

INTELLIGENT AUTOMATED SMALL AND MEDIUM ENTERPRISE (SME)  
LOAN APPLICATION PROCESSING SYSTEM USING  
NEURO-CBR APPROACH

A project submitted to Dean of Research and Postgraduate Studies Office in partial  
Fulfillment of the requirement for the degree  
Master of Science (Intelligent System)  
Universiti Utara Malaysia

By  
Mohd Hanif Bin Yusoff

© Mohd Hanif Yusoff, 2011. 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)*

**MOHD HANIF BIN YUSOFF**  
**(806285)**

calon untuk Ijazah  
*(candidate for the degree of)* **MSc. (Intelligent System)**

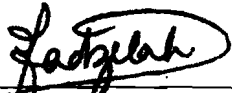
telah mengemukakan kertas projek yang bertajuk  
*(has presented his/her project of the following title)*

**INTELLIGENT AUTOMATED SMALL AND MEDIUM ENTERPRISE (SME) LOAN**  
**APPLICATION PROCESSING SYSTEM USING NEURO-CBR APPROACH**

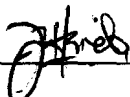
seperti yang tercatat di muka surat tajuk dan kulit kertas projek  
*(as it appears on the title page and front cover of project)*

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  
*(Name of Supervisor)* : **ASSOC. PROF. FADZILAH SIRAJ**

Tandatangan  
*(Signature)* :  Tarikh (Date) : 3/3/2011

Nama Penilai  
*(Name of Evaluator)* : **MISS JUHAIDA ABU BAKAR**

Tandatangan  
*(Signature)* :  Tarikh (Date) : 3/3/2011

## PERMISSION TO USE

In presenting this project in partial fulfillment of the requirements for a postgraduate degree from 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 scholarly purpose may be granted by my supervisor(s) or, in their absence by the Dean of Postgraduate and Research. 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 to Universiti Utara Malaysia for any scholarly use which may be made of any material from my project.

Requests for permission to copy or to make other use of materials in this project, in whole or in part, should be addressed to

Dean of Research and Postgraduate Studies  
College of Arts and Sciences  
Universiti Utara Malaysia  
06010 UUM Sintok  
Kedah Darul Aman  
Malaysia

## ABSTRAK (BAHASA MALAYSIA)

Membina sebuah kumpulan perusahaan kecil dan sederhana (PKS) yang kompetitif dan pelbagai merupakan tema utama untuk mencapai pertumbuhan ekonomi secara berterusan. PKS adalah penting untuk proses pertumbuhan ekonomi dan memainkan peranan penting dalam keseluruhan rangkaian pembuatan negara. Fokus kajian ini adalah untuk membuat model sokongan keputusan automatik untuk sektor PKS yang dapat digunakan oleh pihak pengurusan bank SME untuk mempercepatkan proses permohonan pinjaman kewangan. Kajian ini mencadangkan sebuah sistem pintar secara automatik untuk sistem pemprosesan permohonan pinjaman kewangan PKS (i-SMESs) yang merupakan sistem aplikasi berasaskan web untuk pemprosesan dan pemantauan aplikasi pinjaman kewangan PKS menggunakan teknik “Hybrid Intelligent” yang menggabungkan “Neural Network” dan “Case-based Reasoning” yang dinamakan “NeuroCBR”. i-SMEs digunakan untuk menyokong pengurusan Bank SME dalam mempercepatkan masa pembuatan keputusan dan juga mengurangkan kos operasi. i-SMEs mampu untuk mengklasifikasikan target pasaran PKS kepada tiga kumpulan yang berlainan iaitu MIKRO, SEDERHANA dan KECIL dan juga mampu untuk mempercepatkan proses pra-kelulusan pinjaman kewangan. i-SMEs juga berupaya untuk mengubah corak keputusan yang dijana kepada pelan tindakan yang mampu membantu Bank SME.

Kata Kunci: Sistem Kepintaran Automatik, Pemprosesan kemudahan pinjaman kewangan PKS, Kepintaran Buatan Hibrid, Rangkaian Neural, ‘Case-based Reasoning’.

## ABSTRACT (ENGLISH)

Developing a group of diverse and competitive small and medium enterprises (SMEs) is a central theme towards achieving sustainable economic growth. SMEs are crucial to the economic growth process and play an important role in the country's overall production network. The focus of this study is to develop an automated decision support model for SMEs sector that can be used by the management to accelerate the loan application processing. This study proposed an intelligent automated SME loan application processing system (i-SMEs) that is a web based application system for processing and monitoring SME applications using Hybrid Intelligent technique which integrate Neural Network and Case-based Reasoning namely NeuroCBR. i-SMEs is used to assist SME bank management in order to improve decision making time processing as well as operational cost. i-SMEs be able to classify SME market segment into three distinctive groups that are MICRO, MEDIUM and SMALL and also can make a pre-approval loan processing faster. It is possible to transform the patterns generated from i-SME into actionable plans that are likely to help the SME Bank .

Keywords: Intelligent automated system, SME loan application processing,

Hybrid Artificial Intelligence, Neural Network, Case-based Reasoning.

## ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful. Thank you Allah for Your will and blessing that I am able to complete this dissertation.

I would like to express my appreciation and gratitude to Assoc. Prof. Fadzillah Siraj and Miss Juhaida Abu Bakar for their guidance, advice, and hard work in helping me throughout this research. Without their supervision, this research will not be successful.

Special thanks to all the lecturers especially Assoc. Prof. Azizi Zakaria, Dr. Massudi Mahmuddin, Dr. Yuhanis, Dr. Husniza, Dr Aniza and research members for giving their fruitful opinions and feedback which benefited this research. Special thanks to all the staff from the Department of SME Bank Perlis, Malaysia, Institute of Small and Medium Enterprise (ISME), Universiti Malaysia Kelantan (UMK) and College of Arts and Sciences (CAS), Universiti Utara Malaysia (UUM) for providing the information needed in this research. Special thanks to Assoc. Prof. Abdul Aziz Latiff, my supportive friend, Adam Shariff, Bukhari Othman, Megat Firdaus, Shahrin Rizlan, and Muhammad Ashraq for their help and support.

Lastly, I would like to thank my father, Yusoff Awang, my mother, Samsiah Abd Rahman and all my family for their endless love and support which gave me the will and strength to finish this research.

## TABLE OF CONTENTS

|  | Page |
|--|------|
| PERMISSION TO USE  | i    |
| ABSTRAK (BAHASA MALAYSIA)                                | ii   |
| ABSTRACT (ENGLISH)                                       | iii  |
| ACKNOWLEDGMENTS  | iv   |
| LIST OF TABLE  | vii  |
| LIST OF FIGURES  | viii |
| <br>   |      |
| <b>CHAPTER 1 : INTRODUCTION</b>                          |      |
| <br>   |      |
| 1.1 Overview of the project                              | 1    |
| 1.2 Problem Statement                                    | 3    |
| 1.3 Research Questions                                   | 4    |
| 1.4 Objectives of the study                              | 4    |
| 1.5 Scope of the study                                   | 4    |
| 1.6 Significance of the study                            | 5    |
| 1.7 Thesis Organization                                  | 6    |
| <br>   |      |
| <b>CHAPTER 2 : LITERATURE REVIEW</b>                     |      |
| <br>   |      |
| 2.1 Decision Support System for SME loan processing      | 7    |
| 2.2 Artificial Intelligence (AI) approach for DSS in SME | 10   |
| 2.3 Artificial Neural Network (ANN) prediction model     | 17   |
| 2.4 Case-Based Reasoning Model                           | 22   |
| 2.5 Summary  | 25   |

## **CHAPTER 3 : METHODOLOGY**

|   |    |
|---|----|
| 3.1 Overview of the methodology               | 26 |
| 3.2 The Hybrid Methodology                    |    |
| 3.2.1 Feasibility Study Phase                 | 28 |
| 3.2.2 Data Collection and Preprocessing Phase | 29 |
| 3.2.3 Analysis and Design Phase               | 33 |
| 3.2.4 Implementation Phase                    | 34 |
| 3.2.5 Evaluation Phase                        | 34 |
| 3.3 Conclusion                                | 35 |

## **CHAPTER 4 : RESULT AND DISCUSSION**

|  |    |
|--|----|
| 4.1 Introduction                                     | 36 |
| 4.2 An Example of i-SMEs interface menu and function | 39 |
| 4.3 Test Case of i-SMEs system                       | 47 |
| 4.4 Others functionalities of i-SMEs system          | 56 |
| 4.5 Evaluation of the i-SMEs system                  | 58 |
| 4.6 Summary of i-SMEs system                         | 59 |

## **CHAPTER 5 : CONCLUSION AND RECOMMENDATION**

|                                  |    |
|----------------------------------|----|
| 5.1 Summary of the research      | 60 |
| 5.2 Implications of the research | 62 |
| 5.3 Limitations of the research  | 63 |
| 5.4 Suggestions for future work  | 64 |

|                   |    |
|-------------------|----|
| <b>REFERENCES</b> | 65 |
|-------------------|----|

|                 |    |
|-----------------|----|
| <b>APPENDIX</b> | 71 |
|-----------------|----|



## LIST OF TABLES

|           |   |    |
|-----------|---|----|
| Table 4.1 | Type of SME services and products                     | 40 |
| Table 4.2 | Type of company sector and requirements for the group | 47 |

## LIST OF FIGURES

|             |  |    |
|-------------|--|----|
| Figure 3.1  | Hybrid Methodology (HyM) as proposed by Kendal <i>et al.</i> (2003)                          | 27 |
| Figure 3.2  | Thirteen variables for NN training and testing process                                       | 29 |
| Figure 3.3  | The Basic MLP Methodology of Model Development by<br>ANN Majumder, Roy & Mazumdar (in press) | 30 |
| Figure 3.4  | The Case-based Reasoning cycle developed by Aamodt (1995)                                    | 32 |
| Figure 3.5  | An automated SME loan application processing model system<br>(i-SMEs) architecture diagram   | 33 |
| Figure 3.6  | Pseudocode for CBR module using PHP language programming.                                    | 34 |
| Figure 4.1  | 13 attributes for NN training and testing process using MySQL                                | 38 |
| Figure 4.2  | Attributes for CBR case-base using MySQL   | 38 |
| Figure 4.3  | Main Page of i-SMEs  | 39 |
| Figure 4.4  | SME loan information page  | 40 |
| Figure 4.5  | i-SMEs contact information   | 41 |
| Figure 4.6  | i-SMEs system (section 1)  | 42 |
| Figure 4.7  | i-SMEs system (company profile)  | 43 |
| Figure 4.8  | The example of form that need to download manually before this                               | 43 |
| Figure 4.9  | i-SMEs system (section 2)  | 44 |
| Figure 4.10 | i-SMEs admin login   | 45 |
| Figure 4.11 | i-SMEs admin Control Panel   | 46 |

# CHAPTER 1

## INTRODUCTION

This chapter discusses the background of the study that consists of several sub-parts about the scope, significance and the problem statement of this study. These include overview of Small and Medium Enterprise (SME) Corporation and SME Bank management definitions in Malaysia. In this chapter also describes the framework of SME requirements.

### **1.1 Overview of the study**

Developing a group of diverse and competitive small and medium enterprises (SMEs) is a central theme towards achieving sustainable economic growth. SMEs are crucial to the economic growth process and play an important role in the country's overall production network. SMEs have the potential to contribute substantially to the economy and can provide a strong foundation for the growth of new industries as well as strengthening existing ones, for Malaysia's future development.

SME Corp. Malaysia is the Secretariat to the National SME Development Council (NSDC). In 2005, the National SME Development Council (NSDC) approved the use of common definitions for SMEs in the manufacturing, manufacturing-related services, primary agriculture and services sectors.

The contents of  
the thesis is for  
internal user  
only

## REFERENCES

- Aamodt, A., Spyropoulos & Papagounos, G. (1988). Ethical aspects of the employment Of Expert Systems in Medicine. *Proceedings of the 4th International Conference on Ethical Issues of Information Technology*, 701-711.
- Aamodt, A., Spyropoulos & Papagounos, G. (1995). A theoretical approach to Artificial Intelligence Systems in Medicine. *Artificial Intelligence in Medicine*, 7, 455-465.
- Akerkar, R., & Sajja, P. (2009). Application Areas of Artificial Intelligence. Knowledge Based System, 7-10.
- Albuquerque, R.(1994). The adherence of the object oriented programming paradigm on the simulation of artificial neural networks. *IEEE World Congress on Computational Intelligence*. 6, 3900 - 3904 .
- Au, W.H., Chan, K.C.C., & Yoa,X. (2003). A novel evolutionary data mining algorithm with application to churn prediction. *IEEE Transaction on Evolutionary Computation*, 7 , 532-545.
- Baldi,P., Frasconi,P., & Symth,P. (2003). : Modeling the Internet and the web. *Probabilistic Methods and Algorithms, Wiley, Vest Sussex, UK*.
- Baraglia, R. & Silvertri, F. (2007). Dynamic Personalization of Web Sites without user Intervention. *In Communication of the ACM*, 50(2).
- Bretas, A.S., & Phadke, A.G.(2003). Artificial neural networks in power system restoration Power Delivery. *IEEE Transactions* ,1181 – 1186 .
- Brijs, T., Swinnen, G., Vanhoof, K., & Wets, G. (2004). Building An Association Rules Framework To Improve Product Assortment Decision. *Data mining and Knowledge Discovery*, 8, 7-23.
- Buchheit. P. (1993).INFANT: A Modular Approach to Natural Language Processing.
- Cassino. R., Tortora. G., Tucci.M., & Vitiello. G. (2003). SR-Task Grammars: A Formal Specification of Human Computer Interaction for Interactive Visual Languages.
- Chandrasekaran, B. & Goel, A. (1988). From Numbers to Symbols to Knowledge Structures: Artificial Intelligence Perspectives on the Classification Task.

- Cho, V., & Ngai, E. (2001). Intelligent Decision Support System with Embedded OLAP Technology for the Insurance Industry, From [http://www.sba.muohio.edu/abas/2001/quebec/cho\\_insuredatamining.pdf](http://www.sba.muohio.edu/abas/2001/quebec/cho_insuredatamining.pdf).
- Chunguang. C. , Dongwen. C., Lijie. W., & Bo.G. (2010). An Expert System for Security Diagnosing of Construction Producing by CBR.
- Cooley,R. Mobahser,B., & Srivastave,J.(1997). Web mining: Information and Pattern Discovery on the World Wide Web. *In Proceeding of the 9<sup>th</sup> IEEE International Conference on Tool with Artificial Intelligence*
- Daikui Shouren Hu (1991). An object-oriented neural network language. *IEEE International Joint Conference on Neural Networks*, 1606-1611.
- Deng, P. (1994). Using Case-Based Reasoning for Decision Support. *IEEE Proceeding International Conference on System Sciences*, 552 – 561.
- Dietterich, T.G., & Michalski, R.S.(1983). A Comparative Review of Selected Methods for Learning from Examples in *Machine Learning: An Artificial Intelligence Approach*, Morgan Kaufmann: Los Altos, CA.
- Dunham, M.H. (2003). Data Mining: Introductory And Advanced Topic. *Prentice-Hall*, Upper Saddle River, NJ.
- El Emam, K. (1991). Object oriented neural networks. *International Conference on Control* Pages 1007-1010. From <http://www.dli.iiit.ac.in/ijcai/IJCAI-89-VOL1/PDF/122.pdf>.
- Erkollar, A., Krug, W. & Mayr, H.C. (1999). Defining Computerized Business System Requirements for SMEs. *IEEE International Conference on Management of Innovation and Technology*, 1.
- Faria, P., Vale, Z., Soares, J., Khodr, H., & Canizes, B. (2010). ANN based day-ahead ancillary services forecast for electricity market simulation. *International Conference on Intelligent System Applications to Power Systems (ISAP2009)*, 1159 – 1164.
- Fayyad, U., Piatetsky-Shapiro, G. & Smyth, P., (1996). From Data Mining To Knowledge Discovery In Database. *AI Magazine*, 37-54.

- Gao. H.M., Zeng. J.C., & Xui. Y.B. (2003). Multi Agent Decision Support System. *Proceedings of the Second International Conference on Machine Learning and Cybernetic*.
- Gupta. S., Saraf. J., & Tiwari. N. (2010). A Human Decision Support System with its Enhanced Futuristic Diverse Applications. *International Conference and Workshop on Emerging Trends in Technology (ICWET 2010)*.
- Haigang, L., & Wanling, Y. (2006). Study of Application of Web Mining Techniques in E Business. *IEEE Xplore*.
- Huang, S.H. & Hong-Chao Zhang (2008). Artificial neural networks in manufacturing: concepts, applications, and perspectives. *IEEE Transactions on Components, Packaging, and Manufacturing Technology*.
- Huang, Y. & Li, J. (2009). A Fuzzy-AHP Based Innovation Ability Evaluation System for SMEs clusters. *IEEE International Conference on Information Management, Innovation Management and Industrial Engineering*, 1, 277 – 281.
- Iantovics. B.(2008). The CMDS Medical Diagnosis System. *Ninth International Symposium on Symbolic and Numeric Algorithms for Scientific Computing IEEE Transactions on Systems, Man, and Cybernetics*, 18, 415-424.
- Javad, H., Karim, F., & Majid, A.(2003). N-Feature Neural Network Human Face Recognition. *IEEE Transactions on Components, Packaging, and Manufacturing Technology*
- Jia, Z., Gong, L. & Han, J. (2009). The Application of Fuzzy Control in Strategic Decision-making of SMEs. *IEEE Conference on Measuring Technology and Mechatronics Automatiom*, 2, 602 – 605.
- Kendal S.L., Ashton, K. and Chen, X. (2003). A brief overview of HyM: A methodology for the development of Hybrid Intelligent Information Systems. University of Sunderland, UK. From [www.his.sunderland.ac.uk/ps/kendal03.pdf](http://www.his.sunderland.ac.uk/ps/kendal03.pdf)
- Kendal, S., Chen, X., & Masters, A. (2003). HyM: a Hybrid Methodology for the Development of Integrated Hybrid Intelligent Information Systems, *University of Sunderland, St Peters Campus, Sunderland*.

- Kidwell, D.S., Peterson, R.L., & Blackwell, D.W. (1993). *Financial Institutions, Markets, and Money, Fifth edition, Dryden: Orlando, FL.*
- Kosala, R., & Blockeel, H. (2000). Web Mining Research : A Survey. *ACM SIGKDD Explorations Newsletter*. 2.
- Kotsiantis, S. B., & Pintelas, P. E. (2003). A Hybrid Decision Support Tool Using Ensemble of Classifiers, *Educational Software Development Laboratory, Department of Mathematics, University of Patras, Greece.*
- Lay, C. B., Khalid, M., & Yusof, R., (2000). Intelligent Database by Neural Network and Data Mining, *Center for Artificial Intelligence and Robotics, Universiti Teknologi Malaysia.*
- Leber, J.F. & Moschytz, G.S. (1992). An interactive object-oriented neural network simulator applied to the recognition of acoustical signals. *IEEE International Symposium on Circuits and Systems*, 2937-2940.
- Lee, J., S. & Siau, K. (2001). A review of data mining techniques. *Industrial management & data systems*, 41-46.
- Liu, J., Huang, Z. & Wu, W. (2003). Web Mining for Electronic Business Application. *In Proceedings of the PDCAT'2003 IEEE*. 872- 876.
- Maqsood I., Kham M. R., & Abraham A. (2004). An ensemble of neural networks for weather forecasting. *Neural Comput. & Applic., Springer-Verlay*, 112-122.
- Montana D. J., Davis L. (1998). Training feedforward neural network using genetic algorithms. from <http://www.dli.iit.ac.in/ijcai/IJCAI-89-VOL1/PDF/122.pdf>.
- Nedeu, C., & Jacob, U. (1997). A Case-based Reasoning Approach towards learning from experience connecting design and shop floor. *Computers in Industry*, 33, 127 – 137.
- Norshuhada, S. & Shahizan, H. (2010). Design research in software development: constructing and linking research questions, objectives, methods and outcomes. University Utara Malaysia Press.
- Polur, P.D. (2001). Isolated speech recognition using artificial neural networks. Engineering in Medicine and Biology Society. *Proceedings of the 23rd Annual International Conference of the IEEE*, 2, 1731 - 1734.



- Powell, J. H. & Bradford, J. P. (2000). Targeting intelligence gathering in a dynamic competitive environment. *International Journal of Information Management*, 20 (3), 181-195.
- Royes, G.F. (2004). A hybrid fuzzy-multicriteria-CBR methodology for strategic planning support. *IEE Proceedings*.
- Schmid, B., Schroth, C. & Janner, T. (2007). A Hybrid Architecture for Highly Adaptive and Automated e-Business Platforms. *IEEE International Conference* , 466 – 473.
- Shackel, B. (1984). Information Technology: A challenge to ergonomics and design. *Behaviour and Information Technology*. 3. 263-275.
- Shi, J. & Li, P. (2006). An Initial Review of Policies for SMEs in the US, Japan and China. *IEEE International Conference on Management of Innovation and Technology*,1, 270 – 274.
- Siraj, F., Zakaria, A., Ab. Aziz, A., & Abas, Z. (2003). A Web Based Business Insolvency Classifier using Neural Network. *Proceeding of AIAI*.
- Song, X., Tian, H. & Wu, X. (2010). Study on SMEs-oriented Strategic Decision Support. *IEEE International Conference on Management and Service Science (MASS)*, 1 – 4.
- Sternemann, K.. H. & Zelm, M. (1998). Enterprise modelling for Operational Decision Support. *IEEE International Conference on Systems, Man, and Cybernetics*, 1, 301 – 306.
- Vitthal, R., & Durgaprasada R., C.(1995). Process control via artificial neural networks and learning automata” *Industrial Automation and Control, IEEE/IAS International Conference*, 329 – 334.
- Weiss, S.M., Galen, R.S., & Tadepalli, P.V.(1990). Maximizing the Predictive Value of Production Rules. *Artificial Intelligence*, 45, 47-71.

Zadeh, L. A., (1998). Roles of soft Computing and Fuzzy Logic in Concept, Design and Development of Information/Intelligent System, *Conference on Computational Intelligence: Soft Computing and Fuzzy-Neuro Integration with Application*, 1-9.

Zalud, M. & Steeple, D. (1998). Defining Computerized Business System Requirements for SMEs. *IEEE International Conference on Management of Engineering and Technology, Technology and Innovation Management*.