15, 405 – 419. Education Economics.
- Vlaardingerbroek, B., Dallal, K., Rizkallah, G. & Rabah, J. (2007). A Tracer Study of Lebanese Upper Secondary School Students, 27, 564 – 571. International Journal of Education Development.
- Wook, M., Yahaya, Y. H., Wahab, N., Isa, M. R. M., Awang, N. F. & Seong H. Y. (2009). Predicting NDUM Students' Academic Performance Using Data Mining Techniques, 357 361. Department of Computer Science, Faculty of Computer Science and Defence Technology, National Defence University of Malaysia, Malaysia, 2009.
- Yahya, M. & Siraj, F. (2011). Effect of Data Normalization Techniques on Data Mining. Applied Science Division, CAS, UUM.
- Zhang, N. & Lu, W. F. (2007). An Efficient Data Preprocessing Method for Mining Customer Survey Data, 573 – 578. Fifth IEEE International Conference on Industrial Informatics.