LOAN APPLICANTS SELECTION AND RANKING SYSTEM FOR PRIVATE BANKS IN MYANMAR USING TOPSIS

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STATEMENT OF ORIGINALITY

I hereby certify that the work embodied in this thesis is the result of original research and has not been submitted for a higher degree to any other University or Institution.

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Date Mya Mya Aye

ABSTRACT

Decision support systems are gaining an increased popularity in various domains, including business, engineering, the military, and medicine. They are especially valuable in situations in which the amount of available information is prohibitive for the intuition of an unaided human decision maker and in which precision and optimality are of importance.

Bank loan plays a vital role for enterprises and the decision making for accepting or rejecting loan applicants is also important for banks. In order to achieve loan from bank, the applicants need to fulfill the criteria. The pre selection and analysis of loan applicants required to calculate some criteria according to mathematical equation. The bank loan officer checked and calculated these criteria manually. So, the analysis of criteria is time consuming, and a prior automated system that can support decision requirements is needed to determine the loan applicants who will receive or not receive the loan. One of the Decision Support System (DSS) modeling used in decision making to establish the best criteria from a number of alternatives based on certain criteria is Multi-Criteria Decision Making (MCDM). This method is mainly chosen because the customer selection process deals with various criteria and sub criteria as foundation of loan applications.

Among the MCDM methods, Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is used in a decision support system to search the best loan applicants because of its ability to recommend loan applicants from several variables of applicants. TOPSIS can compute the advantage and disadvantage for several criteria of customers to the decision maker. This system implemented the decision support system for selecting the bank's loan by using TOPSIS. This system will be implemented using JAVA programming language with Microsoft SQL Server database.

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CHAPTER 1

INTRODUCTION

Nowadays, Decision Support Systems (DSS) are specially utilized for tactical and strategic decisions faced by high administrative decisions. The military, planning and management in health protection, business and several area in which management encounters multiplex tasks decision conditions are typical application areas of DSSs. MCDM (Multiple Criteria Decision Making) is well-known in decision making, which to set up the best alternative based on accurate criteria. Criteria used in MCDM methods are the standards, sizes or rules used in decision making. Several MCDM approaches and techniques have been suggested in order to choose the probable optimal options in recent years. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is widely used among the various MCDM methods, to complete the decision making [22]. Decision making process for choosing the loan applicants is important and the decision makers who perform complicated tasks. This system implemented TOPSIS decision support for selection of loan applicant process. Other researchers have been submitted by using some problem solving techniques.

Usually, decision support systems are utilized for tactical and strategic decisions faced by high administrative decisions with the low intensity and high potential implications in which the time required to think through and design the problem generously pays off in the long term. The DSSs application areas are planning the management in the fields of military, education, industry, and several area in which management encounters multiplex decision conditions. Selection the loan applicants is a vital process in bank loan processing system.

Shorouq Fathi et al. proposed an approach which can evaluate of credit applications to assist loan decisions in the Jordanian Commercial banks by using Multi-layer Feed forward Neural Network (MLFN) with back propagation learning algorithm [19]. The proposed model of the neural network was designed to propose the most important points in Jordanian banks ' credit decision. Those considerations have been taken from the criteria used by Jordanian banks for loan officers. In addition, banks can tailor the program to their specific strategies. Long training time is needed to restrict the use of neural networks, however, and the bank needs more successful loan function and unsuccessful function to increase the accuracy.

Vipul K. Gupta. Serkan Celtek [21] presented a Fuzzy logic expert system with CubiCalc fuzzy expert system shell for approval of small business loans which includes three variable levels and two stages of production rules. Knowledge acquisition is made by using the resources and expertise of the small business center. The production rules are developed based on identified input data given by the loan officers. The fuzzy approach is a feasible technique to aid credit analysts on small business loan decision in a systematic manner. Interview with more experts is made to validate membership functions, production rules and the scale.

The i-SME : Loan Decision Support System applying Neo-CBR Approach [6] was presented by Fadzilah Siraj, Mohd Haniff Yusoff et al. The approach used Conversational Case-based Reasoning (CCBR), integrated with Neural Network to further process the output produced by Neural Network. CBR is then used to forecast the loan application status, either the application is accepted or rejected for Loan Decision Support System of SME Banks in Malaysia. However, CBR required processing time when new cases is presented to the system. Moreover, many cases are required to focus the similarity value.

Irfan Fauzi,et al [9] were proposed an approach for the implementation and development decision support system using the MADM model for the bank loans. This work uses the Multiple Attribute Decision Making (MADM) distinction between the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) approach and the Elimination and Choice Expressing Reality (ELECTRE) method. This research took both TOPSIS and ELECTRE strengths to solve the problem of loan choice. They concluded that when applied to relatively few results, the comparison of MADM methods ELECTRE and TOPSIS where it was considered to use between two MADMs is not very different, with calculations using ELECTRE slightly faster than using TOPSIS.

TOPSIS is applied in many decision support systems. Jianli Wei [13] used the TOPSIS Model for MADM with Linguistic Setting Incomplete Weight Data. The purpose of this paper was to examine the multiple attribute decision making issues with linguistic information, which the attribute weight data is incompletely understood, and the attribute values obtain the form of linguistic variables. The researcher was developed a new approach for solving incomplete weight of linguistic MADM. To obtain the attribute's weight vector, the optimization model was built based on the basic ideal of traditional TOPSIS to determine the attribute weights. A

TOPSIS method for ranking alternatives and electing the most preference one(s) was developed based on this model.

The financial performance research conducted by the Scheduled Commercial Banks in India was evaluated in order to explore the financial soundness of banks using a multiple criteria decision-making methodology (TOPSIS) by A.R.Rihana Banu, and G.Santhiyavalli. The data was collected from the secondary sources and an expert opinion was obtained to assign the weights to the ratios. The findings of the study indicated that the banks that effectively reduced their risks garners more profit and upholds consistency in their business [2].

1.1 Motivation

Decision making for accepting and rejecting loan applicants is important for banks and enterprises. There is a great need for selection of applicants without many cases to reduce personal judgment for complex tasks decision maker. Customers need to meet several certain criteria and the number of user increasing; more time the calculation for these criteria. Therefore, there was a need for a powerful decision-making system for banks to select applicants for loan applications between users. This system applied TOPSIS technique selecting applicants for a loan was a system implemented.

1.2 Objectives of the Thesis

There are four main objectives in this system.

This system develops the loan decision support model using TOPSIS. By learning TOPSIS process, we can get choice for best goal in bank loan selection. It can assist customers in their loan application process without time consuming. Decision makers can compare and judge selection by changing weight value references. This thesis tends to help decision makers in order to make decision more easily for a loan.

1.3 Overview of the System

The appearance of the bank's lending activities is certainly one advantage for the bank and the customers. However, the conventional bank loan process is time consuming for both applicants and decision makers. According to the rules of banks,

the applicants must provide certain criteria for loans. Decision making process is complex and important tasks for decision makers to select the loan applicants. In order to calculate the bank loan, the decision maker used personal judgment and checklist of bank's laws. A former election process is necessary to decide the applicants who accept the loan or not. In addition, the use of various and huge data and many processing time is required to be able to make the large number of variables for banking loan decisions. Moreover, the computerized decision support system is required for loan customer's election system in order to control a loan officer's job, to simplify it and to obtain more efficiency and productivity.

Decision support systems (DSS) can assist human cognitive deficiencies by providing intelligent access to relevant knowledge, integrating various sources of information and supporting the process of structuring decisions. Method of multi-criteria decision making (MCDM) has developed to accommodate disparate application types.

There have been hundreds of methods created, with even small variations on existing methods creating new research branches. TOPSIS is one of the commonly used approaches for applying the decision support system. TOPSIS is the methodology that takes into account any number of measurements when searching to distinguish solutions far from nadir and close to an ideal solution.

1.4 Organization of the Thesis

This thesis is divided into five chapters. The introduction has been presented in above section. Chapter 2 describes the theoretical background of decision support system, basic concepts of Multi Criteria Decision Making (MCDM) Methods. Chapter 3 describes the design of the system, and also mentions the description of decision support for loan applicants' selection based on TOPSIS. Chapter 4 presents the system implementation. The last chapter presents the conclusion and benefits, limitation and further extensions of thesis.

CHAPTER 2

BACKGROUND KNOWLEDGE

Decision making is researching the detection and election of alternatives based on the decision-maker's principles and expectations. The very nature of the problem includes the main role in the decision-making process. Decision Support Systems (DSS) are computer-based interactive information systems with a structured set of persons, models, procedures, applications, databases, devices, and telecommunications, which assist decision makers to solve semi-structured or unstructured business problems. Decision Support Systems (DSS) are designed to aid decision makers in order to choose one of the many solutions to an issue [17]. The features of decision support systems are defined by assisting but not replacing the decision making process. Many decision-making processes are automated, and computer based DSS is sophisticated, and analyzed large amount of information fast. The use of decision support systems generally increases the leader's ability to make rational and informed decisions. It allows companies to increase profitability, reduce costs, increase market share, and improve quality.

2.1 Major Components of Decision Support System

Like any other software system, DSS also requires implementation elements and phases. The four fundamental components of DSS are:

1. **Input data:** what sort of input does the research require?
2. **User Knowledge / Expertise:** Whether or not outputs need manual user analysis.
3. **Output:** Should the results be comparative or general?
4. **Decisions:** Should it be a framework to help suggestions? Or do you just want the information and outcomes of different actions to be analyzed?

The design of a DSS is a complex process and therefore takes longer. It goes through three phase’s repeatedly-inputs, activities and outputs in each step of the lifecycle of system development.

2.2 The Structure of DSS

The overall structure consists of three components which are discussed as follows:

2.2.1 Database Management System (DBMS)

For Decision support systems, a DBMS serves as data storage. This saves large amounts of information and data related to the issues and applications for which the DSS database is developed and enriches the user with a structured view of data (diverging from the physical data layout) that is easily handled and shared by a user. So the DBMS code shares physical features with users [17].

2.2.2 Model-Base Management System (MBMS)

The basic purpose of this part is to free the user from the software used by the user from specific models used in a DSS. It component's function is to turn DBMS data into useful information that is used in the decision-making process. Since many of the problems faced by the program administrator may be amorphous, the design base management system has the capabilities of supporting the user in model management [15].

2.2.3 Conversation and Conversation Management

Awareness is the major benefit of using a decision support system. Operators are mostly managers who don’t have the ability to use computer aided systems, so they should be easy to use interfaces for Decision support systems. Conversation management not only helps to create a template, but also creates the rich environment for communication with the overall system, such as learning about hidden things and recommendations from it. The major function is to enhance the user's capacity for conversation with system and enable operators to gain maximum benefits from the system.

Three elements are combined to create the decision support system. Management and preparation of the decision support system in the fields of industry, agriculture, education, and medicine are typical application areas of DSSs.

2.3 Approaches to Decision Support System

There are many categories of decision support system leadership. All forms pose unique business-level assistance concepts, resource ratios, and effects on organizational development of these variables. Decision support systems use various technologies and tools to assist and sustain various management activities. Another

element of DSS growth is improving technology quality, as the surfacing of each DSS class is associated with the availability of improved technologies and tools. DSS can be applied in various ways. It can be used as:

1. Personal Decision Support System
2. Group Decision Support System
3. Executive Decision Support System

To support individual decision-making, the personal DSS was developed. Personal Decision Support Systems (PDSS) are small scale information systems that are typically built for an important decision-making role for one director, or a small number of managers. We were the original way of using IT to assist decision-making in management. They remain the most valuable component of DSS are used by managers in most organization today.

Group decision-making support system has been created to support group level decision-making [20]. The group decision support system (GDSS) is an interactive computer-based system that makes it easier for a variety of decision makers (working together in a team) to search solutions to unstructured problems of a nature. They are designed to take input from many users who interact with the systems simultaneously to reach a decision as a group. The group decision support system's techniques and tools improve the quality and effectiveness of group meetings. Many community decision-making software and web-based resources for online videoconferencing and meetings also help some of the group decision making process, but their major function is to make possible communication between the decision makers.

The Executive Support System facilitates senior-level decision-making [18]. Executive Information System may also be viewed as a standardized version of a decision support system. Executive Information System focuses on user interfaces and graphical presentations that are easy to use. The benefits of this are that they provide detailed documentation and willingness to drill down. Drill downs capabilities are when users switch from focusing on something from brief information to detailed data. Executive Information Systems are important as they help top executives assess, compare and highlight patterns in key areas so that they track progress and recognize issues. However, due to Business Intelligence, analytics and digital dashboards, the popularity of Executive Information Systems has declined in recent years. This

worker and operator support has made DSS software much better, faster, more flexible and more reliable [12].

Communication, knowledge based, document based, data oriented, and model based approaches are the primary methods.

2.3.1 Communication Based Approach

Decision making is based on communication between group members in the communication-based decision-support system. Communication can take place via text messages, emails and video conferencing.

Communications-Driven DSS technology has at least one of the following features:

1. Enables contact between people's groups
2. Facilitates knowledge sharing
3. Collaborative support.
4. Support group decision making

Key communication-driven DSS research issues include effects on team processes and group understanding, multi-user interfaces, group competition management, connectivity and collaboration, shared information processing, and support for a heterogeneous, open environment that integrates existing single-user applications. Communications-Driven decision-making support systems are time and location matrix by distinguishing between times (synchronous) and time (asynchronous) and position (face-to-face) and place (distributed) [7].

2.3.2 Model Based Approach

It's a complex decision support system based on the model. For example, numerical, cost-effective, simulation and optimization systems, Model-Driven DSS emphasize model access and manipulation. Simple analytical and statistical methods provide the most basic level of usability. Many Online Analytical Processing (OLAP) systems for complex data analysis can be classified as hybrid DSS systems that support both modeling and data retrieval and data summarization functionality. In general, model-driven DSS uses complex economics, optimization, multi-criteria or simulation models to assist in decision-making. Model-driven DSS uses data and criteria provided by decision makers to help decision makers analyze a scenario, but

generally they are not data-intensive, which is usually very huge databases that are not needed for model-driven DSS. This helps users evaluate the decisions made and choose between different options. It was used by administrators and users to solve complex situations.

2.3.3 Data Oriented Approach

Data-driven DSS is the type of DSS that emphasizes the time series of internal company data and sometimes external data access and manipulation. The most basic level of functionality is offered by simple file systems accessible by search and retrieval software. Data warehouse systems allow the manipulation of data by computerized tools tailored to a specific task and setting or by more general tools tailored to a specific task and setting or by more general tools and operators provide additional functionality. OLAP information-driven DSS provides the highest degree of usability and decision support linked to the study of huge historical data collections. Data-driven DSS is a special function of Geographic Information Systems (GIS) and Executive Information Systems (EIS).

2.3.4 Document Based Approach

The most common type of document-based decision support system used in organizations. Document-Driven DSS focuses on retrieving and handling unstructured files. Documents take many forms, but they are divided into three types: written, oral, and video. Types of oral records are transcribed conversations; images can be news reports or advertisements on television; commercials; written documents are written catalogs, reports, and letters from memos, consumers, and even e-mail.

2.3.5 Knowledge Based Approach

Knowledge-based decision support system includes information that may not be previously available to the user. This involves the detection of secret trends between records of information, management advice and services. In a new generation of decision support tools called Intelligent Decision Support Systems (IDSS), the knowledge-based system design approaches in decision support developed. Decision support systems can assist managers in making decision processes by describing various alternatives and presenting information. Three relevant approaches to the growth of the new DSS for information research are:

1. Rule-Based Reasoning (RBR)
2. Case-Based Reasoning (CBR)
3. Hybrid (the combination of CBR and RBR)

Different techniques are used to gain information in personal DSS, team DSS or executive structure design for decision making processes. The choice of a particular problem-solving technique is based on some constraints:

1. What is the troubling area?
2. How to solve the problem?
3. Software accessibility for problem solving
4. Alternatives of clients' decision

The solution process is started after obtaining the required knowledge. In every region, Decision Support System is used.

2.4 Decision Support Systems and its Application

In almost every region, the decision support system is being implemented. The broad implementation of DSS has simplified detection protocol for medical problems. Decision Support Systems have the built-in capability of adopting new atmosphere and adjusting over time when executed with the support of Artificial Intelligence. Artificial intelligence can aid in the diagnosis of disorders in the medical field in the diagnosis of disease.

There is a need for advance computer-based software to test the level of pain and illness that can capture all patient data and use the detailed data to calculate the severity of pain and then save all records in the databases. Disease will kill the dignity of any person and patient will lose heart and stop asking for further examination due to less successful evaluation methods [20].

Critical patient treatment after surgery is very important as patients need intensive care at that point and overtaking can sometimes lead to life risk. It is proficient, operative and necessary to use Clinical Decision Support System to estimate and identify the degree of pain. The essential components of the support system for medical decision-making are shown below.

1. Neural networks
2. Genetic algorithms
3. Database
4. Fuzzy logic

All these components combine to accomplish tasks in medicine field.

In recent years, the decision support system in the business field has gained a growing value among users and researchers due to a number of success stories that have shown incredible progress in the performance of the organization [5,7].

The decision support system helps the business staff to create policy, execute and use technical means to assist the decision making professionals. Decision support system is the information model that is accompanied by a mathematical model, information databases and user-friendly environment for communicating suggested decisions to managers and users [15]. Decision-making in the Decision Support System (DSS) is diverse from a rational information system or information management system because it not only provides users with information and knowledge, databases and reports, but also provides user queries with answers. In complex situations, DSS helps managers to make decisions. Better decisions involve improving the information provided. Concepts of decision-making should be adopted to improve work in the business field. Knowledge application depends on choice, duty to make decisions, situation, time, interest, etc. Modeling management decisions includes concepts of optimization and management.

E-commerce has the potential to improve the efficiency and performance of company behavior. E-commerce is no longer a technical issue, but it is the business issue. Database-equipped decision support system is a shared database system that provides information, templates, and data manipulation tools to assist in complex situation decision making.

Throughout schools, colleges and universities, support for decision-making was also implemented after success in every region. There has been increasing pressure on educators to tackle competitive external and internal demands related to valuation of students such as quizzes, tasks, intelligence tests [1].Student data is stored in repositories from which assessment is performed. Database is the critical part of the system of decision support in colleges, schools, and universities. It is used to assess students, teachers ' results. Data availability is the starting point for the decision support system. Data is collected, stored in data storage and successive means of accessing data from database are used.

In schools, colleges, universities, data based decision support system is implemented. Teachers use data-driven DSS to help teachers ' future decisions; the success of students is measured. Data based DSS may include student assessment

reports, attendance, test results to assess student performance to determine student performance, which can then be used to determine student performance.

2.5 Advantages and Limitations of DSS

The benefits and limitations of DSS are presented in this part, which are the common disadvantages and advantages of DSS shared by DSS served in various areas. This enables decision-making support due to computerizing the decision-making processes.

(1) Speedy Computations Timeliness means Efficiency

The high speed responses are shown. In multi-cases from a doctor in an emergency room to a stock trader on the trading floor, prompt decision is crucial. It also lowers the additional cost of complex computations. Hundreds of alternatives is evaluated in seconds with a computer.

(2) Improving Communication and Collaboration

Wherever the data material and decision makers are, the data can be collected and communicated via web-based tools and provided to decision makers.

(3) Improving Data Management

Text, audio, graphics and video are included in various data formats. And they're big in quantity. All of them will be processed anywhere in the local repository and even outside of the company. The computers are able to quickly, securely and transparently search, store and transmit the information.

(4) Quality Support

The decisions have a high quality as well as decreased processing costs through the processes of risk analysis and experience.

(5) Agility Support

To counter the raging rivalry, companies must be able to reform their tactics. Therefore, to adapt to changing conditions, it should change their mode of operation, reengineer processes and systems and innovate. DSS information engine can support good decision-making people.

Nevertheless, some of the DSS limitations required for improvement are still exiting [10].

(1) Cognitive Limits

Managers or other decision-makers have different intelligence and history rates. Their personal experience will affect the final decision outcomes. In addition, to provide better suggestions, the expert systems are continuing to learn.

(2) Collection of the Data

Because most databases are distributed globally, it is difficult to collect all the information at the same time and ensure information is correct and safe.

2.6 Multi Criteria Decision-Making (MCDM)

Multi Criterion Decision-Making (MCDM) is becoming increasingly important as potential methods for evaluating complex real problems due to their inherent ability to decide different alternatives (strategy, scenario, rule, choice is also used synonymously) on different criteria for potential election of the best / appropriate alternative(s). For their final implementation, these alternatives can be further explored in depth. In many cases, multi-criteria decision-making has been implemented. The MCDM approach helps to select the best alternatives where there are many parameters, the best one is obtained by evaluating the different range of the criteria, the weights of the criteria and choosing the right ones using any multi criteria decision-making techniques.

Multi criterion decision-making (MCDM) research has some unique features like the existence of numerous non-commensurable and overlapping criteria, different units of measurement between criteria, and the presence of different alternatives. It is an effort to study the different methods of MCDM and there was a need for more advanced methods for experimental evaluation and the different of testing approaches available to apply MCDM to team decision making scenarios for the treatment of uncertainty. **Figure 2.1** illustrates the structure of multi criteria decision making trees.

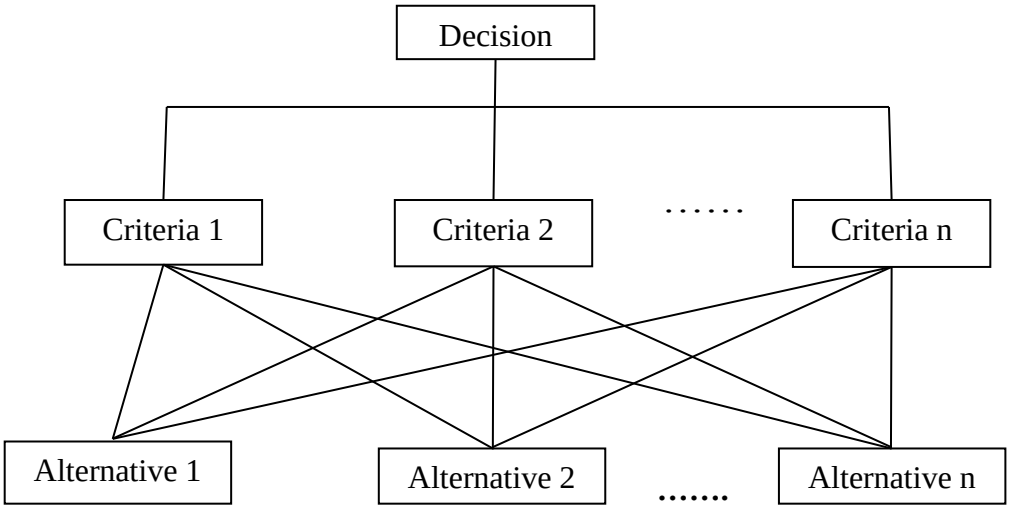


Figure 2.1 The structure of Multi Criteria Decision-Making Process

Decision-making multiple criteria (MCDM) is considered a complex decision-making mechanism that includes both quantitative and qualitative considerations. Several MCDM strategies and methods have been proposed in recent years in order to pick the likely optimal choices.

2.7 Steps in MCDM Methodology

MCDM processes may be summed up as:

1. Define the problem and set the requirements
2. Adequate set of data
3. Establishing feasible / effective alternatives
4. Formulation of matrix reward (alternative vs. set of criteria)
5. Select the right approach to solve the problem
6. Incorporation of the preferential system of the decision maker
7. Selecting one or more of the best / appropriate alternative(s) for further study.

2.8 MCDM Methods

MCDM approaches are extended to various applications and the best solution to choose the best alternative was found. The **Figure 2.2** illustrates the hierarchical view of MCDM methods.

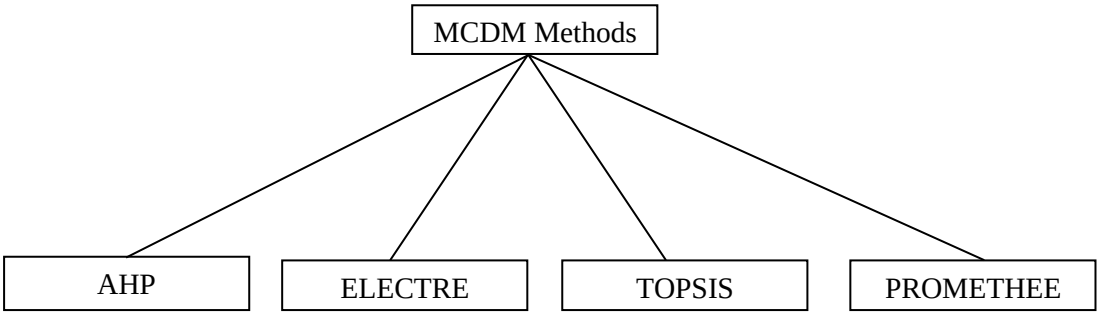


Figure 2.2 The Hierarchical View of MCDM methods

2.8.1 Analytic Hierarchy Process (AHP)

AHP's basic idea is to harness the awareness of the phenomenon being studied by experts. The systematic approach to alternative choice and justification problem is pursued using the principles of fuzzy set theory and hierarchical structure analysis. Decision makers find that decisions of intervals are more comfortable than judgments of fixed value. This approach can be extended if a user preference is not clearly specified due to fuzzy design. AHP requires expert opinions and analysis of multi-criteria; it cannot represent the abstract thoughts of humans. The classical AHP considers the decision-makers ' definite decisions, making the evaluation process more versatile and able to explain the experts ' preferences. The Analytic Hierarchy Process (AHP) decomposes the difficult MCDM problem into a systematic hierarchy procedure [14]. Analytic Hierarchy Process (AHP) decomposes into a formal hierarchy process a complicated MCDM problem [14]. The final step in the AHP approach discusses the m*n matrix structure (where m is the number of alternatives and n is the number of criteria). In terms of each criterion, a matrix is constructed using the relative importance of the alternatives. Analytical hierarchy (AHP) method is based on priority theory. It deals with the complex problems which include the consideration of multi criteria/alternatives simultaneously.

2.8.2 Elimination and Choice Translating Reality (ELECTRE)

The ELECTRE for Elimination and Selection Translating Truth was published in 1966 [9] for the first time. The ELECTRE method's basic concept is deal with "outranking partnerships" by using parley correlations between alternatives separately under one of the parameters. The direct relationship between the two

alternatives Ai and A_j explains that the j^{th} is not calculated even if the i^{th} alternative does not decide the j^{th} alternative quantitatively, then the decision maker may take the risk of regarding Ai as almost better than A_j. Alternatives are said to be dominated in the remaining criteria there is another alternative that excels them in one or more criteria and is equivalent. Under each condition, the ELECTRE approach starts with pair comparisons of alternatives. Using the physical or monetary values referred to as $gi(A_i)$ and $gj(A_j)$ of the alternatives A_i and A_j and applying the thread hold rates for the specific $gi(A_i)$ and $gj(A_j)$, the decision-maker either declare that he / she is indifferent to the alternatives under consideration, that he / she has a weakness or that he / she has a weakness or a weakness. Thus a set of binary alternatives relationships may be complete or incomplete, the so-called outranking relationships. First, the decision maker is asked to assign factors or weights of significance to reflect their relative importance. The ELECTRE method elicits the so-called concordance index described as the through consecutive evaluations of the outstanding relationships of the alternatives, the ELECTRE method elicits the so-called concordance index defined as the amount of evidence to support the conclusion that alternative A_j outranks or dominates, alternatives Ai, as well as the discordance index the counter-part of the concordance index. Finally, the ELECTRE approach provides a binary dominant relationship scheme between the alternatives. This approach is particularly suitable when there are decision problems with a huge number of alternatives that require a few parameters.

2.8.3 The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

Yoon and Hwang developed the technique of TOPSIS [3]. This method's basic concept is that the chosen alternative might be the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution. The TOPSIS approach suggests that each criterion tends towards an utility that increases or decreases monotonically. It is therefore easy to define the possible solutions that are positive and negative. To determine the relative closeness of the alternatives to the ideal solution, the Euclidean distance method was proposed. Therefore, a sequence of comparisons of these relative distances extracts the preferred order of the alternatives [11]. It has numerous benefits. It has a process that is simple. The number of environmental management, marketing management, human resource management,

and water resource management are easy to use and programmable. This is another approach that has kept its software popular due to its ease of use. Many of the applications seen in the analysis of literature had TOPSIS supported the responses suggested by other methods of MCDM. The strength of its simplicity and its ability to maintain the same amount of steps regardless of problem size has allowed it to be easily used to analyze the other approaches or stand alone as a decision making tool.

2.8.4 Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE)

The PROMETHEE is an excellent method of rating a finite set of alternative acts when various, frequently contradictory parameters are involved with multiple decision-makers [14]. PROMETHEE uses partial aggregation and, by comparing alternative actions in pairs, it makes it possible to check whether one action exceeds the others under specific conditions. A few years later, some iterations of the PROMETHEE techniques, such as the PROMETHEE III for interval ranking, the PROMETHEE IV for full or partial ranking of alternatives when the collection of viable solutions is continuous, the PROMETHEE V for segmentation constraint problems, the PROMETHEE VI for human brain representation. The downside of this is that it's easy to use. It does not include the presumption of proportionate requirements. The disadvantages are that it does not support a clear weight assignment method and requires value assignment but does not support a clear assignment method. PROMETHEE has seen a great deal of use in hydrology and water management, environmental management, business and financial management, engineering, logistics and shipping, production and assembly, energy management and agriculture. PROMETHEE has been used for several decades and as its iterations have improved, its ease of use has made it a popular tool.

2.9 Methods of Estimation of Weights

Relative importance or weight of a criterion shows the significance that the decision-maker gives to the criterion when rating the alternatives in an atmosphere of multi-criteria decision making (MCDM). Problems of multi-criteria require standards of varying significance to decision makers. Details about the relative importance of the criteria are then needed, and this is done by assigning a weight to each criterion. Consequently, weight derivation is the key step in producing the expectations of the

decision maker. To this end, a weight is defined as a value assigned to an evaluation criterion that demonstrates its importance to other criteria. Usually, the weights are standardized to amount to one [21]. MCDM literature has suggested a variety of weighting approaches for parameters. The methods are available in literature for computing the weights, Notable among them, that are applied frequently, are Ranking Method, Entropy Method, etc.

2.9.1 Ranking Methods

In the ranking methods, the criterion is ranked from the most important to the least, the most important= 1, next important= 2, and so on in order of the DMs favorite. There are three types of rankings to assign criteria weights: RR method, RS method, and ROC method, RE method [5].The four subsections below address each of the four methods of ranking. Due to their ease of use and reliability characteristics, these methods were chosen.

2.9.1.1 Rank Sum (RS) Method

The RS method is calculated that the individualized weight in RS is normalized by the sum of all criteria' weights, where each criteria is weighted (K-r_i+1) , r_i is the rank position of the attribute or criterion i, =1,2,..K, K is the number of attributes under consideration. The weight, w_i, is the normalized weight for each attribute i, is calculated as given in **Equation 2.1**.

$$W_i(RS) = \frac{K - r_i + 1}{\sum_{j=1}^{k} K - r_j + 1} \tag{2.1}$$

2.9.1.2 Rank Reciprocal (RR) Method

The RR weights are uniform reciprocals of the rank of the criteria or by dividing the reciprocal rank of each attribute by the sum of the reciprocals of all the ranks of the criteria as shown in the **Equation 2.2**.

$$W_i(RR) = \frac{1/r_i}{\sum_{j=1}^{k}(1/r_j)} \tag{2.2}$$

2.9.1.3 Rank Exponent (RE) Method

The RE method is a generalization of the RS, which is considered as given in **Equation 2.3**.

$$W_i(RS) = \frac{(K - r_i + 1)^p}{\sum_{j=1}^{k}(K - r_j + 1)^p} \tag{2.3}$$

Where p parameter is describing the attributes, i=12….n. The parameter is assessed by a decision maker using the weight of the most major attribute or via interactive.

2.9.1.4 Rank Order Centroid (ROC) Method

In ROC method, weights acquired from this method were very stable. They showed that the expected value of the weight of any attribute can be calculated using Equation (2.4).

$$W_i(ROC) = \frac{1}{k}\sum_{n=1}^{k}\frac{1}{n} \tag{2.4}$$

Where k is the number of attributes, n is the rank position of attribute i, i=1,2,…..n.

2.9.2 Entropy Method

Entropy is a concept that measures the uncertainty of the predicted information content of a certain message correlated with random phenomena, and this uncertainty is expressed by a discrete distribution of probability. The Entropy Method calculates the weights from the given payoff matrix of the different criteria and is independent of the decision-maker's views [12]. This approach is especially useful in exploring contrasts between data sets. Such data sets can be represented in the payoff matrix as a series of alternative solutions where each alternative solution is evaluated according to its outcome. This method's philosophy is based on the amount of available information and its relationship to the criterion's importance. If the entropy value is small, the uncertainty in the vector of the criterion is high, the information diversification is low and the criterion is less important accordingly. This approach is useful as it reduces the decision-maker's burden on large-scale issues. In cases where consensus can be achieved in a team, it can also be used as a reference solution.

CHAPTER 3

DESIGN OF THE PROPOSED SYSTEM

Selecting the loan applicants is important in bank loan system. The goal of the system is to reduce the cost of loan processing and to aid the decision maker in order to build decision more easily. The applicants can apply loan via online and only pre-selected applicants need to continue the loan process. The system makes pre-selection process and TOPSIS method was used to rank the applicants.

3.1 The Proposed System Design

The system collects the information of the loan applicants in the database. Admin can generate information of the applicants and the ranked list according to the criteria chooses. The expected system design is shown in **Figure 3.1**.

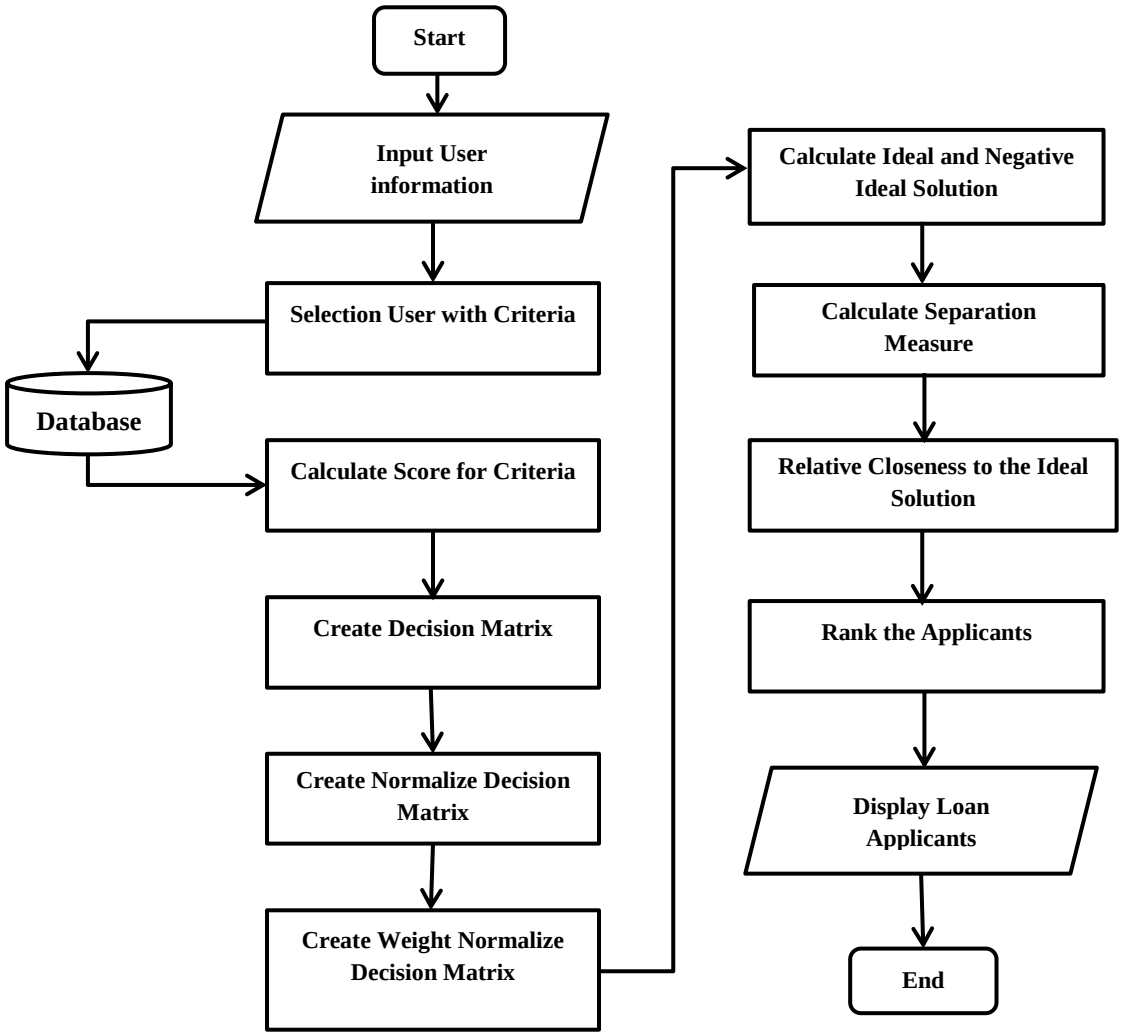


Figure 3.1 Process Flow Diagram of Loan Applicants Selection

For the selection of loan applicants TOPSIS method is applied and the TOPSIS algorithm is shown in **Figure 3.2**.

Input: Decision matrix DM= $(X_{ij})_{mxn}$ with m alternatives and n criteria.

Weight for each criteria $w_1, w_{2,\ldots,}w_n$.

Output: A list L.

Step 1: Normalize the decision matrix.

for i=1 to m

for j=1 to n

$r_{ij} = X_{ij} / (\sqrt{\sum x_{ij}^2})$

Step 2: Construct the weighted normalize decision matrix.

for j=1 to n

$v_{ij}=w_j * r_{ij}$

Step 3: Determine the ideal (A^+) and negative ideal solution (A^-).

$A^+ = \{ (\max(X_{ij} | i = 1,2, \ldots., m) | j \in J+), (\min(X_{ij} | i = 1,2, \ldots., m) | j \in J-)\}$

$A^- = \{ (\min(X_{ij} | i = 1,2, \ldots., m) | j \in J+), (\max(X_{ij} | i = 1,2, \ldots., m) | j \in J-)\}$

$J+$ = associate with the criteria having a positive impact

$J-$ = associate with the criteria having a negative impact

Step 4: Calculate the separation measures for each alternatives.

for i =1 to m

$S_i^+ = \sqrt{\sum_{i=1}^{n} (V_j^+ - V_{ij})^2}$

for i =1 to m

$S_i^- = \sqrt{\sum_{i=1}^{n} (V_j^- - V_{ij})^2}$

Step 5: Calculate the relative closeness to the ideal solution.

$C_i = S_i^- / (S_i^+ + S_i^-), 0 \leq C_i \leq 1$

Step 6: Rank the preference order.

Figure 3.2 TOPSIS Algorithm

The election of loan applicant process includes of three stages. These are:

1. The loan customer can apply loan from network.
2. According to criteria, the applicants can pre-select.
3. TOPSIS method can evaluate and dedicate the alternatives of the last rank.

In the early stage, the applicants must give precise information in order to compose decision process more efficiently.

Thereafter, the decision maker can investigate loan customers' information, can calculate score of applicants, can rank the applicants, can look rejected list.

In this model, some criteria are analyzed before going to calculate with TOPSIS. Some limitations are decided according to domain expert. The pre-selection rules are described in **Figure 3.3**.

1. IF age < 20 OR age > 70 THEN reject.
2. IF nationality = “other” THEN reject.
3. IF land_types = “other” THEN reject.
4. IF business period < 3 years THEN reject.
5. IF warranty value period <3 years THEN reject.
6. IF loan_purpose = “other” THEN reject.
7. IF business_type = “other” THEN reject.
8. IF DCR_Range < 1 THEN reject.
9. IF ICR_value < 1.5 THEN reject.
10. IF WarrantyValue > 80% THEN reject.

Figure 3.3 Pre-selection rules for TOPSIS

After this selection, the scores of customers can be decided. Seven attributes are determined the customers’ selection in this TOPSIS based decision support system. These are

1. Interest Coverage Ratio (ICR)
2. Debt Coverage Ratio (DCR)
3. Loan from other bank exists
4. Loan Type
5. Period of Loan

6. Warranty Value
7. House Status

For Interest, if loan from other bank exists, interest is decided as **Equation 3.1** and if the loan from other bank does not exist, interest is determined with **Equation 3.2**.

Interest= (loan amount + loan amount from other bank)* 13% (3.1)

Interest=loan amount*13% (3.2)

For the loan type is over draft, if the loan from other bank exists, total debt is calculated as **Equation 3.3** and if the loan from other bank does not exist, total debt is calculated as **Equation 3.4**.

Total Debt= [loan amount/2 *3%]*12 + [loan amount *13%]
+ [loan from other bank*20%]
+ [loan amount from other bank *13%] (3.3)

Total Debt= [loan amount/2 *3%]*12 + [loan amount *13%] (3.4)

For the loan type not overdraft, if the loan from other bank exists total debt is determined as **Equation 3.5** and if the loan from other bank does not exist total debt is considered as **Equation 3.6**.

Total Debt = [loan amount*3%]*12+ [loan amount *13%]
+[loan amount from other bank *13%]
+ [loan from other bank*20%] (3.5)

Total Debt = [loan amount*3%]*12+ [loan amount *13%] (3.6)

In order to calculate DCR, ICR and EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization) are needed. The EBITDA, ICR and DCR values are determined according to the **Equation 3.7**, **Equation 3.8** and **Equation 3.9**, respectively.

$$\text{EBITDA} = \text{Net profit} + \text{Interest} + \text{Taxes} + \text{Depreciation} \quad (3.7)$$

$$\text{ICR} = \frac{\text{EBITDA}}{\text{Interest}} \quad (3.8)$$

$$\text{DCR} = \frac{\text{EBITDA}}{\text{Total Debt}} \quad (3.9)$$

Warranty value can get from the Forced Sale value and it can be achieved from **Equation 3.10**.

Forced Sale value = Current price of building* building_type_percent
+ (Current Price of Land *land type_percent) (3.10)

Score Range for ICR

- IF ICR_value>4.5 THEN assign score=1.
- IF ICR_value >=1.5 and <2.5 THEN assign score=2.
- IF ICR_value >=2.5 and <3.5 THEN assign score=3.
- IF ICR_value >=3.5 and <4.5 THEN assign score=4.

Score Range for Warranty Value

- IF Warranty_value between 70% and 80% THEN assign score=1.
- IF Warranty_value between 60% and 70% THEN assign score=2.
- IF Warranty_value between 50% and 60% THEN assign score=3.
- IF Warranty_value between 40% and 50% THEN assign score=4.
- IF Warranty_value between 30% and 40% THEN assign score=5.

Score Range for Loan from other Bank

- IF exists THEN assign score=1.
- ELSE score=2.

Score Range for Loan Type

- IF type="overdraft" THEN assign score=1.
- IF type="loan" THEN assign score=2

Score Range for DCR

- IF DCR_Range > 4 THEN assign score =1.
- IF DCR_Range >=1 and <2 THEN assign score=2.
- IF DCR_Range >=2 and <3 THEN assign score=3.
- IF DCR_Range >=3 and <4 THEN assign score=4.

Score Range for Loan Period

- IF Loan_period=1 THEN assign score=3.
- IF Loan_period=2 THEN assign score=2.
- IF Loan_period=3 THEN assign score=1.

Score Range for House status

- IF House_status="parent" THEN assign score=1.
- IF House_status="own" THEN assign score=2

Figure 3.4 Rules for Criteria

The land type percent is decided in order to land. Grand land and free hold land the percent is defined 70% and 50% is defined for others type of land. The competed building is defined as 30% and the percent of building otherwise only 50% is defined.

The warranty value is obtained the **Equation 3.11**.

Warranty= (Loan Amount/Forced Sale Value)*100 (3.11)

The nature of TOPSIS calculation is to define score values for each criterion. So, some rules are needed to define to for score. The defined rules for calculate score values according to domain expert's suggestions is shown in **Figure 3.4**.

In this model, ranking method can be used to evaluate the principal of weights which includes the every attribute under discussion, is ranked in according to decision maker liking. According to loan officer's proposition, weights value references are assigned to each criterion. Their associated weight value references and the elected criteria are shown in **Table 3.1**. The most major attribute gives the rank value 1 and so on.

Table 3.1 Rank Value for Each Criterion

Name	Define Rank Value
ICR	1
DCR	1
Warranty Value	1
House Status	2
Other Loan Exists	3
Loan Type	3
Loan Period	4

The weight values for each criterion are planned by using rank sum (RS) method.

In the rank of sum procedure, the weights are the single ranks normalized by dividing the ranks of sum. The formula producing the weights is shown in **Equation 3.12**.

$$W_j = \frac{n - r_j + 1}{\sum_{k=1}^{n} n - r_k + 1} \quad (3.12)$$

Where, n is the number to attributes and r_j is the rank of the j^{th} attribute.

3.2 The Experimental Result for Loan Applicants Selection

The decision support system for loan applicant's selection via online needs a lot of information from applicants. The required information of applicants is listed in **Table 3.2**. The applicants must provide all information correctly.

Table 3.2 Required Information Lists of Loan Applicants

No	Input Information	No	Input Information
1	Name	13	Loan from other bank
2	Nrc	14	Interest rate from other bank
3	Age	15	Loan/Overdraft
4	Address	16	Tax (Income & commercial)
5	Loan Amount	17	Depreciation
6	Warranty Value	18	Net profit
7	Land Types	19	Current price of land
8	Income	20	Current price of House
9	Loan Period	21	Purpose of Loans
10	Business Period	22	Business type
11	Nationality	23	House status
12	Period of warranty value	24	Building type

Table 3.3 Sample Data of Applicants

Name	Loan Amount	Loan Period	Loan Type	Warranty Value	Land Type	Building Type	Interest
Daw Po	80000000	1	Loan	247600000	G	Complete	-
U Ye Myint	80000000	1	Loan	328412345	LaNa	Complete	-
U Yin Mg Oo	200000000	1	OD	499066667	LaNa	Complete	-
U Myint New	30000000	2	Loan	82200000	LaNa	Complete	-
U Tin Myint	80000000	3	Loan	331000000	LaNa	Complete	-
U Win Zaw	450000000	1	OD	1853600000	G	Complete	-
U Mya Thein	40000000	3	Loan	114500000	G	Complete	-
U Ye Win	150000000	1	OD	433600000	G	Complete	-
Daw Khin Win	30000000	2	Loan	75300000	G	Complete	6500000
U Hla Thwin	50000000	2	OD	270800000	LaNa	Complete	1300000

Table 3.4 Sample Data of Applicants

Tax	Depreciation	Net Profit	Business Period	Loan Amount form other bank	Current Price of Land	Current Price of Building	House Status
99000	3416000	42151700	19		158800000	88800000	own
227744	6732744	44524256	15	0	231066667	97333333	own
960000	6400000	102481000	15	0	400666667	98400000	own
88000	1500000	40885000	10	0	40900000	41300000	own
390000	2000000	42950000	16	0	201700000	332000000	own
92736	5000000	171553264	13	0	1521600000	54500000	own
59400	1000000	22851600	15	0	60000000	54500000	parent
132000	1560000	99723500	17	0	251000000	182600000	own
55000	1500000	38043000	12	50000000	46700000	28600000	parent
50000	2660000	24180000	12	10000000	173600000	97200000	parent

The sample data of applicants is described in **Table 3.3** and **Table 3.4**. The data is collected from the private bank to test the correctness of the model used in this system. The collected data cannot directly used in TOPSIS calculation. In this TOPSIS based on decision support system seven attribute are used to determine the applicants' collection. These are Interest Coverage Ratio (ICR), Debt Coverage Ratio (DCR), Loan from other bank exists, Loan Type, Period of Loan, Warranty Value and

House Status. In order to determine ICR and DCR, EBITDA (Earnings Before Interest, Taxes, Depreciation and Amortization) is needed. The Interest, Total Debt, EBITDA, ICR and DCR, Forced Sale Values and Warranty Values are adjusted according to the above equation respectively. The calculated result is shown in **Table 3.5**.

Example for Daw Po

Interest	= Loan amount * 13%
	= 80000000 *13%
	= 10400000
Total Debt	= (Loan Amount*3%)*12+ (Loan Amount*13%)
	= (80000000*3%)*12+ (80000000*13%)
	= 28800000+10400000
	= 39200000
EBITDA	= 42151700 + 0 + 99000 + 3416000
	= 45666700
DCR	= EBITDA/Total Debt
	= 45666700 / 39200000
	= 1.2
ICR	= EBITDA/Interest
	= 45666700/10400000
	= 4.4
Forces Sale Value	= Current Price of Land*Land type percent+ Current Price of Building*Building type percent
	= 158800000 *70%+ 88800000*50%
	= 155560000
Warranty Value	=80000000/155560000
	=51.43

Table 3.5 Calculated Results for Applicants

Name	EBITDA	Total Debt	Warranty Value	ICR	DCR	Interest	Force Sale Value
Daw Po	45666700	39200000	51.43	4.4	1.2	10400000	155560000
U Ye Myint	51484744	39200000	48.72	5.0	1.3	10400000	164200000
U Yin Mg Oo	109841000	62000000	80.15	4.2	1.8	26000000	249533334
U Myint New	42473000	14700000	72.99	10.9	2.9	3900000	41100000
U Tin Myint	45340000	39200000	48.34	4.4	1.2	10400000	65500000
U Win Zaw	176646000	139500000	36.55	3.0	1.3	58500000	1231120000
U Mya Thein	23911000	19600000	57.76	4.6	1.2	5200000	69250000
U Ye Win	101415500	46500000	56.18	5.2	2.2	19500000	267000000
Daw Khin Win	46098000	31200000	79.68	4.4	1.5	10400000	37650000
U Hla Thwin	28190000	18800000	36.93	3.6	1.5	7800000	135400000

In TOPSIS weight needed to be defined as a value elected to an evaluation criteria which indicates its influence relative to other criteria under consideration. In this model, the every criterion used to decide in this system is ranked in the order of decision maker options and then ranking method is used for evaluating the important of weights which includes in system. So, weights value references are assigned to each criterion according to loan officer's instruction.

Rank Sum (RS) method can be used to determine the weight values for each attribute. The weights enforced in the method of rank sum are the singular ranks normalized by dividing by the sum of the ranks. By using **Equation 3.12**, example of weight for loan type is determined.

Example of Weight for Loan Type

N = 7 r = 3

$$w_j = \frac{n - r_j + 1}{\sum_{k=1}^{n} n - r_k + 1}$$

$$w_2 = \frac{7 - 3 + 1}{(7 - 3 + 1) + (7 - 4 + 1) + (7 - 1 + 1) + (7 - 1 + 1) + (7 - 1 + 1) + (7 - 2 + 1) + (7 - 3 + 1)}$$

=0.1219512

Then, the early step is to make, for individual attribute, to insert score values. This result is shown in **Table 3.6**

. **Table 3.6 Score Values for Each Attribute**

Name	Loan Type	Period	Warranty Value	ICR	DCR	House Status	Loan from other Bank
Daw Po	2	3	3	4	2	2	2
U Ye Myint	2	3	4	1	2	2	2
U Myint New	2	2	1	1	3	2	2
U Tin Myint	2	1	4	4	2	2	2
U Win Zaw	1	3	5	3	2	2	2
U Mya Thein	2	1	3	1	2	1	2
U Ye Win	1	3	3	1	3	2	2
Daw Khin Win	2	2	1	4	2	1	1
U Hla Thwin	1	2	5	4	2	1	1

The later stage is to build the normalized decision matrix and the outcome of this matrix is shown in **Table 3.7.**

Table 3.7 Normalized Decision Matrix

Name	Loan Type	Period	Warranty Value	ICR	DCR	House Status	Loan from other Bank
Daw Po	0.384900	0.424264	0.284747	0.455842	0.29488	0.384900	0.365148
U Ye Myint	0.384900	0.424264	0.379663	0.113960	0.29488	0.384900	0.365148
U Myint New	0.384900	0.282842	0.094915	0.113960	0.44233	0.384900	0.365148
U Tin Myint	0.384900	0.141421	0.379663	0.455842	0.29488	0.384900	0.365148
U Win Zaw	0.192450	0.424264	0.474579	0.341881	0.29488	0.384900	0.365148
U Mya Thein	0.384900	0.141421	0.284747	0.113960	0.29488	0.192450	0.365148
U Ye Win	0.192450	0.424264	0.284747	0.113960	0.44233	0.384900	0.365148
Daw Khin Win	0.384900	0.282842	0.094915	0.455842	0.29488	0.192450	0.182574
U Hla Thwin	0.192450	0.282842	0.474579	0.455842	0.29488	0.192450	0.182574

The later stage is to organize the weighted normalize decision matrix. The weight value for particular criteria is determined as in **Equation 3.12** and is shown in **Table 3.8**. The products of weighted normalized for each customer is demonstrated in **Table 3.9**.

Table 3.8 Weight Value for Each Criterion

Name	Loan Type	Period	Warranty Value	ICR	DCR	House Status	Loan from other Bank
Rank Value	3	4	1	1	1	2	3
Weight Value	0.121951	0.09756	0.170731	0.170731	0.1707	0.146341	0.121951

Table 3.9 Weight Normalized Decision Matrix

Name	Loan Type	Period	Warranty Value	ICR	DCR	House Status	Loan from other Bank
Daw Po	0.046939	0.041391	0.048615	0.077826	0.05035	0.056326	0.044530
U Ye Myint	0.046939	0.041391	0.064820	0.019456	0.05035	0.056326	0.044530
U Myint New	0.046939	0.027594	0.016205	0.019456	0.07552	0.056326	0.044530
U Tin Myint	0.046939	0.013797	0.064820	0.077826	0.05035	0.056326	0.044530
U Win Zaw	0.023469	0.041391	0.081025	0.058370	0.05035	0.056326	0.044530
U Mya Thein	0.046939	0.013797	0.048615	0.019456	0.05035	0.028163	0.044530
U Ye Win	0.023469	0.041391	0.048615	0.019456	0.07552	0.056326	0.044530
Daw Khin Win	0.046939	0.027594	0.016205	0.077826	0.05035	0.028163	0.022265
U Hla Thwin	0.023469	0.027594	0.081025	0.077826	0.05035	0.028163	0.022265

Then, determine the positive ideal (A+) and negative ideal solution (A-). Positive Ideal Solution maximizes the benefit criteria and minimizes the cost criteria. Negative Ideal Solution minimizes the benefit criteria and maximizes the cost criteria. The outcomes are shown in **Table 3.10**. Ideal status for each criterion is viewed in **Table 3.11**.

Table 3.10 Positive Ideal and Negative Ideal Solution

Name	Loan Type	Period	Warranty Value	ICR	DCR	House Status	Loan from other Bank
Ideal Solution	0.046939	0.013797	0.081025	0.077826	0.07552	0.056326	0.022265
Negative Ideal Solution	0.023469	0.041391	0.016205	0.019456	0.05035	0.028163	0.044530

Table 3.11 Ideal Status for Each Criterion

Criteria	Ideal Status
Interest Coverage Ratio(ICR)	Positive
Loan Type	Positive
Period	Negative
Warranty Value	Positive
Debt Coverage Ratio(DCR)	Positive
House Status	Positive
Loan from other bank	Negative

The next stage is to determine the separation measures for each alternative. Then, relative closeness for each customer can be calculated. The products of separation measure and relative closeness are displayed in **Table 3.12** and **Table 3.13**. The final process is ranked the applicants and the ranked lists are displayed. According to the ranked list, the decision maker of the bank decides which customers are more appropriate to grant the loan. The applicants who have the best closeness value are the most appropriate for granting the loan.

Table 3.12 Separation Measure for Each Alternative

Name	S+	S-
Daw Po	0.05423371	0.076167486
U Ye Myint	0.07456902	0.060888876
U Myint Nwe	0.09107615	0.046562225
U Tin Myint	0.03730984	0.08874666
U Win Zaw	0.05310603	0.080679192
U Mya Thein	0.07987543	0.04860757
U Ye Win	0.07915488	0.049772334
Daw Khin Win	0.07628188	0.06814676
U Hla Thwin	0.04656223	0.091076153

Table 3.13 Relative Closeness to Ideal Solution

Daw Po	0.58410115
U Ye Myint	0.44950408
U Myint New	0.33829391
U Tin Myint	0.7040229
U Win Zaw	0.60305012
U Mya Thein	0.37831907
U Ye Win	0.38604986
Daw Khin Win	0.47183688
U Hla Thwin	0.66170609

Sorted Lists of Applicants

1. U Tin Myint
2. U Hla Thwin
3. U Win Zaw
4. Daw Po
5. Daw Khin Win
6. U Ye Myint
7. U Ye Win
8. U Mya Thein
9. U Myint Nwe

3.3 Database Design and Use Case Diagrams

This system applies the TOPSIS: specific of the Multi Criteria Decision Making techniques. The applicants apply the loan via online and system maintains the applicant's information. The admin or loan decision maker applies the system to process the loan applicant's information for supporting decision making process and ranking the applicant's lists. Also, this system has two working areas, namely: loan applicant view and admin view. Therefore, **Figure 3.5** describes the use case diagrams of loan applicant and admin.

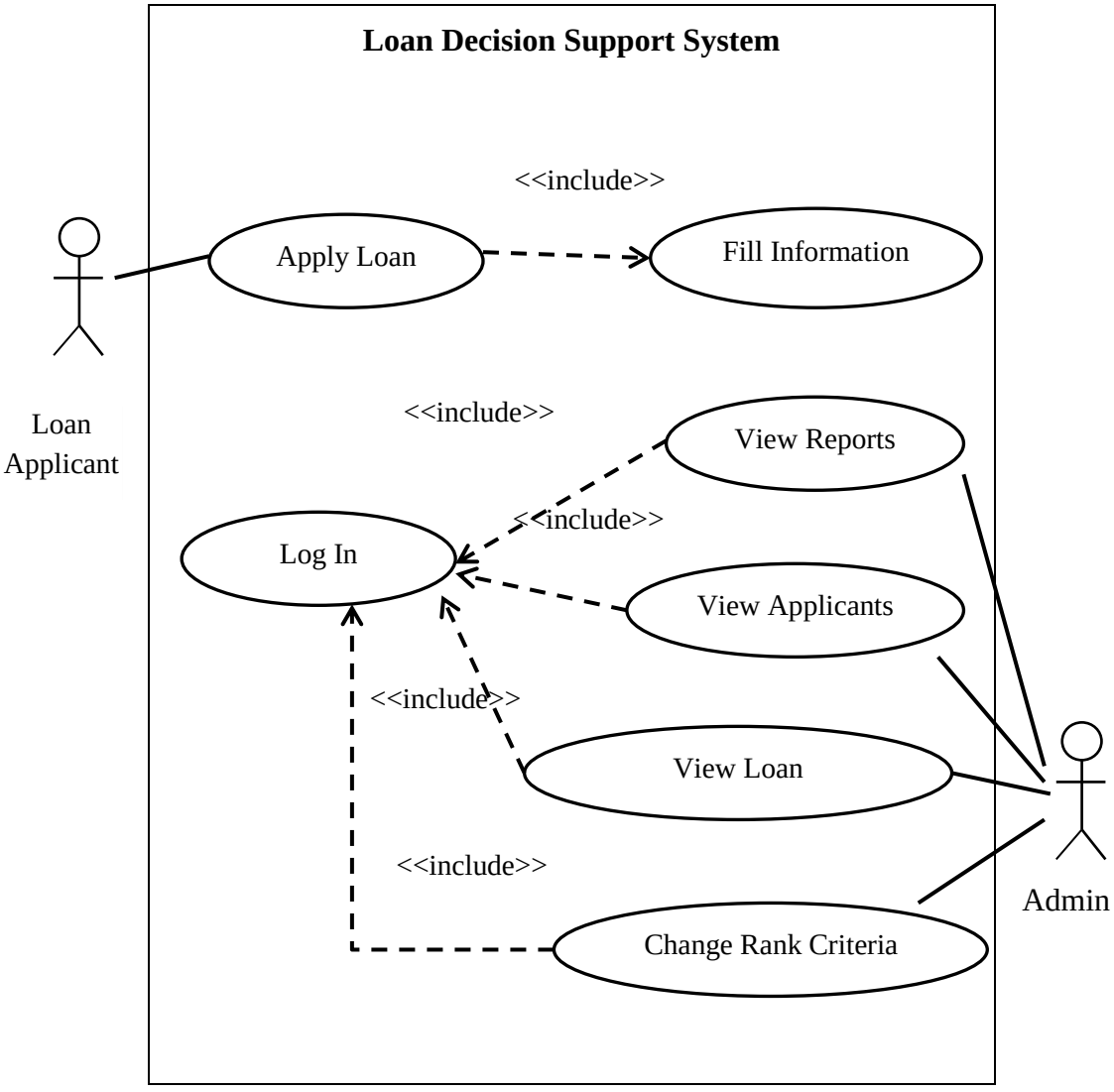


Figure 3.5 Use Case Design of the System

The database design for Loan applicants' selection system is implemented in **Figure 3.6** and five tables are used. These are Admin table, Score table, User table, Weight Value table and Loan Info table. Name and Password are included in Admin table. UserID, DCR, ICR, LoanType, LoanPeriod, WarrantyValue, HouseStatus and LoanExists are field names of Score table. Other field names are inserted in some table respectively.

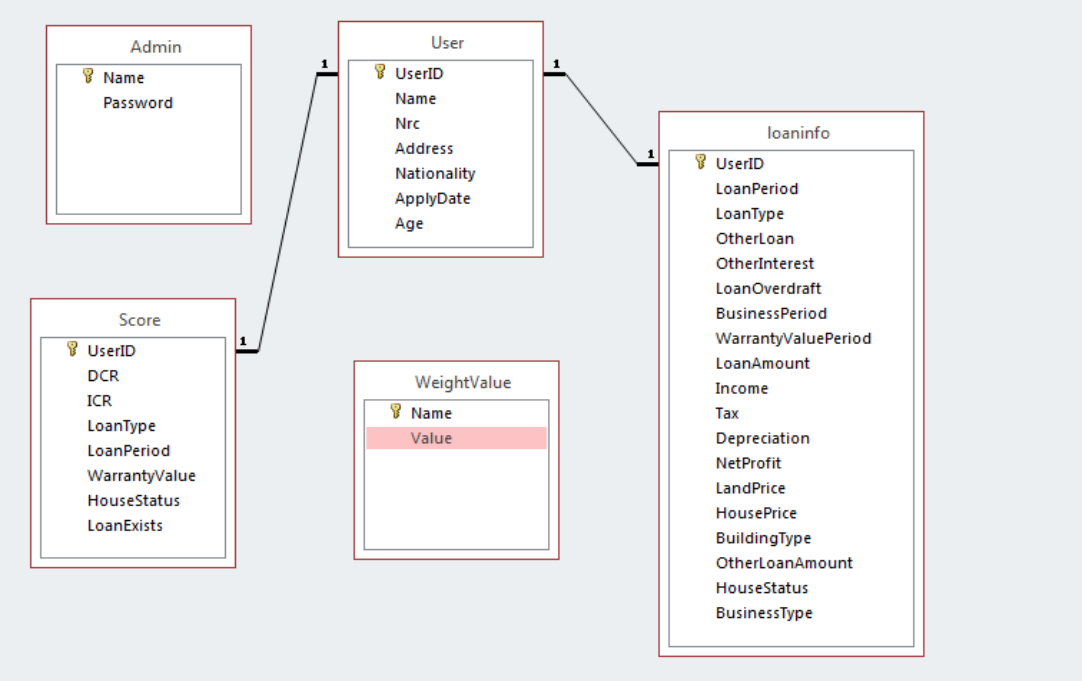


Figure 3.13 Database Design of the Proposed System

CHAPTER 4

IMPLEMENTATION OF THE PROPOSED SYSTEM

The TOPSIS based loan applicant's selection approach can help the decision maker of loan approval works. This system can be used as the pre-selection of applicants via online. The system is implemented by using JAVAEE programming language with TOMCAT 8.0 web server and XAMPP database server. Microsoft SQL Server Express 11.0 used to store database.

The implementation to access the proposed system is divided into three sections. They are:

(i) Home Page of the System

(ii) Implementation of User Level

(iii) Implementation of Admin Level

4.1 Home Page of the System

In this system, there are two levels, namely: user and admin, the system implements home page of the system as demonstrated in **Figure 4.1**.

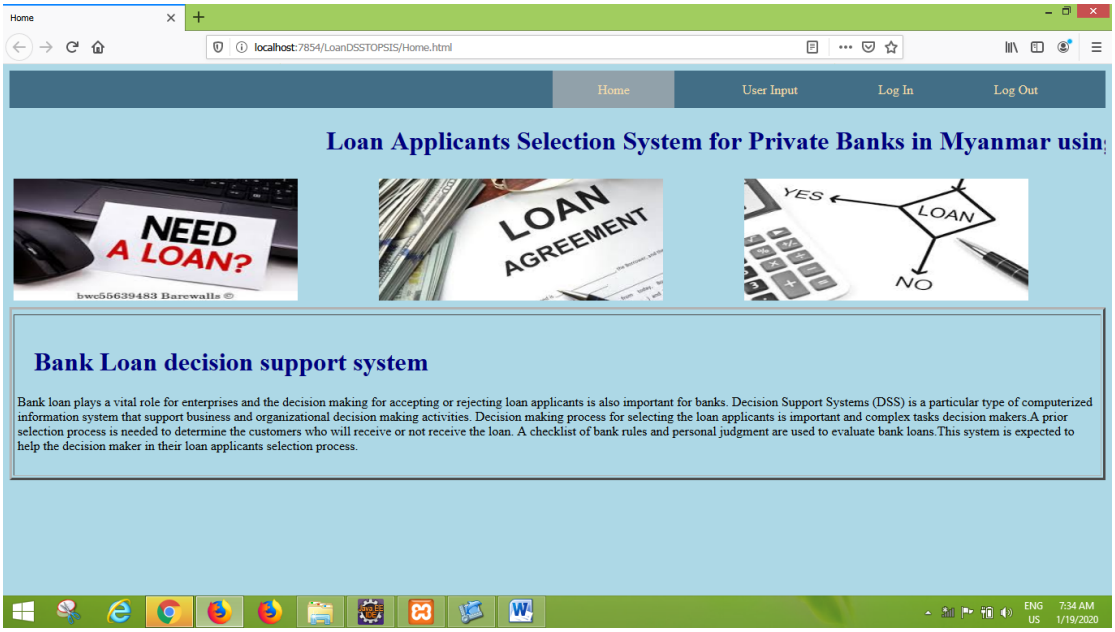


Figure 4.1 Home Page of the System

In home page, user can see description of the system. The applicants can apply the loan by filling required information.

4.2 Implementation of User Level

In user's part, the user who wants to apply the loan needs to fill the information in the user input form. The input form of the applicants is shown in **Figure 4.2**. After filling the input form, the applicants are waiting until the bank reply. The applicants can apply the loan via online and only the selected applicants will receive "reply" from bank.

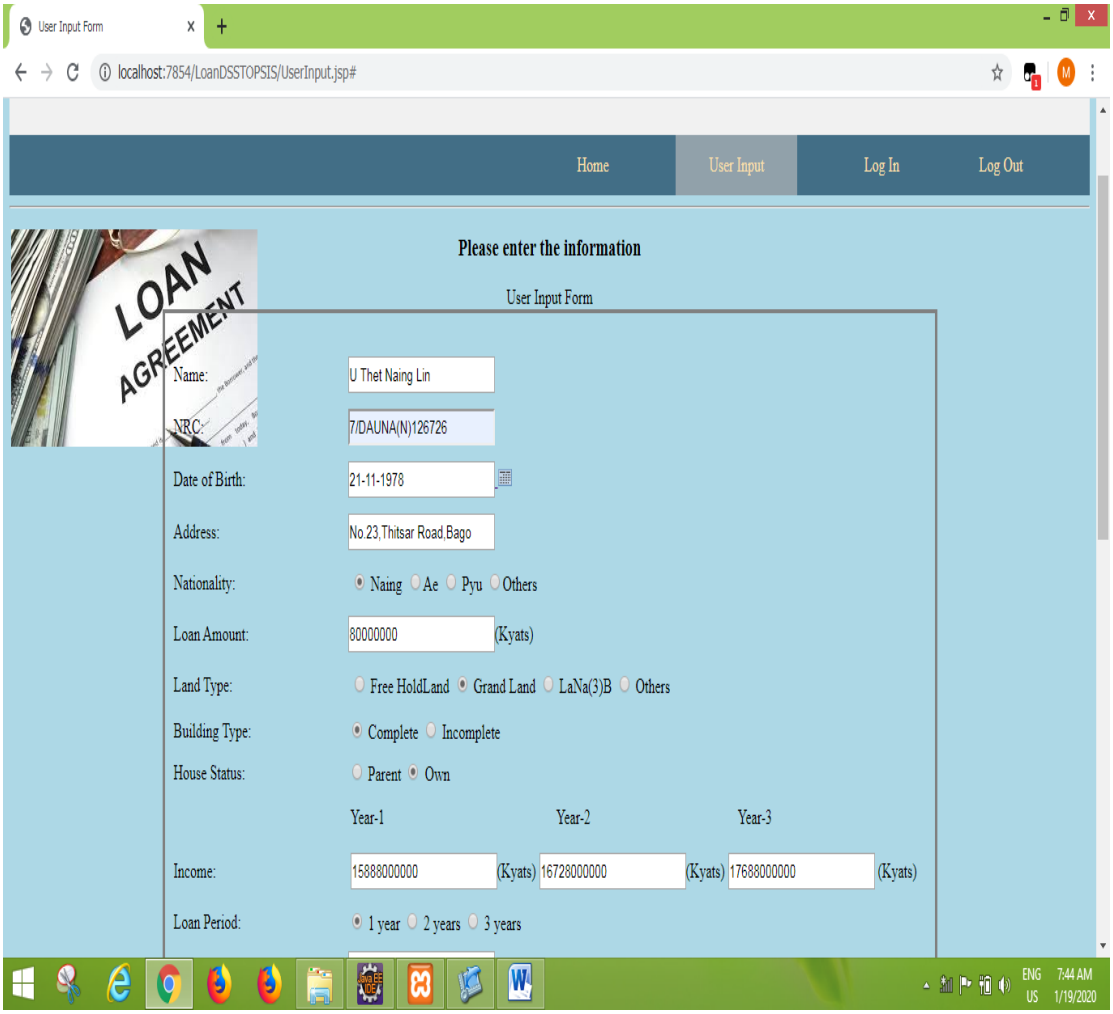


Figure 4.2 Inputs Form of Applicants

4.3 Implementation of Admin Level

This system provides the administration's part and this process begins when the admin logs into the system and requests to enter the system for creation of criteria and executing the lists of applicants using TOPSIS as shown in **Figure 4.3**.

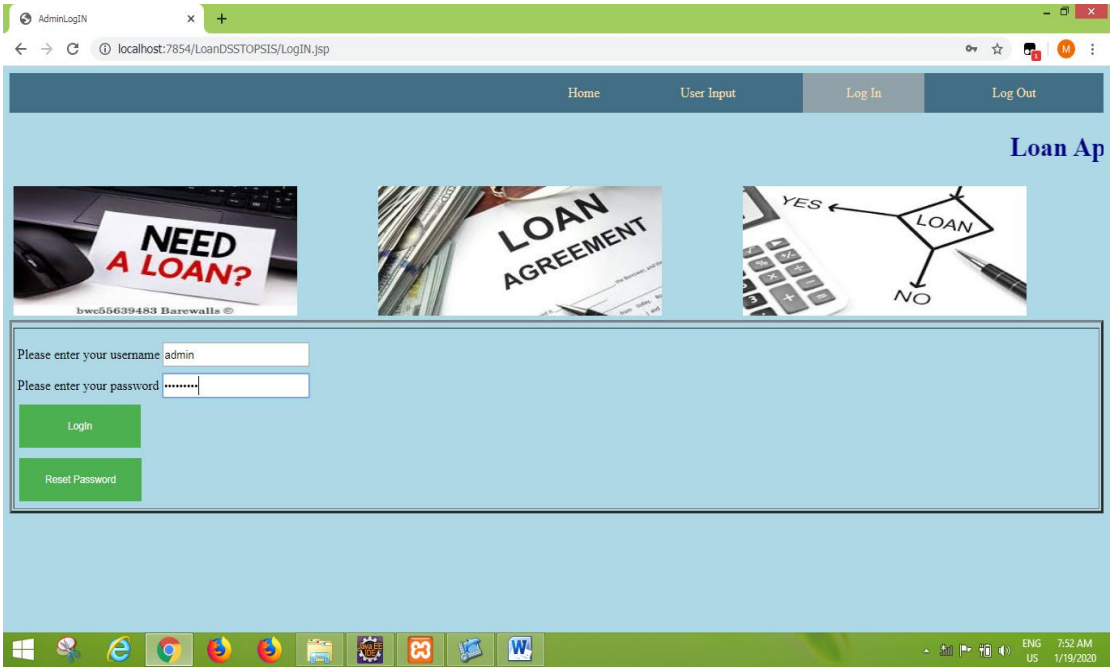


Figure 4.3 Login Form of Admin

Reset password page of admin is seen in **Figure 4.4.** If the user no longer wants to use the old password, user can use the new one. New password must contain at least one number, one uppercase and lowercase letter and at least 8 or more characters.

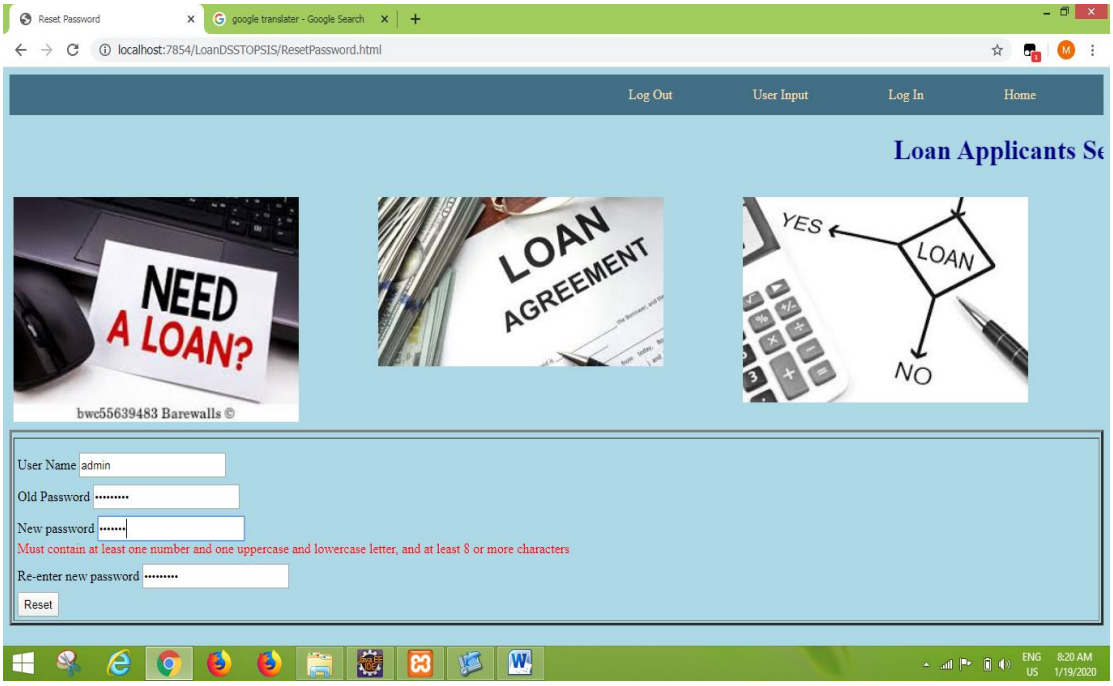


Figure 4.4 Reset Password Page of Admin

The Web page of the admin is shown in **Figure 4.5**. In the admin home page, the tasks provided are displayed by lists. Admin can view list of applicants, can calculate the criteria to rank applicants, can change the rank of criteria, can view the applicants who are sorted according to calculated results, can view rejected lists of applicants who do not meet the decision rules of bank and can view the summary reports of applicants.

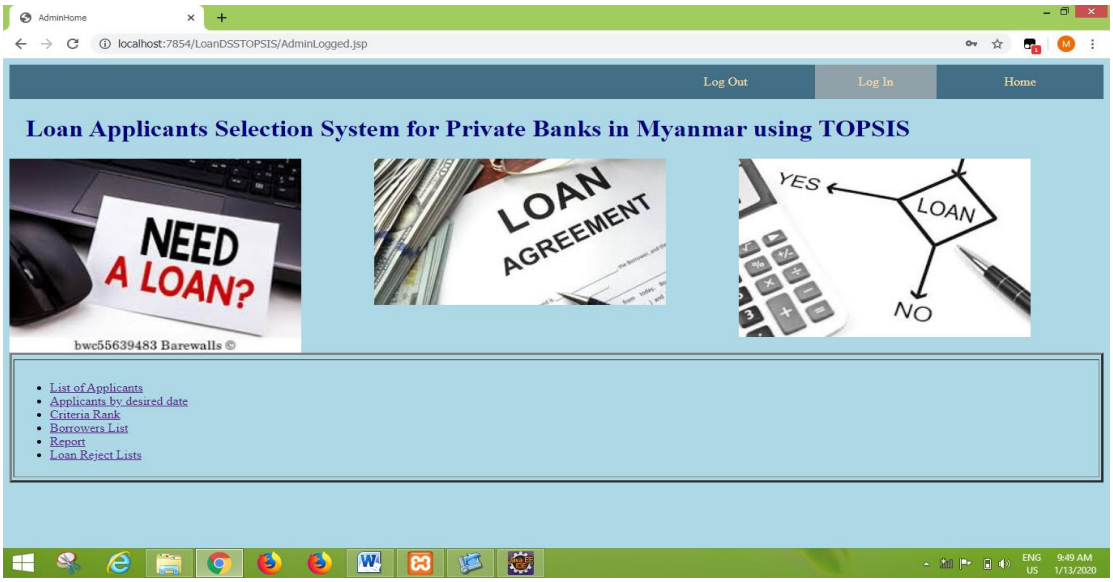


Figure 4.5 Home Page of Admin

In All Applicants Page in **Figure 4.6**, admin can see loan information of users (Name, NRC no, Address, Apply Date, Details and amount of applicants).If admin would like to view other of loan information of each loan applicant, admin can click View Details button.

No	Name	NRC	Address	Apply Date	Details	Total applicants=363
1.	Daw Po	7/DAUNA(N)000071	KaDote Pha Yar Kyi Village, Dagon-Man Road, Bago	2018-01-01	View Details	
2.	U Ye Myint	7/DAUNA(N)059800	Dayalmi ,Dagon-Man Road, Bago	2018-01-02	View Details	
3.	U Yin Mg Oo	7/DAUNA(N)000388	AungBaLay Village, Dagon-Man Road, Bago	2018-01-02	View Details	
4.	U Myint Nwe	7/DAUNA(N)013229	No.6,Min Tae Quarter, Bago	2018-01-03	View Details	
5.	U Tin Myint	7/DAUNA(N)017778	No.8, Dagon-Man Road,Bago	2018-01-03	View Details	
6.	U Win Zaw	7/DAUNA(N)079257	Ywartanshae Village, Dayalmi Quarter, Bago	2018-01-03	View Details	
7.	U Mya Thein	7/DAUNA(N)034561	No.6,Mintae Quarter, Bago	2018-01-04	View Details	
8.	U Ye Win	7/DAUNA(N)023749	Dayalmi Road, Bago	2018-01-04	View Details	
9.	Daw Khin Win	7/DAUNA(N)086457	No.3 Quarter, Bago	2018-01-05	View Details	
10.	U Hla Thwin	7/DAUNA(N)068710	U Daung Su Village, KaDote Pha Yar Kyi,Bago	2018-01-05	View Details	
11.	U Khin Mg Tint	7/DAUNA(N)002266	YwarWineGyi Village,Dagon-Man Road,Bago	2018-01-11	View Details	
12.	U Phyu	12/SAKHANA(N)136722	No.7,Baho Road,Sanchaung Township,Yangon	2018-01-11	View Details	
13.	U Tin Soe	7/TANGANA(N)100645	No.21,MgNgan Quarter,Mawlamyine	2018-01-12	View Details	
14.	U Phoe Tote	10/THAHTANA(N)110317	No.2,KyaukTan Quarter, Mawlamyine	2018-01-15	View Details	
15.	U Kyaw Swe	10/MADANA(N)007485	No.13,ZayCho Quarter, Mawlamyine	2018-01-16	View Details	

Figure 4.6 Page of All Applicants

The admin can calculate the criteria value for each applicant for specific year as shown in **Figure 4.7**. The admin can calculate the criteria value of applicants by providing starting date and end date. The system selected the all applicants that are between the start date and end date. TOPSIS calculates the selected applicant's information.

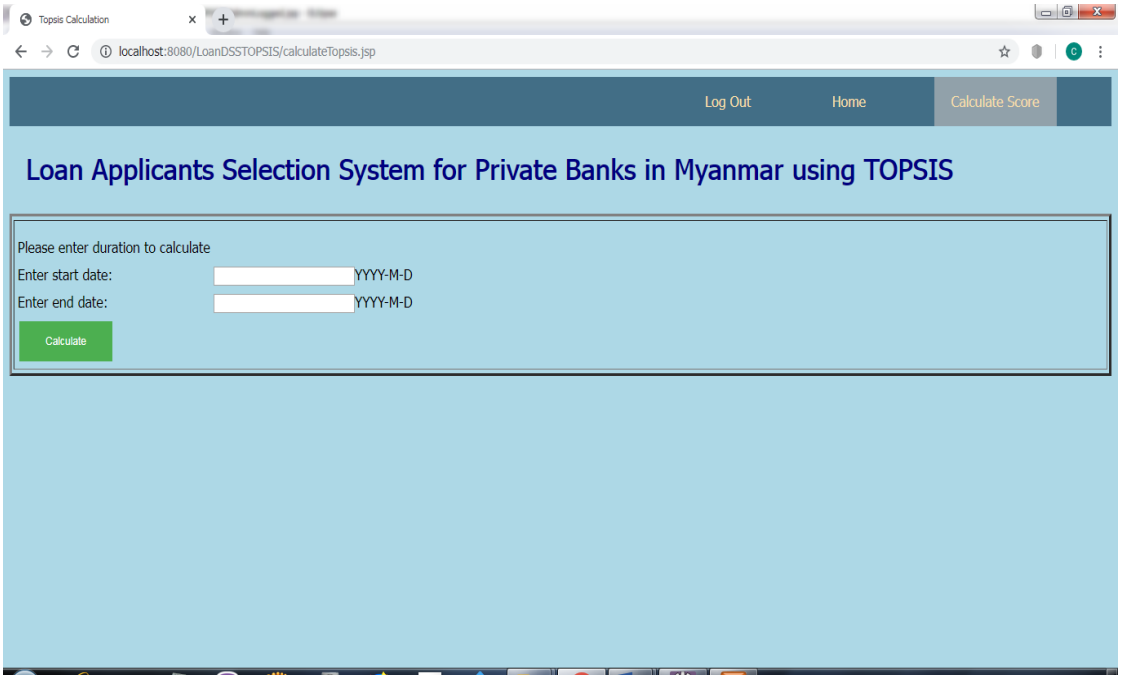
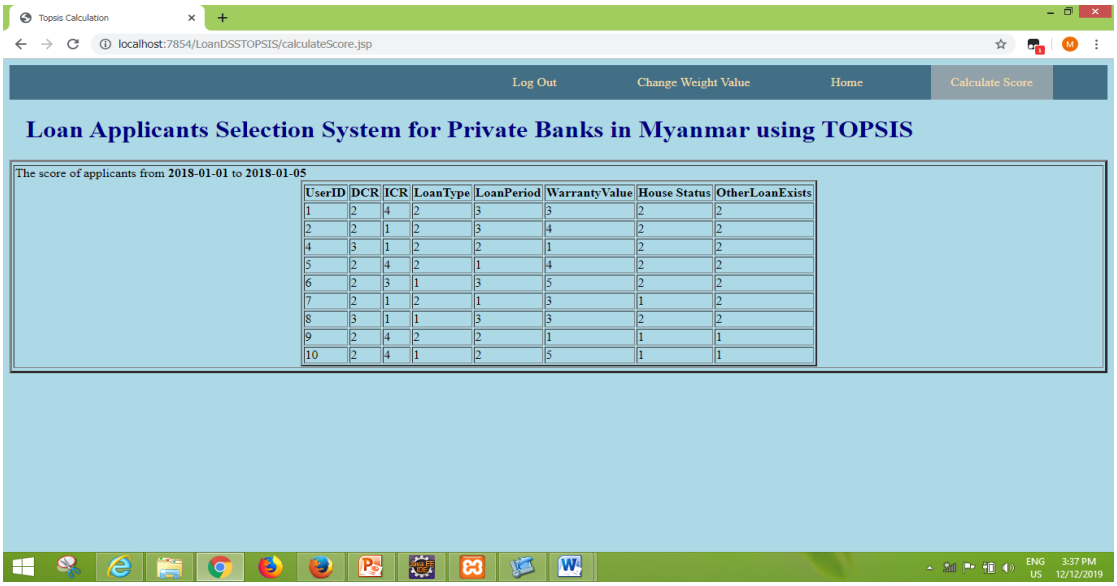


Figure 4.7 Calculation of Criteria

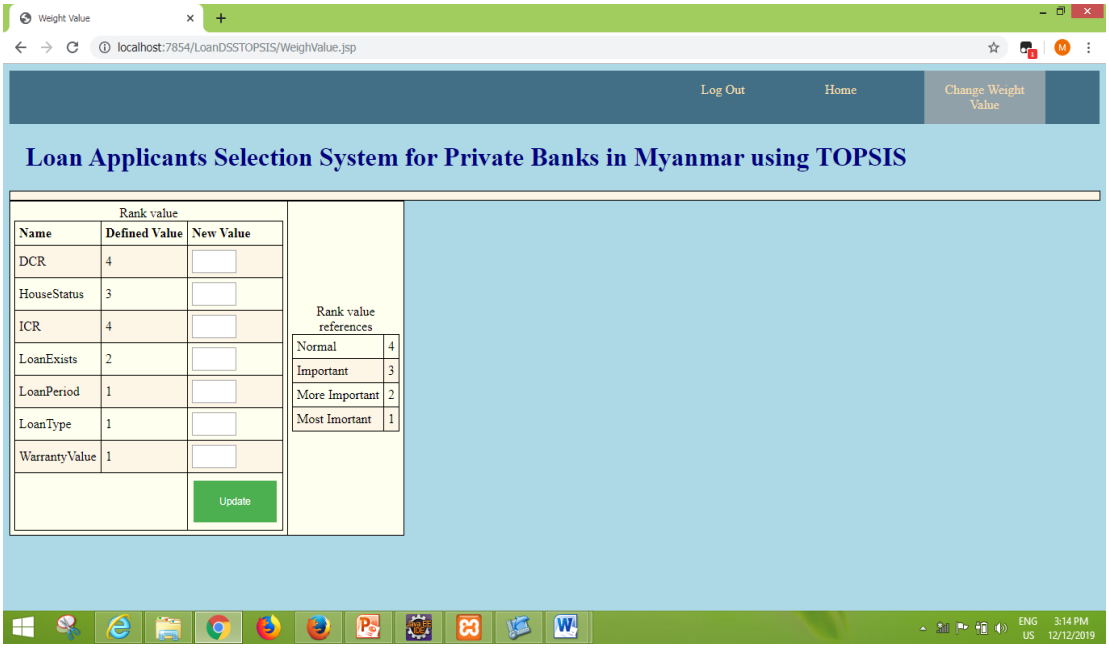
The score of applicant can sight between two dates and admin wants to calculate the limitation of data date. It results as look at in **Figure 4.8**.



UserID	DCR	ICR	LoanType	LoanPeriod	WarrantyValue	House Status	OtherLoanExists
1	2	4	2	3	3	2	2
2	2	1	2	3	4	2	2
4	3	1	2	2	1	2	2
5	2	4	2	1	4	2	2
6	2	3	1	3	5	2	2
7	2	1	2	1	3	1	2
8	3	1	1	3	3	2	2
9	2	4	2	2	1	1	1
10	2	4	1	2	5	1	1

Figure 4.8 Page of Calculated Score

If the admin want to change rank value of each attribute, Change Weight Vaule Page can enter in **Figure 4.9**. In this page, rank value of each criteria can vary according to concerning bank rules. Depending on rank values reference, admin can compare and judge the importance of rank value.



Figuer 4.9 Changes of Weight Values

The admin can get the sorted applicant lists between start date and end date, who desire to arrange the attributes, order of weight value. The outcomes show in Sorted Applicants Page as **Figure 4.10**.

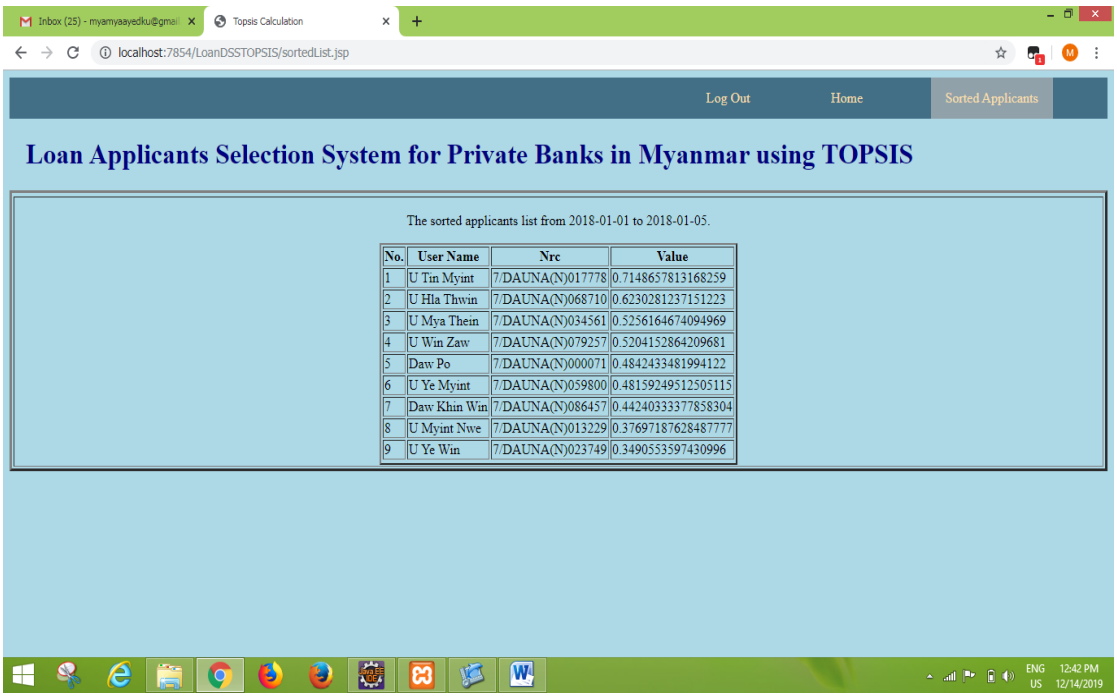


Figure 4.10 Page of Sorted Applicants

The Report Page include four parts of report. These are All Applicants, Applicants by Yearly Report, Reasonable for Loan Report and Business Type Report pages. Among of its four pages can be observed in **Figure 4.11**, **Figure 4.12**, **Figure 4.13** and **Figure 4.14** repectively.

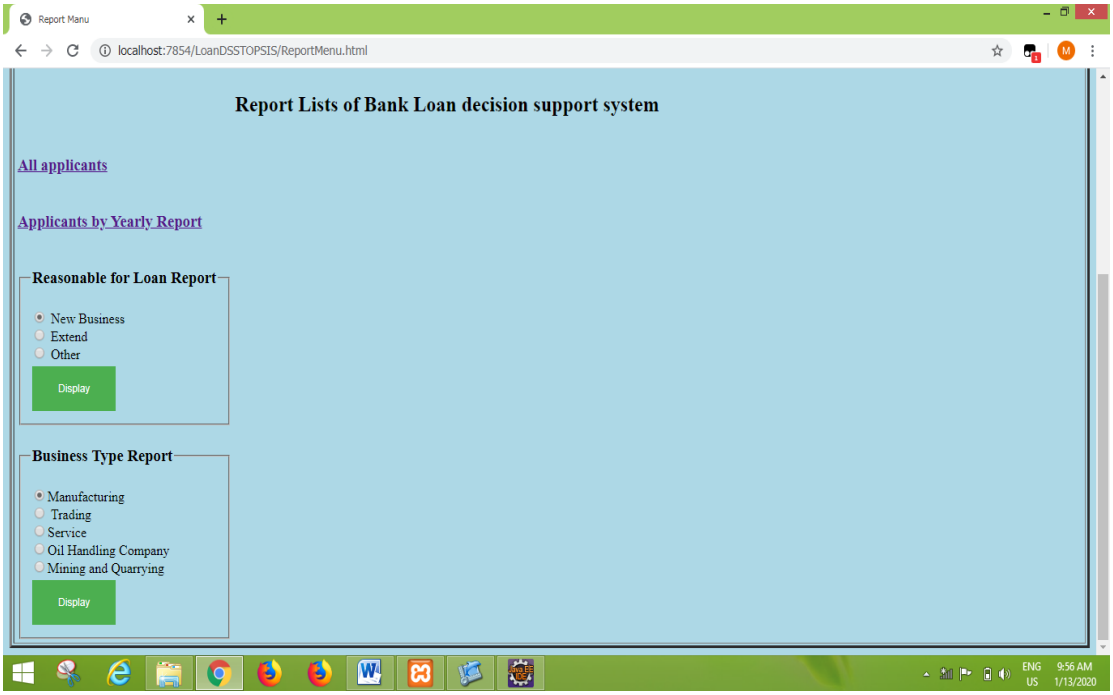


Figure 4.11 Page of Report Lists

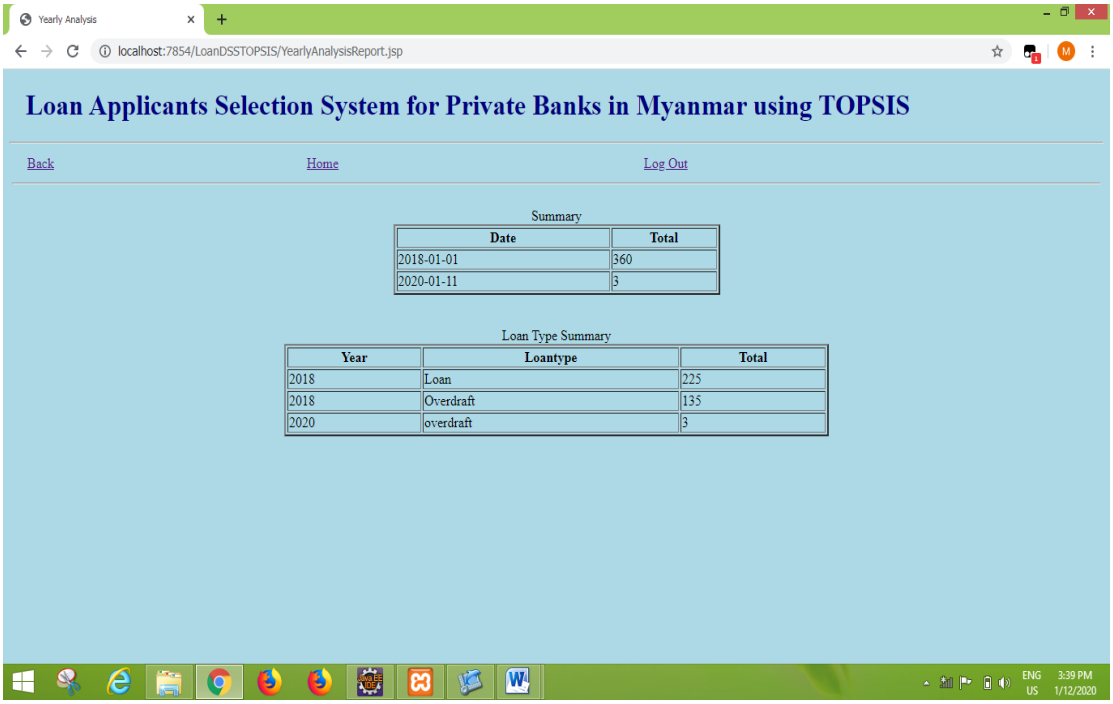
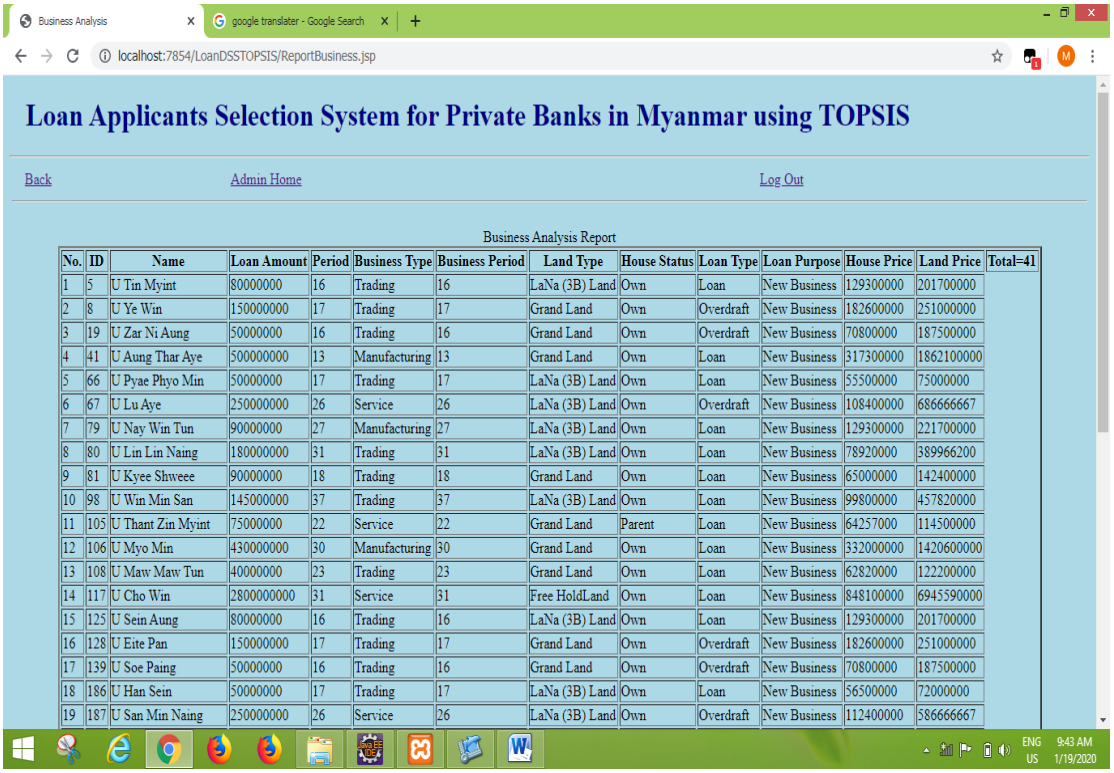


Figure 4.12 Page of Applicants by Yearly Report



No.	ID	Name	Loan Amount	Period	Business Type	Business Period	Land Type	House Status	Loan Type	Loan Purpose	House Price	Land Price	Total=41
1	5	U Tin Myint	80000000	16	Trading	16	LaNa (3B) Land	Own	Loan	New Business	129300000	201700000	
2	8	U Ye Win	150000000	17	Trading	17	Grand Land	Own	Overdraft	New Business	182600000	251000000	
3	19	U Zar Ni Aung	50000000	16	Trading	16	Grand Land	Own	Overdraft	New Business	70800000	187500000	
4	41	U Aung Thar Aye	500000000	13	Manufacturing	13	Grand Land	Own	Loan	New Business	317300000	1862100000	
5	66	U Pyae Phyo Min	50000000	17	Trading	17	LaNa (3B) Land	Own	Loan	New Business	55500000	75000000	
6	67	U Lu Aye	250000000	26	Service	26	LaNa (3B) Land	Own	Overdraft	New Business	108400000	686666667	
7	79	U Nay Win Tun	90000000	27	Manufacturing	27	LaNa (3B) Land	Own	Loan	New Business	129300000	221700000	
8	80	U Lin Lin Naing	180000000	31	Trading	31	LaNa (3B) Land	Own	Loan	New Business	78920000	389966200	
9	81	U Kyee Shweee	90000000	18	Trading	18	Grand Land	Own	Loan	New Business	65000000	142400000	
10	98	U Win Min San	145000000	37	Trading	37	LaNa (3B) Land	Own	Loan	New Business	99800000	457820000	
11	105	U Thant Zin Myint	75000000	22	Service	22	Grand Land	Parent	Loan	New Business	64257000	114500000	
12	106	U Myo Min	430000000	30	Manufacturing	30	Grand Land	Own	Loan	New Business	332000000	1420600000	
13	108	U Maw Maw Tun	40000000	23	Trading	23	Grand Land	Own	Loan	New Business	62820000	122200000	
14	117	U Cho Win	2800000000	31	Service	31	Free HoldLand	Own	Loan	New Business	848100000	6945590000	
15	125	U Sein Aung	80000000	16	Trading	16	LaNa (3B) Land	Own	Loan	New Business	129300000	201700000	
16	128	U Eite Pan	150000000	17	Trading	17	Grand Land	Own	Overdraft	New Business	182600000	251000000	
17	139	U Soe Paing	50000000	16	Trading	16	Grand Land	Own	Overdraft	New Business	70800000	187500000	
18	186	U Han Sein	50000000	17	Trading	17	LaNa (3B) Land	Own	Loan	New Business	56500000	72000000	
19	187	U San Min Naing	250000000	26	Service	26	LaNa (3B) Land	Own	Overdraft	New Business	112400000	586666667	

Figure 4.13 Page of Reasonable for Loan Report

No.	ID	Name	Loan Amount	Period	Business Type	Business Period	Land Type	House Status	Loan Type	Loan Purpose	House Price	Land Price	Total=43
1	12	U Phyu	3500000000	5	Manufacturing	5	Grand Land	Own	Overdraft	Extend	848100000	7045590000	
2	14	U Phoe Tote	100000000	12	Manufacturing	12	Grand Land	Own	Overdraft	Extend	19200000	299700000	
3	16	U Myint Soe	35000000	10	Manufacturing	10	Grand Land	Parent	Overdraft	Extend	39300000	94600000	
4	17	U Saw Mon	80000000	8	Manufacturing	8	Grand Land	Own	Loan	Extend	86700000	252200000	
5	18	U Hlaing Bwar	150000000	10	Manufacturing	10	Grand Land	Own	Loan	Extend	100800000	459900000	
6	26	U Phoe Taw	25000000	19	Manufacturing	19	Grand Land	Own	Overdraft	Extend	29458200	38449100	
7	41	U Aung Thar Aye	500000000	13	Manufacturing	13	Grand Land	Own	Loan	New Business	317300000	1862100000	
8	51	U Phyoe Paing Oo	90000000	14	Manufacturing	14	Grand Land	Own	Overdraft	Extend	120771000	205500000	
9	52	U Di Par Aung	100000000	18	Manufacturing	18	Grand Land	Own	Overdraft	Extend	129500000	207500000	
10	59	U Wai Phyoe	50000000	7	Manufacturing	7	Grand Land	Own	Loan	Extend	77300000	102900000	
11	60	U Myo Tun Aung	130000000	19	Manufacturing	19	Free HoldLand	Own	Overdraft	Extend	182600000	251000000	
12	61	U Eite San	200000000	4	Manufacturing	4	Grand Land	Own	Loan	Extend	97500000	400237567	
13	79	U Nay Win Tun	90000000	27	Manufacturing	27	LaNa (3B) Land	Own	Loan	New Business	129300000	221700000	
14	94	U Shwe	3100000000	6	Manufacturing	6	Grand Land	Own	Overdraft	Extend	848100000	7045590000	
15	106	U Myo Min	430000000	30	Manufacturing	30	Grand Land	Own	Loan	New Business	332000000	1420600000	
16	132	U Thein Tan	3500000000	5	Manufacturing	5	Grand Land	Own	Overdraft	Extend	848100000	7045590000	
17	134	U Kyin Sein	100000000	12	Manufacturing	12	Grand Land	Own	Overdraft	Extend	19200000	299700000	
18	136	U Myint Ohm	35000000	10	Manufacturing	10	Grand Land	Parent	Overdraft	Extend	39300000	94600000	
19	137	U Hla Thein	80000000	8	Manufacturing	8	Grand Land	Own	Loan	Extend	86700000	252200000	

Figure 4.14 Page of Business Type Report

The loan selection system rejected the user, who cannot be conformable with constraints of bank's rules as shown in **Figure 4.15**.

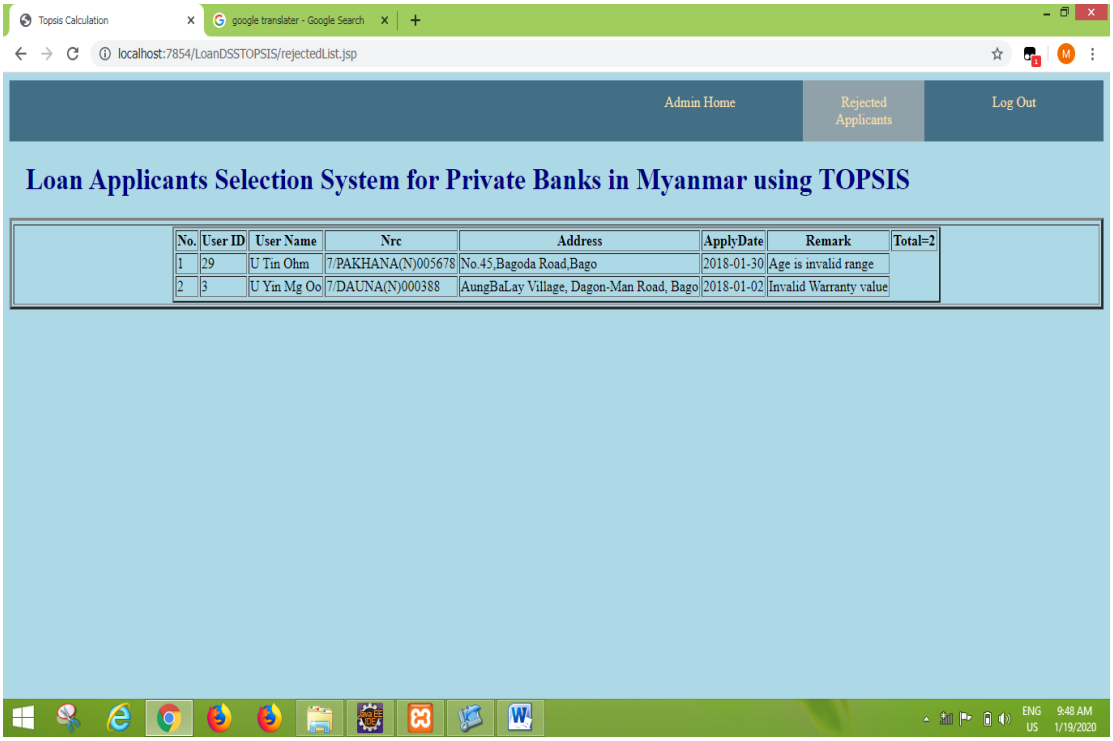


Figure 4.15 Page of Rejected Applicants

CHAPTER 5
CONCLUSION AND FURTHER EXTENSION

Bank loan plays as a critical role for enterprises, and the decision making for receiving or not receiving loan applicants is also important for banks. In their loan applicants election process, the introduce system is expected to assist the bank decision maker. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is used in a decision support system to search the favorite loan applicants because of its ability to recommend loan applicants from several variables of applicants. This thesis intends to develop Loan Decision Support System for private banks in Myanmar using TOPSIS. The major contents of thesis are concluded, advantages and limitation of the system and future work are suggested in this chapter.

The proposed system is solved to assist the decision maker in bank loan applicant's selection process. The system is concluded with an effort to rank the loan applicant lists that meet the criteria considered in the bank loan decision. The Decision Support System to assist the loan officer to select applicants for loan is implemented using TOPSIS. TOPSIS can be used to choose the finest alternative or the finest customer to be given a loan by ranking the customer according to the input data. This system used seven criteria (ICR, DCR, warranty value, house status, loan type, loan from other bank, period) for loan applicant selection process. Criteria are varying depend on bank nature. The proposed system implemented with the analysis data from four private banks in Myanmar such as KBZ banks, AYA banks, YOMA banks and AGD banks. This system assists the customers in their loan application process without time consuming. This suggested system can reduce by personal judgment and also can decrease the cost of loan processing. Moreover, the decision can compare and judge the loan applicants by varying weight values dynamically. The proposed system supports for private banks decision maker and loan applicants as a powerful tool. To conclude, this study helps the loan decision maker using TOPSIS to reduce the manual analysis of applicant's data.

5.1 Benefits of the Thesis

Decision making is time consuming and complex tasks for loan decision maker. Decision maker needs to analyze the applicant's data before the bank decides to accept or reject the loan. By using the decision support system, it can assist the

decision-making process and can achieve the many benefits. This system reduces the cost of loan processing tasks and can decrease personal judgment. Moreover, loan decision-making process needs to compare various criteria. This system can compare and judge the loan applicants by differing weight values of criteria. From the applicant point of view, the applicants can apply the loan via online. Only the applicants who satisfied the required criteria need to go to the bank.

5.2 System Limitations

The major limitation of this system is the applicants need to support many data that are necessary in loan decision-making process. In order to assist the decision-making effectively the data supported by the applicants need to be the correct data. Another limitation is that system only considers the loan for Mortgage Loan. Although weight value for the criteria considered in this system can be changed, the system cannot change the criteria.

5.3 Further Extension

In this system, the weight value is using rank sum method. For further extension, other loan type such as Personal Loan, Project Loan, Home Loan, Business Loan, Education Loan and SME Loan can be considered using TOPSIS approach. Other methods can be applied as weight value references in further study.

AUTHOR'S PUBLICATION

[1] Mya Mya Aye, Thin Lai Lai Thein, "Loan Applicants Selection System for Private Banks in Myanmar Using TOPSIS", the National Journal of Parallel and Soft Computing (NJPSC 2020), Yangon, Myanmar 2020.

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