DEPLOYING ARTIFICIAL INTELLIGENCE TECHNIQUES IN LOAN APPLICATION PROCESSING

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Abstract: *The granting of loans by a financial institution is one of the important decisions that require insubstantial care. The institution usually employs loan officers to make credit decisions or recommendations for that particular institution. These officers are given some hard roles in evaluating the worthiness of each application. Some researchers recognize that the capability of humans to judge the worthiness of a loan is rather poor. Since business data warehouses store historical data from previous application, it is likely that there is knowledge hidden in this data may be useful in decision making. Unfortunately the task of discovering hidden information and useful relationship from data is difficult for human. This is due the fact that the data to be examined is very large and the nature of the relationship within the data is not obvious. To this end, Artificial Intelligence (AI) techniques can be beneficial to assist the decision maker in making decisions regarding loan application. AI provides a variety of useful tool for discovering the non-obvious relationships in historical data, while ensuring those relationships discovered will generalize to the future data. This knowledge is important and can be used by the loan officer in determining whether to accept or reject an application. This study suggests that loan application processing system integrates two components of computer-based information system namely, office automation system and AI system that comprises of intelligent decision support system and knowledge based system. In essence, the potential use of such a system can be accelerated to promote any organizations as an efficient and effective organization that has competitive advantage.*

INTRODUCTION

In Malaysia, loan or scholarship are required in funding the teaching and learning of higher education. Certain amounts of fund are given to our students for their allowances and fees, thus the learning institutions can provide more facilities for a well conducive learning environment. Today, loans or scholarships are granted by a number of institutions and organizations that includes PTPTN, JPA, MARA and state intuitional bodies. For the purpose of mortgaging loan or scholarship, a few processes and procedures are required for ensuring loan or scholarship are granted to an eligible student with a sufficient of amount. The institution usually employs loan officers to make credit decisions or recommendations for that particular institution. These officers are given some hard roles in evaluating the worthiness of each application. As the number of applications increases every year, the loan processing and approval tasks have become more challenging and difficult especially for the funding institutions which are still practicing manual or semi-manual processing. This may delay the loan or scholarship payment for students of higher learning institution. In addition, due to inefficient filing system, some funding institutions face a problem in tracing back the higher learning leavers for payment back purpose.

In improving routine office tasks that includes data processing and reporting, a number of software have been invented such as Microsoft Word, Access, Spreadsheet and also applications designed for specific needs. Nevertheless, today's demands are not only for documenting and reporting, most of organizations' tasks deal with decision-making which some decisions that may require the presence of experts in the domain. For the

purpose of aiding the decision-making, a number of decision support systems have been developed for specific organizations needs for example Student Information System (SIS) and Accounting System (Pusat Komputer UUM, 2004). These systems are used to assist in decision making that provide statistics, data analysis and graphical charts.

For the analysis purposes, the decision support systems are helpful in summarizing data, processing data to information and representing diagnostics information. Nevertheless, it lack of prediction and explanation capability which some organizations might need this facilities to answer questions such as why did July's sales drop down? or can sales be increased next month?, and what is the characteristic of students enrolled in this May or what types of student will be registering next May?. The answers can only be provided by the experts in that particular domain who have years of experience to predict and explain certain occurrences.

Hence, the needs to mimic or replicate human thinking processes have motivated the research in Artificial Intelligence (AI). The capability of AI techniques in predicting, diagnosing and advising has made AI becoming popular in decision-making. A number of AI techniques have been integrated into decision support system software such as SAS, Clementine and Data Mining software.

The first invention of AI system was knowledge based system or Expert System (ES) whose objective was to model and implement human expert knowledge. An ES can act as a human expert in diagnosing and troubleshooting of certain problem. With the enhanced features and capability, ES is commonly used for the advisory purposes that can assist decision-making.

In addition to advisory capability, some AI techniques such as Fuzzy Logics and Neural Networks, are designed with forecasting capability. If there rules provided for a given problem, Fuzzy Logic can be employed, but if rules are absent or insufficient to model decisions then Neural Network is recommended. In the real world problem, rules are not easy to elicit from domain experts, hence Neural Network has become more popular. Neural Network requires a set of data, and from this data, the association between variables in the data are obtained to predict or forecast new data (Teng, 1996).

In this study, integration of office automation system and intelligent decision support systems that comprises of AI techniques; knowledge based system and Neural Network is proposed for improving loan application processing that such integration can be beneficial to assist the decision maker in making decisions regarding loan application. AI provides a variety of useful tool for discovering the non-obvious relationships in historical data, while ensuring those relationships discovered will generalize to the future data. This knowledge is important and can be used by the loan officer in determining whether to accept or reject an application.

LOAN APPLICATION PROCESSING

In general, application for loan or scholarship is announced in every academic term each year. A funding institution announces the release of the application form via newspaper and or media, but there are still institutions that require applicants to go to the main office to get and to return the application form personally with an amount of price.

Starting from the submission, funding institution staffs will collect all the application forms and calculate the merit for each complete application form. Merit is given by accumulating the total mark for each applicant based on the criteria defined the institution. The application process will take about couple of months, starting from the submission of application up to listing out those approved applicants.

The range of merit that indicates the eligibility of the applicants is determined by each institution. The list of eligible applicants will then be tabled in the institution committee board meeting, which is also held once a year. In the meeting, the number of applicant selected is based on the quota allocated for each public and private university. For the number of applicant that is less than the university's quota, the applicant will be selected based on the rank of merit. Once the approved applicants are selected, the offer letters and the agreement will then be posted to them. When the acceptance letters are received from the applicants, their profiles will be stored in files for further use.

From the managerial point of view, every application of loan needs to be processed and revised for every criteria defined by particular funding bodies. As number of applicants increases year by year, the application processing has become challenging and difficult, which creates problems when most of the processes are still done manually with no systematic filing system and database. Instead of using hardcopy form, a few managements have moved to online form for the application purposes (Lembaga Biasiswa Negeri Kedah, 2002; JPA, 2005). This may reduce the task of encoding and storing applicants' information into a database. Nevertheless, evaluation to select or shortlist applicants are still consuming more time as number of application increases every year.

The current manual (semi-manual) processing practices can create some problems such as applicant's information search is slow and inefficient as the application forms are processed manually without any computerized file system. This may delay the application evaluation process as well as keeping track the student information updates which consequently could delay payment to students. Most of students need to use their own money for their first semester fee.

In addition, any funding institutions that are still practicing manual merit system will have more workload as number of applicant increases. The approval of any loan or scholarship is time-consuming as the evaluation is done manually based on human judgement. Recently, a few issues arise due to qualified student were not granted applied loan or scholarship. This could be due to flaws in judging the loan or scholarship. Inefficient file system also could create problems in tracing the student's status for the payment back purposes. This issue has also been raised in our media that reported the

funding institutions are facing problems regarding loan payment back by the graduated students. In addition to student unawareness of this issue, the inefficient of file system also contributes to the same problem.

Hence, in this study, an integration of office automation system and intelligent decision support systems is proposed. Web based automation system can assist applicants and management and in performing loan application processing, while intelligent decision support system that integrates knowledge based system and Neural Network, can be as a helpful tool in loan approval decision making.

OFFICE AUTOMATION SYSTEM

Office Automation Systems are systems that try to improve the productivity of employees who need to process data and information. Perhaps the best example is the wide range of software systems that exist to improve the productivity of employees working in an office (e.g. Microsoft Office XP) or systems that allow employees to work from home or whilst on the move. Fig. 1.0 illustrates the Office Automation System Model.

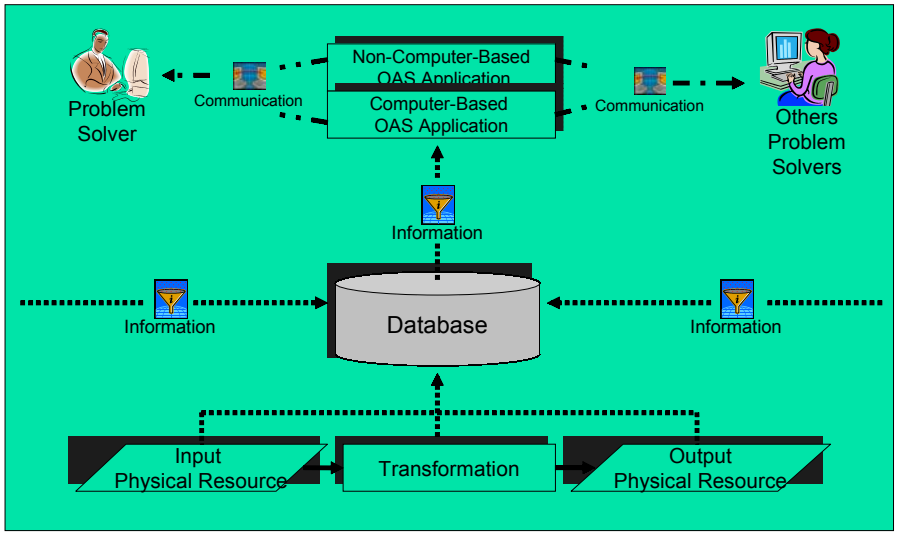

Figure 1.0: Office Automation Model

With the rapid evolution of electronic technology in the 1980's, office automation systems were developed that provided for the storage, manipulation, computation, reporting, and transmission of large amounts of information (Baker, 1996). These office automation systems were designed as a single piece of stand-alone equipment or as a work station or terminal linked to a mainframe, mini-computer, or local area network. They provided the capability for using more than one type of software within the same system. Now, in addition to word processing, these systems could provide capability for electronic spreadsheet, database management, electronic mail, desktop publishing, and other types of software (Hsu and Gough, 2000).

In addition to word processing software, office support staff frequently use database management, electronic spreadsheet, electronic mail, electronic calendar, and other types of office automation software. These different office automation systems allow automation of much of the administrative work of the office, e.g., office budgeting, forms tracking, action item tracking, time and attendance, directories and logs, correspondence and memoranda (Ruohonen, 1996; Tee, 2001). Current trends in office automation technology indicate that many offices have recently obtained or are in the process of obtaining electronic systems with multiple software capabilities. Also, an increasingly greater variety of functions are being included within software packages. Word processing software packages, for example, include increasingly greater capabilities for graphics, calculations, and sorting information. At the same time, an increase in user aids such as menus and screen prompts facilitates use of the full range of functions available within software packages. These increases in the types of software available, the functions available within software packages, and various user aids generate new opportunities for automating the administrative work of the office.

DECISION SUPPORT SYSTEM

A decision support system (DSS) (Fig. 2.0) is a computer program application that analyzes business data and presents it so that users can make business decisions more easily. It is an "informational application" (in distinction to an "operational application" that collects the data in the course of normal business operation). Typical information that a decision support application might gather and present would be:

- Comparative sales figures between one week and the next.
- Projected revenue figures based on new product sales assumptions.
- The consequences of different decision alternatives, given past experience in a context that is described.

(Igbaria and Guimaraes, 1994).

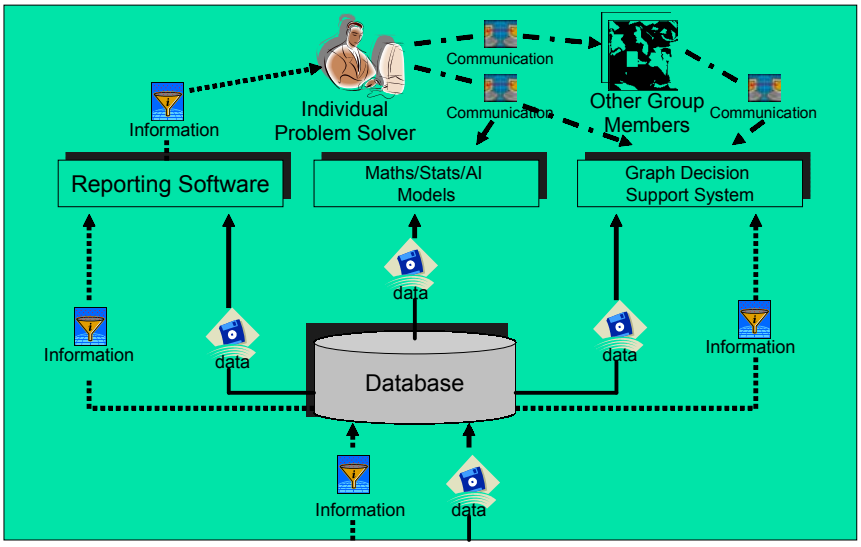

Figure 2.0: Decision Support System Model

A decision support system may present information graphically and may include an expert system or artificial intelligence (AI). It may be aimed at business executives or some other group of knowledge workers.

Decision-support systems are specifically designed to help management make decisions in situations where there is uncertainty about the possible outcomes of those decisions. DSS comprise tools and techniques to help gather relevant information and analyze the options and alternatives. DSS often involves use of complex spreadsheet and databases to create "what-if" models. The very nature of a DSS requires a different design technique from traditional batch, or online, transaction processing systems. The traditional approaches for analysis and design have proven inadequate because there is no single comprehensive theory of decision making, and because of the rapidity of change in the conditions which decision makers face. Designers literally "cannot get to first base" because no one, least of all the decision maker or user, can define in advance what the functional requirements of the system should be. A DSS needs to be built with short, rapid feedback from users to ensure that development is proceeding correctly. It must be developed to permit change quickly and easily. A very promising aspect of a DSS is its ability to integrate data access and decision models. It does so by imbedding the decision models in an information system which uses the database as the integration and communication mechanism between models.

ARTIFICIAL INTELLIGENCE TECHNIQUES

In this study, two AI techniques; knowledge based system and Neural Network, are identified to be integrated with decision support system in improving the loan application processing. Knowledge based system can assist in decision making by providing advisory services based on loan approval rules and policies predetermined by the funding institution, while Neural Network can be used to predict an application is to be accepted or rejected. Nevertheless, the final decision is based on the management whether to agree or disagree with the system's recommendations.

Knowledge Based System

Knowledge-based systems (KBS) (Figure 3.0) use human knowledge to solve problems normally requiring human intelligence. To succeed they should possess performance at the same level as the human expert. These systems have been used in industry and finance (Pomykalski *et al.*, 1999), and government (Cheng *et al*., 1996; Shrobe, 1996) for many years.

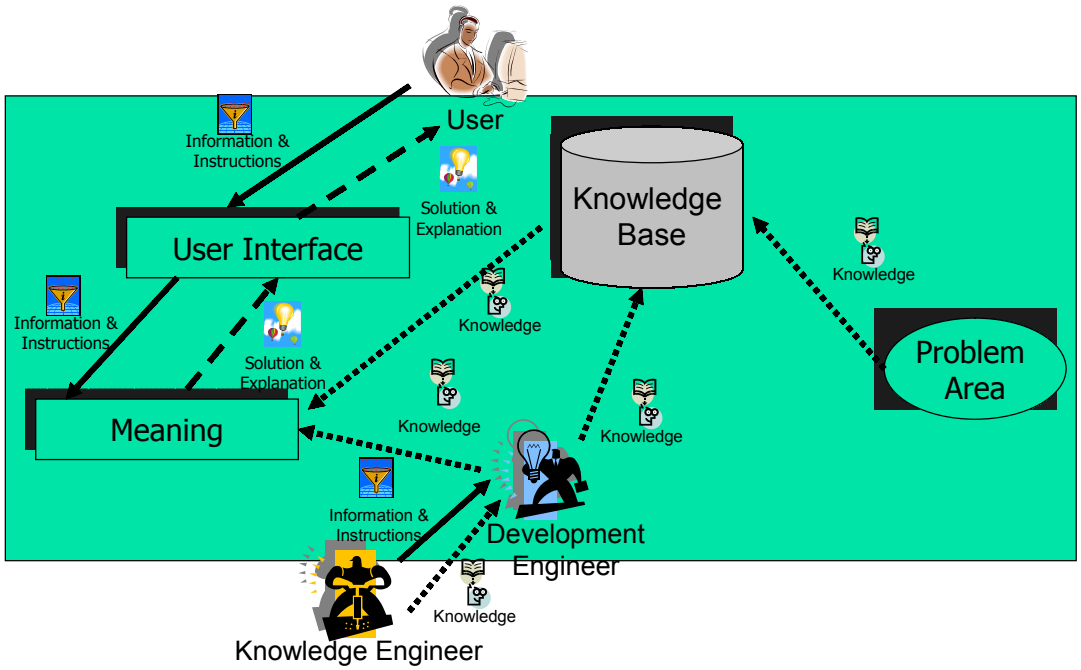

Figure 3.0: Knowledge Based System Model

Escalating workloads, cost constraints and evidence-based medicine create the need for such tools in the clinical laboratory. A number of systems exist in chemical pathology and hematology. Approaches have varied from simple rule-based systems to more complex models using fuzzy logic and artificial neural networks and incorporating probability theory, pattern recognition and multi-variety analysis techniques. In the hands of enthusiasts these systems have been judged to operate satisfactorily (produce a correct differential diagnosis) in 85-90% of patients (++++). The KBS shell is a software environment containing a knowledge acquisition system, the knowledge base itself, inference engine, explanation subsystem and user interface. The core components are the knowledge base (human knowledge represented by e.g. If-Then rules) and the inference engine (forward or backward chaining). The explanation subsystem, which renders the rules transparent, is an important attribute for user acceptance.

Neural Networks

With the advent of modern computer technology and information science, sophisticated information systems can be built that can make decisions or predictions based on information contained in available past data. Such systems are called learning systems and are currently used for the purpose of classification and prediction (Principe *et al.*, 2000). Neural Networks are popular techniques for classification and prediction problem.

A neural network system is an artificial intelligence model that replicates the human brain's learning process. Tsoukalas and Uhrig (1997) define a neural network as: "A data processing system consisting of a large number of simple, highly interconnected processing elements (artificial neurons) in an architecture inspired by the structure of the cerebral cortex of the brain."

In an artificial neural network, a number of inputs, or attributes, and their corresponding outputs, or classes, are given. A training algorithm uses these sample inputs, called the training set, to design a decision function that can accurately predict the class for any sample thereafter. The algorithm response is compared to the actual response to determine how well the classifier performs (Barker *et al.*, 2004).

Nodes are used to represent the brain's neurons and these nodes are connected to each other in layers of processing. Fig 4.0 illustrates the three types of layers of nodes: the input layer, the hidden layer or layers (representing the synapses) and the output layer. The input layer contains data from the measures of explanatory or independent variables. This data is passed through the nodes of the hidden layer(s) to the output layer, which represent the dependent variable(s). A nonlinear transfer function assigns weights to the information as it passes through the hidden layer nodes, mimicking the transformation of information as it passes through the brain's synapses. The goal of the artificial neural network model is that the effect of these weights will result in a response that is equivalent to the response that would result from the relationship that really exists between the input independent variables and the output, or dependent, variable(s).

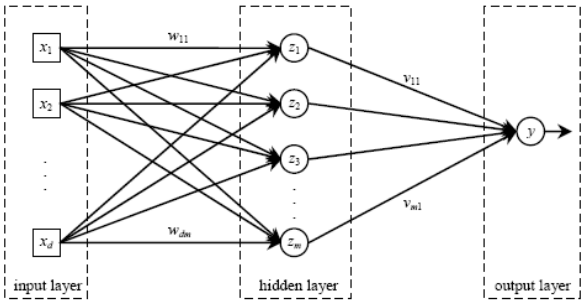

Figure 4.0: Neural Network Architecture

In contrast a traditional rule-based system would have rules encoded within it that a designer has previously identified. The advantage of neural network systems is that it is not always possible for a human designer to express and encode rules in a reasonable time-frame or even express then at all. A further disadvantage of rule-based systems is that if the rules change for some reason then it is necessary for the designer to reincorporate the new rules within the rule-base (Barker *et al*., 2004)

A number of Neural Networks applications found in literature include business (Hanke and Reit- sch, 1998; Hall,2000; Siraj *et al*.,2003), economi (Siraj and Junoh, 2002), financial (Kaastra and Boyd,1996; Perez,1999; Surkan, 1999; Siraj *et al*., 2000; Jingtao and Chew, 2001), and education (Whitson, 1999; Carlson,2000; Mullier,2001; Gonzalez and Des Jardins,2002; Siraj, and Asman, 2002; Siraj and Rahman,2003;Siraj and Sudin,2003; Barker,2004).

INTELLIGENT LOAN APPLICATION PROCESSING SYSTEM

In improving the capability of decision support system and loan processing this study suggest that loan application processing system integrates two components of computer-

based information system namely, office automation system and AI system that comprises of intelligent decision support system and knowledge based system. In essence, the potential use of such a system can be accelerated to promote any organizations as an efficient and effective organization that has competitive advantage.

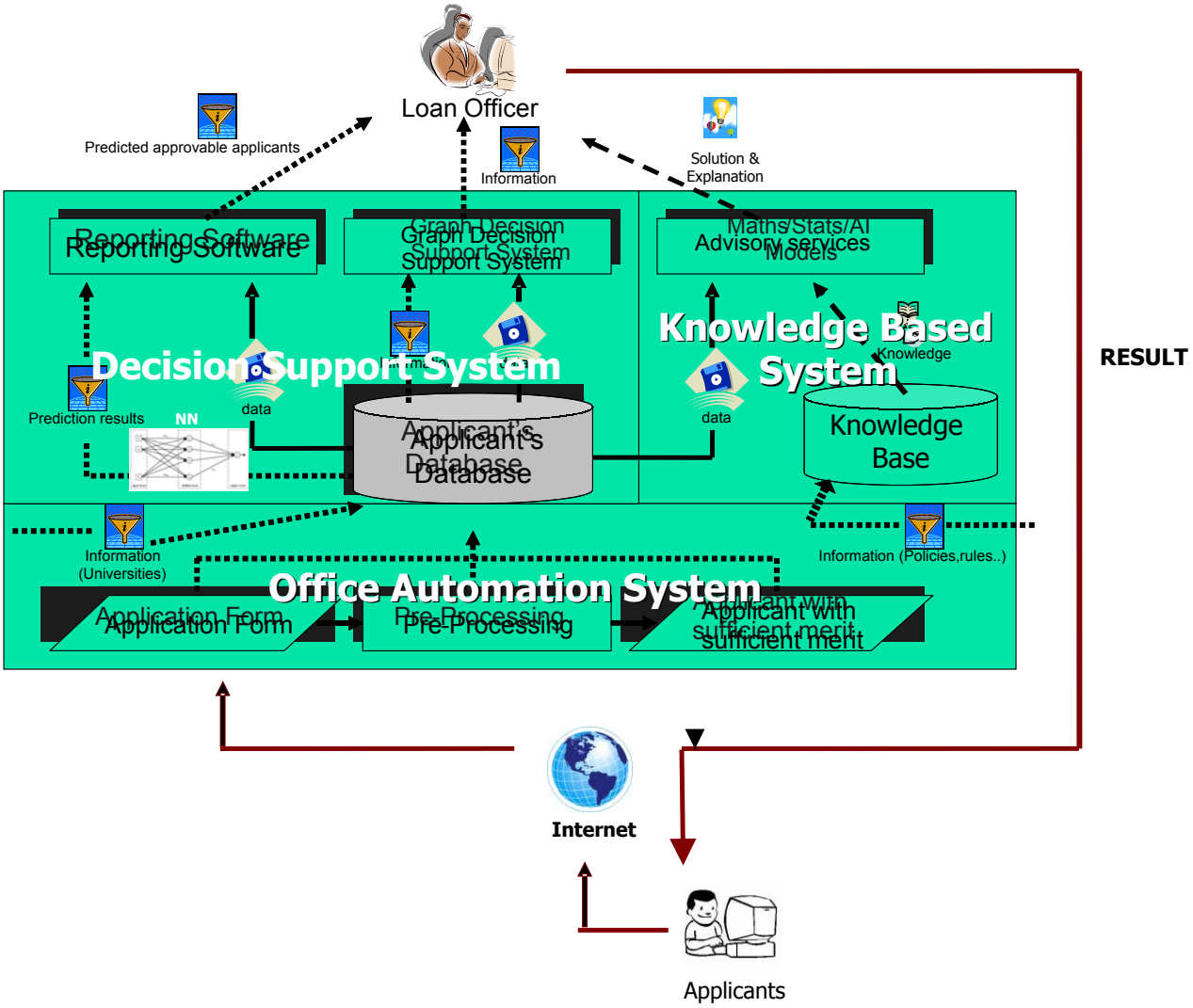

Figure 5.0: Intelligent Loan Application Processing System

Web office automation system can be implemented to ease the loan application access with some payment mechanisms such as online payment. The form application can filled up and submitted through online. As an application submitted, the information will automatically be stored into the system database. Before evaluation takes place, the merit calculation for each application can be done automatically whenever the management needs the information. Even the acceptance letter can be generated automatically. The stored information can accessed easily with some authorization procedures when the evaluation to be performed. Some funding institutions have implemented the online

application, but the stored information still requires a few more manual processing such as merit calculation and applicants short listing.

The integration of knowledge based system can provide advisory services to the management in loan approval decision making. The system consists of rules that explicitly explain why an application is recommended to be accepted or rejected. In addition to knowledge based system, Neural Network system can help the management to predict which application to accept or reject. This can be done as Neural Network has trained previous batch of loan application data and stored association between application characteristics (attributes) that explains which applications were accepted and rejected. The association in previous data can predict the new current application data with same characteristic but no loan acceptance result (Garrett and Leatherman, 2000; Baesens *et al.*, 2003; Handzic *et al*, 2003).

Both knowledge based and Neural Network system can assist the management in evaluating application. The management only needs to agree or disagree to the system recommendations and advices without reviewing each application one by one. All the information and explanation provided by system are based on human represented knowledge or previous loan application results. The proposed integration can be beneficial in reducing the time required for loan application processing and with efficient database management system, the information can be updated easily that can ease the process of tracing the graduated students for payment back purposes.

CONCLUSIONS

This study focuses on loan or scholarship application processing, emphasizing on the information management perspectives, specifically the way the organization manages loan application processes. From the information management point of view, this study identifies several flaws in loan application processing. One of the apparent problems is the time taken for processing application forms. Since the number of staffs that have to deal with the applications is small, the processing time is bound to increase as the number of applicants increases from year to year. There will be a point of time that the staffs could no longer cope with the applications. Therefore, the importance of automation system in loan application processing is undeniable. Consequently, once the automization of the information system takes place, the paper-based management can be transformed into paperless management. In effect, the cost of providing application forms is reduced and the number of staff required is minimal.

Based on the discussed inefficiencies in loan application processing, this study proposes the funding institutions to deploy a computer-based technology. This study also identifies the types of such technology that are appropriate to match with loan application processing that is an integration of office automation system and intelligent decision support system that comprises of knowledge based system and Neural Network.

Office Automation Systems are systems that try to improve the productivity of employees who need to process data and information. This system can assist funding institutions in

capturing applicant's data. Once the data is stored in the database, the data can then be transformed. The processed result can be used by another unit for any purposes. Meanwhile an intelligent decision support system with AI techniques is a computer program application that analyzes business data and presents it so that it can assist users in making decisions. By integrating this system into any funding institutions' systems, inevitably it can ease the decision-making for the institutions especially in the loan process application. This system can also assist in screening for eligible applicant. Hence, with integration of those three systems in funding institution information system, the institution would be able to improve its services and reduce the time, cost and manpower to manage loan application process.

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