Hybrid Decision Models of Leasing Business for Thailand Using Neural Network

Nachapon Jiamahasap ¹ and Sakgasem Ramingwong ²,*

¹ Graduate Program in Industrial Engineering, Department of Industrial Engineering, Faculty of Engineering, Chiang Mai University, Chiang Mai 50200, Thailand
² Industrial Engineering Department, Chiang Mai University, Chiang Mai 50200, Thailand
* Correspondence: sakgasem@gmail.com

Abstract: The research aims to improve the effectiveness of financial lending business decision-making by developing dynamic models involved in the money-lending business. The objectives of this study are to identify preference factors that affect a customer’s decision of choosing a particular financial institution, to determine the important approval factors that providers need to take into consideration while approving loans and to identify any relationship between and among the factors. The data are taken from a case study of a lending company in northern Thailand. The first model is the preference model, comprising 68 inputs factors, which are used to determine the reasons why a customer chooses service providers, which can be either commercial or non-commercial banks. The model is developed using a neural network (NN) with a history data of 2973 records and comprising four sub-models. The model is improved by varying the NN structure and EPOC. The best model provides an accuracy rate of 100%. The second model is the approval model, comprising 55 input factors for predicting the result of loan requests, which can determine if the loan should be approved with the full amount of the request, approved with a lesser amount or another outcome. The model is developed using a neural network with history data of 787 records. This model is composed of three sub-models; the best model of which gives an accuracy rate of 55%. The third model is the hybrid decision model, linking preference factors and approval factors with external factors. The model is constructed using system dynamics factors, approval factors, financial institutions and system dynamic modeling and the model can simulate the result if the input is changed.

Keywords: neural network; preference factors; approval factors; financial institutions; system dynamic

1. Background

1.1. Introduction

Commercial banks offer several services, such as deposits, withdrawals and loans. When people have financial problems, they first approach these commercial entities to receive the assistance required. There are factors which customers use to choose financial institution services, identified in a paper as “preference factors” [1]. They are divided into two parts. First, one of seven P factors is used for analyzing the research such as the price term [2] and it was found that the most important factor was a low interest rate. Regarding the people term [3], it was established that the most important factors were employees having good relationships with each other, being appropriately dressed and being able to suggest solutions for problems. Regarding the process term [4], it was found that the most important factor that customers focused on was the safety of funds and prompt service with regard to the customers’ choice of bank. Regarding the physical term [5], it was found...
that the most important factor was the stability and reputation of the financial institution but a paper [6] identified that customers also focused on automatic teller machine (ATM) facilities and convenient ATM locations. Furthermore, another study used more than one of the seven P factors, such as product and physical terms [7], and it was found that the most important factors in the product term were being humble, being smartly dressed, giving helpful advice, etc. and the most important factors in the physical term were office facilities, organizing various devices, etc. In people and physical terms [8], it was established that the most important factors in the people term were the personnel, with importance placed on staff being good-natured and knowledgeable, who could offer solutions. The important factor in the physical term was modern technology. In product, process, people and physical terms [9], it was found that the most important factors in the product term were variety of products and having a standard credit system, whereas what was essential in the process term was providing an accurate, fast service from loan application to completion. Moreover, importance in the physical term was placed on the provision of comfortable seats for waiting. In the people term, what was necessary was staff who provided reliable information about credit and who had good interpersonal skills, in addition to a fast service throughout the process of providing the product.

Moreover, as the population grows, the number of people in debt also increases. The bank loan services of commercial banks demand more complicated procedures, causing a delay in approval and the requirement of more documents by the banks. People then pursue alternative loan options, including credit cooperatives and lending companies, namely, “non-commercial banks” (NCBs). An increasing number of NCBs compete with commercial banks by offering customers lower fees, higher loan amounts and faster approvals. In product, price and promotion terms, this research studied the factors and behaviors of using the NCB service [10] and identified that there are five factors that customers take into account when choosing whether to use the service: conditions and benefits from the use of services, fees and interest rates, service, marketing promotions and advice and persuasion. In the product term category [11], it was found that the essential factors that users give priority to were product factors, including: the approval period, the approval limit, the installment period and guarantee conditions.

In the product and price term categories [12], it was established that approval and amount of hire-purchase as well as the sufficiency of the products were the important considerations in the product term, whereas the most important factors in the price term were appropriate interest rates, service fees, the ability to bargain over interest rates and duration of payments.

However, NCBs must also consider customer risk in order to protect and maintain their businesses’ 5Cs in credit, described in the paper as “approval factors”. They consist of two parts. First, one of the 5Cs of credit was used to analyze the research such as the characteristics term [13] and the fundamentals of debtors which took into account the circumstances of debtors such as their financial background. This was the most important factor for loan approval. However [14], minimum documents was the important factor for the capacity term [15], and the issue of the amount of funds for approval being flexible and adaptable according to needs and the interest rate being lower than that of competitors were important for approval. Other 5C factors were used [16,17] such as in the characteristics term and the debtor not being in a position to pay the debt, but another consideration is whether the debtor has knowledge of new business management. In the capacity term, the customer’s salary may not be high enough but another finding is the debtor facing the problem of being defrauded. In the capital term, the business may lack liquidity but another scenario is the that business has more expenses than income. In the condition term, the general problem was operation, but another is that the business is sluggish both inside and outside the country.
1.2. Decision-Making Tools

Based on the research analysis, the methodology is identified of how lending businesses gain an advantage over their competitors (commercial banks and non-commercial banks) in the business field. The analysis focuses on three major issues: the preference model, the approval model and the hybrid decision model. The former issue focuses on customers’ selection and the latter involves customers’ loan approval. This research data record is recorded from questionnaires completed by customers that are used to identify the preference factors and providers that are used to identify approval factors. The findings were analyzed confirmatory factor analysis (CFA) for further analysis to determine the direction of the service provider (lending companies). After the analysis was finalized, the model of preference and approval were created. Data mining was the tool used to create models that were applied to a supervised neural network (SNN). There are three models that were created for further analysis: the preference model, the approval model and hybrid decision model. In this research, the preference model means customer preferences and the reasons for their choosing commercial banks or non-commercial banks. The approval model means how providers from commercial banks and non-commercial banks tailor their products to their customers’ requirements. The preference and approval relationship model means the relationship between customers’ preference factors and providers’ approval factors, as shown in Figure 1. After the models were created and analyzed, the preference model provided the results of customers’ choices, while the approval model assessed the customers’ risk and identified methods of attracting customers. In addition, the preference and approval relationship model evaluated the probability for model approval at present and suggested ways to surpass policy. This analysis result will enable providers to reach the top in the ranking of their competitors in the same business line and to gain a substantial market share.

![Figure 1. Preference and approval in financial institutions.](image)

To develop the preference and approval models, a neural network is used to design and develop a model. A multiple-layer structure can be used by increasing the number of nodes or layers as back-propagation [18]. From the literature reviewed [19], the neural Network (NN) is efficient at sorting desirable from undesirable customers as well as discriminant analysis (DA), a statistical method that is used to analyze two or more groups which are classified by analyzing one dependent variable and independent variable from one character or more, using the statistical principle of pairing to test (t-test and p-value). The NN could predict good customers with a confidence of 75.4% while DA could do so at a rate of 74.39%. [20] The NN gave an accuracy rate of 74% compared to prediction by employees at 58.6%. [21] Data envelopment analysis (DEA), a non-parametric estimation method for measuring performance, and DA are the best at predicting the results, followed by the neural network, and [22] the accuracy of results was 95% for classification [23]. The logistic model provided the predicted results and classified debtors slightly better than the neural network, at 88.62%, while the neural network gave an accuracy of 88.58%. In addition [24], the resulting accuracy for loan predictions was around 93%. After review, it was found that no previous research has been performed to create a model for supporting decision-making for both the preference model that customers use to select services, and
the approval model that providers use for approving a credit request. The area of interest of this paper is northern Thailand. This paper focuses on small and medium-sized lending companies which are the economic drivers in the area.

Due to fierce competition, organizations need to have a plan or change strategies quickly so as not to waste business opportunities. Moreover, previous studies had been separated between preference factors and approval factors. So, this study has attempted to find a relation between two factors and create a hybrid decision model. System dynamics \cite{25} is a tool that was used for analyzing the problems in this paper. This tool is able to identify the relations between factors. It has been used for several terms such as the medical term, and research \cite{26} studied the behavior of the system of hospital treatment services. The results showed that there are increases in the quality of services and the productivity of the staff. Another study \cite{27} studied behavior of the system, the service process, the environmental footprint of the hospital and the effect of policy on the implementation of the green supply chain method. It was found that the environmental footprint value decreased significantly from 59.46 hectares per person per year to 53.09 hectares per person per year. Furthermore, the use of green supply chain concepts can further substantially reduce this to 31.61 hectares per person per year. There was also \cite{28} a study on estimating the needs of pharmaceutical staff in the northern provinces from 2010–2029. The result showed that there is still no need to replace the pharmaceutical officials, due to the fact that the inward production is still more than the amount lost. In addition, when compared with the pharmaceutical staff needed to meet the demand in the next 20 years, it was found that the demand of every professional tends to increase.

In the supply chain \cite{29}, a study was conducted on creating a dynamic model of the system and measuring performance of collaboration in the supply chain. The results included three measurements:

1. Measuring the performance of the inventory supply chain: it was found that the cause of the high inventory level was the fluctuation caused by the collaboration between the raw material processor and the manufacturer of rubber part products.
2. Supply chain performance: the ability to fill orders. It looks at delivery delays which are factors that result from shortages and order fulfillment rates.
3. Supply chain performance: comparing transportation rates and orders from customers, in order to respond to orders caused by the number of shipments that occur in each phase of the connection of members in the supply chain to customers.

Another study \cite{30} studied how to apply a dynamic model of supply to analyze strategic data in organizational management for designers and manufacturers who produce products according to customers’ orders. The results are the same as previously stated except the parts of the raw materials warehouse and production lines can be adjusted as appropriate. A third study \cite{31} studied how to implement value chain analysis of teak from forest to final furniture in Indonesia. The result showed that furniture exports shrank due to the collapse of teak, mismanagement and illegal logging. However, future scenarios and vertical integration can create a price premium for tree growers and furniture SMEs. A study \cite{32} studied ethanol plants using system dynamics simulation in order to assess the effects of three production plans. The result showed that they can satisfy the customer demand if the procurement and production are properly coordinated under current operational conditions such as whether the molasses is processed, the time for equipment maintenance which affected storage capacity for sorghum rice, the storage capacity of ethanol, the time spent on maintenance and the order quantity for sorghum grain.

In the financial term \cite{33}, a study was conducted on system dynamic modeling, an alternate method for budgeting. The results from the system implementation showed that the accuracy of the system is 94.70%, compared to other tools that use linear prediction regression at 56.86%. Moreover, other research \cite{34} conducted a study on modeling crediting volume by using the system dynamic method. It has three models:

Model 1 is the dynamic model of the crediting volume system.
Model 2 is the model for calculating the volume of a loan.
Model 3 is the model for calculating loan repayment volume. The result found that payment is related to the loan.

In the transportation term, research [35] was conducted to determine optimal ship sizes and type in coaster liner services in South Korea. The result showed that the addition of a large ship will accommodate the rising passenger volumes and improve customer service due to the increased number of sailing days. Further research [36] evaluated the economic impact of implementing energy-efficient strategies in transportation in Bangladesh. The result showed that 50:50 was the best choice which reduced costs by 60.35%. However, this research does not address concerns such as fuel demand price elasticity, economic changes and technological changes and also does not assess preferences such as travel demand management, vehicle capacity and governmental regulatory opportunities. However, in [37], policies were developed to cover business (REF), transport demand management (TDM), the introduction of fuel economy (FE), standard and feebate system (FEE) and EV. The result showed that policy mix is preferred, which is a combination of all plausible policies and is based on the ASIF framework.

In the performance and sustainable term, research [38] was conducted on a prediction and sensitivity analysis for make-to-order production. The result showed that the replenishment of material policy is the most important factor that affects shortages. A sensitivity analysis was conducted to suggest the optimal policy for the replenishment of material. Further research [39] proposed a dynamic, comprehensive and systemic modeling method to model PPM for making better decisions about resource allocation in a competitive industry. The result showed that SD can be applied to make better decisions by indicating that hybrid scenarios are in reality not preferable. Research [40] was conducted to seek sustainable ways to utilize low-grade metal resources through technical-economic systems analysis and to ensure both technical feasibility and economic justification for the Sanshandao gold mine in China. The result showed that it is possible for the Sanshandao gold mine to enlarge its throughput to exploit and utilize lower grade mineral resources and, thus, to improve the efficiency of resource utilization and to support sustainable development under the premise of guaranteeing the realization of the production and operation targets. Production strategies, the determination of the cut-off grade and throughput can be formulated according to the simulation results.

1.3. Research Question

After reviewing the current literature on the research topic, it can be claimed that financial institutions require a more effective system to analyze customers’ preferences of usage of services and to determine loan approval based on a set of criteria. Developing this system to become more effective can potentially help businesses work in a more efficient manner. This research aims to identify important preference and approval factors, while taking hybrid factors and other related matters into consideration, in order to develop an effective model for leasing companies and businesses. The research question for this study is “How can we create effective models for leasing businesses?” The inputs used to answer this question were preference and approval factors, which were later grouped, allowing us to identify any potential correlation. The next step was to use a neural network to create different types of models. The results from the developed models’ other tools were then compared. This research aims to answer other questions too, such as “What are some customer requirements?”, “What are customers interested in?”, “What are some of the criteria that lending companies need to look at before approving a loan?”, “Is there any relationship between different factors?”, “What is the relationship between preference and approval factors?” and “What external factors are related?”. To answer these questions, this research developed preference, approval and hybrid decision models for lending businesses.

The objectives of this study are to identify preference factors that affect a customer’s decision of choosing a particular financial institution, to determine the important approval factors that providers need to take into consideration while approving loans and to identify any relationship between and among the factors. The study also aims to develop a prefer-
ence model that customers use when selecting services, to develop an approval model that providers use to approve credit requests and, finally, to develop a hybrid decision model to evaluate and improve outcomes.

This research can beneficially contribute to the field of finance in multiple ways. Firstly, it will allow us to better understand preference factors that customers use when choosing a financial institution. It will also enable us to explore the approval factors that providers can use when approving a credit request. Furthermore, it will also help us understand the relationship that exists between the aforementioned factors. Another benefit of this research is that the developed models can increase the effectiveness of leasing companies, thereby improving customer satisfaction as well. So, leasing companies can use the developed models as a guideline to make decisions and implement policies.

2. Research Methodology

The factors that customers use to select financial institutions, as well as the factors that the leasing company uses to approve loan requests, are studied. These factors are analyzed to find relationships for predicting profit, as seen in Figure 2.

![Figure 2. Research methodology.](image)

The study is divided into three phases. Phase I investigates preference, approval factors and analyzed factors to establish the relationships between the factors regarding preference factors, approval factors and external factors that affect the profit of a leasing company in Chiang Mai. Phase II is the model development stage. This research created three models, i.e., the preference model, the approval model and the hybrid decision model. Phase III, the last phase, independently validates each of the models.

Phase I identifies preference factors and approval factors based on the literature review. This phase is divided into two stages, i.e., the development of the questionnaire and categorization of factors. After that, the relationship between preference factors and approval factors is investigated in order to predict the profit in the future as well as to analyze the external factors influencing the profit of a leasing business in Chiang Mai. SWOT analysis, PEST and Five Forces are applied.

Phase II is the model development. It is divided into two parts. First, the target is to develop the model for a leasing company by creating two groups, i.e., the preference model and the approval model, using the data mining technique, as seen in Figure 3 below.
The hybrid decision model shows the percentage of the profit at the time for the leasing company. Decision-makers will determine practice guidelines such as increasing profit or reducing some costs. They can select some factors in the preference factors, approval factors or external factors.

(1) The hybrid decision model links dynamic factors (preference and approval), external factors and hybrid model in the stock and flow diagram.

(2) The hybrid decision model shows the percentage of the profit at the time for the leasing company. Decision-makers will determine practice guidelines such as increasing profit or reducing some costs. They can select some factors in the preference factors, approval factors or external factors.

(3) After defining an interval of some factor’s value, the model will test by using sensitivity to show a profit for each sensitivity case.

**Figure 3.** Preference model and approval model development.

In the first stage, the factors from the first phrase are applied as the input data using the NN. The NN predicts by learning. The system utilizes a back-propagation neural network (BPN) to design the internal structure that is composed of input layers, output layers, hidden layers and nodes of layers. C# programming is used for developing models. Secondly, it is to develop a model for predicting profit which is called the hybrid decision model. Profit is taken from 4 models, i.e., profit model, revenue model, expense model and appraisal model. As the preference factors’, approval factors’ and external factors’ relationships are inconsistent, it is difficult to define the various factors. The steps to solve the problem, using the framework hybrid decision model, are shown in Figure 4 below.

**Figure 4.** Framework of hybrid decision model.
The model will replace the factor until the new policy is matched. Then, the model stops working.

Phase III is the implementation and validation of the various models and is divided into two parts. First, K-cross-validation is used to validate the preference model and approval model. K-cross-validation in learning model testing involves dividing data into K equal parts to create. It tests the model (train + validate) to calculate average accuracy or error (i.e., model performance) before the model is used to predict the test set data. K-cross-validation is applied to 90% of data for training. The remaining 10% is used for testing. In this research, K = 1 is used for validation, to calculate both accuracy and error. Mean squared error (MSE) is used. The result is compared with cutting factors by the Pareto and cutting off 50% technique. The Pareto technique is a statistical technique in decision-making used for the selection of a limited number of factors that produce a significant overall effect. It uses the Pareto principle (also known as the 80/20 rule). The idea is that by doing 20% of the work, it can generate 80% of the benefit of factors. The cutting factors by 50% technique screens 50% of factors whereby they are ranked by the correlation method to improve the model efficiency. Second, a hybrid decision model is composed of 4 steps for a validation model as follows.

1. Loan officers will retrieve customer information in the database.
2. Upon receiving the information, the loan officers will calculate the turnover of the company in the past year by splitting the total revenue of the company, net profit for 36 months.
3. The model evaluates the data using the same set of loan officer evaluations and manifests in the form of profit.
4. The calculation is then compared with the current value of the calculation in the past. If the current value is higher, it indicates that the model developed in this study is more accurate than the past one.
5. The model can forecast future data in the form of profit. After verifying and validating the models, they will be implemented.

3. Preference Model

The preference model comprises factors used by customers in choosing financial institutions. The objective of the model is to predict the probability of choosing any financial institution. The model will show the reasons as the output factors of model prediction, which are then categorized by market mixed factors.

The “market mixed factors” are used to categorize factors into seven groups in Table 1. The other group is fundamental data. It comprises career, monthly revenue, education level, status, age, household revenue per month, gender and being a debtor of any financial institutions.

Factors are categorized and are used to develop the questionnaire, using the market mix principle. The content is validated by experts who have experience in this field. The index of objective congruence (IOC) is used to validate the questionnaire. For this research, IOC is an acceptable level at 0.67–1. Then, the questionnaire is tested by the sample group which contains 30 samples. The factor analysis and the confirmatory factor analysis (CFA) are used. It has a Cronbach’s alpha coefficient of 0.709–0.873. The final stage is to use the questionnaire with those who are interested in a loan service or those who are already the customers of the financial institutions. The duration of data collection is 1 March 2018–31 July 2018. The questionnaires are completed by 2,973 customers who use the services from financial institutions in Chiang Mai province in northern Thailand.
Table 1. Market mixed factors.

<table>
<thead>
<tr>
<th>Market Mixed Factors</th>
<th>Sub-Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>service quality, loan credit, duration of payment, assets for guarantee, no guarantor, non-complex conditions such as documents, increase the loan credit, variety of installment payment method, the ratio of loan credit per guarantee, lowest salary criteria, method of evaluating the guarantee that is standardly appropriate and reliable, additional products such as credit protection plan and allow proxy and inspection of credit bureau.</td>
</tr>
<tr>
<td>Price</td>
<td>approved rate of interest, charge rate, expense for evaluation, interest types, the appropriate duration of installment payment, calculation of principal and interest reduction, charge for payment in advance, sum of every installment and appropriate interest charge when payment is delayed.</td>
</tr>
<tr>
<td>Place</td>
<td>location, easy travel, convenience of car parking, operation hours, contact channels, number of branches, application, everywhere application, online application and easy or convenient.</td>
</tr>
<tr>
<td>Promotion</td>
<td>data transfer, advertisement via media such as radio and newspaper, allow refinancing, inform customers of privileges and provide additional privilege to the loan applicant.</td>
</tr>
<tr>
<td>People</td>
<td>staff attentive, knowledge and ability of staff, human relation, manner, follow-up, equality of customers, staff responsible, listening to opinions, being open-minded, ability to solve problem.</td>
</tr>
<tr>
<td>Process</td>
<td>fast service, fast approval, easy steps, no error service, provide documents for loan application, sufficient employees and checking progress.</td>
</tr>
<tr>
<td>Physical and evidence</td>
<td>stable, organizational image, reputation, office tools, conveniences for customers, space, worth using the service, participation in society, executives' reputation, security system and the organization development.</td>
</tr>
</tbody>
</table>

3.1. Model Used for Predicting the Results of Selection in Using the Services of Financial Institutions

The results of the model are divided into four types, i.e., commercial banks, credit unions, others leasing companies and the case study leasing company. They are in the form of probability. The model shows the reasons of selection. There are 4 sub-NN models of the preference model as follows.

3.1.1. NN by Considering Only the Basic Features

The structure of the model comprises 1 input layer, 8 input nodes, 1 output layer, 4 output nodes, 1 hidden layer and 4 hidden nodes. The structure of the model is shown in Figure A1.

3.1.2. NN with Full Factors

The structure of the model comprises 1 input layer, 68 input nodes, 1 output layer, 4 output nodes, 1 hidden layer and 8 hidden nodes. The structure of the model is shown in Figure A2.

3.1.3. NN with Cutting Factors by Pareto (80:20)

The input factors are eliminated using the Pareto technique. In the input data, there are 32 input factors. The structure of the model comprises 1 input layer, 42 input nodes, 1 output layer, 4 output nodes, 1 hidden layer and 8 hidden nodes. The structure of the model is shown in Figure A3.

3.1.4. NN with Cutting Factors by 50%

Fifty percent of the inputs are removed to keep only 36 important input factors. The structure of the model comprises 1 input layer, 36 input nodes, 1 output layer, 4 output nodes, 1 hidden layer and 8 hidden nodes. The structure of the model is shown in Figure A4.

After the structural design of each model has been determined, the accuracy of the model and MSE are tested. EPOC or EPOCH is the number of rounds used to train the data, which are the total data used for training data per round. In this paper, EPOC is set up to 100 rounds. The data, which are used for the training set in the test, are derived from the information obtained from the questionnaire. It is summarized in Table 2.
Table 2. Summarized models predicting the structure.

<table>
<thead>
<tr>
<th>Model Prediction Results</th>
<th>Accuracy (%)</th>
<th>MSE</th>
<th>EPOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>NN by considering only the basic features</td>
<td>62</td>
<td>0.01806</td>
<td>100</td>
</tr>
<tr>
<td>NN with full factors</td>
<td>95</td>
<td>0.01802</td>
<td>100</td>
</tr>
<tr>
<td>NN with cutting factors by Pareto (80:20)</td>
<td>100</td>
<td>0.01316</td>
<td>100</td>
</tr>
<tr>
<td>NN with cutting factors by 50%</td>
<td>100</td>
<td>0.02485</td>
<td>100</td>
</tr>
</tbody>
</table>

Note: EPOC is the number of training cycles.

3.2. Prediction Improvement

To improve the efficiency of the prediction, EPOC number, number of hidden nodes, number of hidden layers and value of sigmoid function are all increased. There are four hypotheses, i.e., Hypothesis I: to improve efficiency of the prediction models by increasing the EPOC number, EPOC numbers are varied from 500 to 20,000. Hypothesis II: increasing the number of hidden nodes. The number of nodes is increased, i.e., 4 nodes to 18 nodes, 4 nodes to 32 nodes, 4 nodes to 50 nodes and 4 nodes to 64 nodes at EPOC 500–20,000. Hypothesis III: increasing the number of hidden layers. The number of hidden layers is increased, i.e., from one hidden layer to two hidden layers and from one hidden layer to three hidden layers at EPOC 500–20,000. Hypothesis IV: increasing the value of the sigmoid function. The value of the sigmoid function is increased, i.e., the value of the sigmoid function changes from 0 to 0.2, 0 to 0.4, 0 to 0.6, 0 to 0.8 and 0 to 1 at EPOC 500–20,000.

After proving the hypothesis for model prediction, the final structure for prediction Model 1 is shown in Table 3 below.

Table 3. Summary of model predicting the results of selecting the services of financial institutions by using NN.

<table>
<thead>
<tr>
<th>Model</th>
<th>Input Layer</th>
<th>Input Nodes</th>
<th>Output Layer</th>
<th>Output Nodes</th>
<th>Hidden Layer</th>
<th>Hidden Nodes</th>
<th>Accuracy (%)</th>
<th>EPOC</th>
<th>MSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NN by considering only the basic features</td>
<td>1</td>
<td>8</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>32</td>
<td>84</td>
<td>3000</td>
<td>0.00494</td>
</tr>
<tr>
<td>NN with full factors</td>
<td>1</td>
<td>68</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>18</td>
<td>99</td>
<td>200</td>
<td>0.01738</td>
</tr>
<tr>
<td>NN with cutting factors by Pareto (80:20)</td>
<td>1</td>
<td>42</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>8</td>
<td>100</td>
<td>100</td>
<td>0.01316</td>
</tr>
<tr>
<td>NN with cutting factors by 50%</td>
<td>1</td>
<td>36</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>8</td>
<td>100</td>
<td>100</td>
<td>0.02485</td>
</tr>
</tbody>
</table>

From the above table, NNs using the Pareto technique and NNs using cutting 50% were accurate at 100% with no change in EPOC, hidden nodes and hidden layers. NN by considering only the basic features before the change had an accuracy of 62%. After improved prediction by four hypotheses, the best result was 84% with 1 input layer and output layer, 3 hidden layers, 32 hidden nodes and 4 output nodes. NN with full factors before the change had a significantly higher accuracy rate of 95%. After improved prediction by four hypotheses, the best result was 99% with 1 input layer, 1 output layer and 1 hidden layer, 18 hidden nodes and 4 output nodes.

The model was tested on the website “preferenceandapprovalmodels.com”. If the prediction result is a leasing company, the model will show no reason. However, if the prediction result is another financial institute which is not a leasing company, the model will present the reasons and recommendations. Table 4 illustrates an example of the output. In this case, a commercial bank is selected. The model then shows the reason why a customer selected the commercial bank service.
Table 4. Factor suggestion for adjusting leasing company’s factors.

<table>
<thead>
<tr>
<th>Marketing Mixed Type</th>
<th>Factors</th>
<th>Commercial Bank (Weight)</th>
<th>Leasing Company (Weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>Loan credit</td>
<td>0.62</td>
<td>0.37</td>
</tr>
<tr>
<td>Price</td>
<td>Charge rate</td>
<td>0.5</td>
<td>0.19</td>
</tr>
<tr>
<td>Place</td>
<td>Convenience of car parking</td>
<td>0.6</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td>Data transfer, e.g., sending</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>letters regularly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Promotion</td>
<td>Treat all customers equally</td>
<td>0.20</td>
<td>0.18</td>
</tr>
<tr>
<td>People</td>
<td>Treat all customers equally</td>
<td>0.20</td>
<td>0.18</td>
</tr>
<tr>
<td>Process</td>
<td>Fast service</td>
<td>0.09</td>
<td>0.22</td>
</tr>
<tr>
<td>Physical and Evidence</td>
<td>Participate in society</td>
<td>0.09</td>
<td>0.14</td>
</tr>
</tbody>
</table>

Market mix factors, indicated by the model, influence how customers choose their commercial bank and leasing business factors. SWOT’s core principle is a survey analysis of a situation based on two aspects. It is composed of internal and external situations (situation analysis) as follows.

The internal situation is to analyze resources and competence within the organization in all aspects.

Strengths (s) were data transfer and fast service factors. Leasing companies should maintain the strengths of the organization.

Weaknesses (w) were participating in society and convenience of car parking factors. Leasing companies should improve the benefits of the organization such as participating in sponsorships at the district or sub-district level.

The external situation is to find opportunities and obstacles for the performance of organizations affected by both domestic and international economic environments.

Opportunities (O) were participating in society and fast service factors. Leasing companies can use these advantages to strengthen the agency such as fast approval within one day.

Threats (T) were loan credit, convenience of car parking and charge rate factors.

3.3. Validation

To validate the model, it was found that the NN with the cutting factors by 50% technique gives the best result. This was tested on the web with 100 questionnaires which are composed of 25 commercial banks, 25 credit unions, 25 other leasing companies and 25 leasing companies. The accuracy of prediction is 58%. Although this is a lower accuracy than for the training data, the result is satisfactory because the NN can give a better prediction if the models have a larger amount and variety of data for the training model.

4. Approval Model

An approval model is a model collecting the factors used by the business owner for approving customers in the leasing company. Due to the fact that this model is utilized to approve consumer credit, this field is highly competitive. The Five Force principle was introduced to help with the analysis in order to accomplish the goals. Five Forces is a tool for examining the five pressures that have the following effects on the competitive environment.

(1) The customers’ bargaining power is significant. Customers can choose the services that best suit their needs and level of satisfaction by using both commercial banks and non-commercial banks, such as leasing businesses, credit unions, etc.

(2) There is a moderate power of suppliers because leasing companies must conduct their operations in compliance with Bank of Thailand laws.
The threat posed by new entrants is moderate, as seen by the assistance received by businesses from established companies or the extensive credit extended by banks to finance operations.

There is a significant threat of substitutes, including gold mortgages, auto pawns, condo mortgages, etc.

The level of industry competition is significant, as seen by the competition for quick and convenient loan approval, the reduction of collateral assets, the expansion of the time period of principle and interest payment, etc.

The objective of this model is to increase the efficiency for evaluating customer approval and reducing the risk. If the output of model prediction is disapproval, the model will show output factors of model prediction or reasons which could be categorized by the 5Cs. To obtain factors, questionnaires are developed using the literature reviewed [13,17] and by experts who have worked in this field. The “5Cs” are used to categorize factors into five groups in Table 5. The other group is fundamental data. It comprises gender, age, type of loans, duration of debt payment, type of customer, amount of money requested, criteria for evaluation of approval, approved interest rate and fee of contract.

Table 5. 5Cs of credit factors.

<table>
<thead>
<tr>
<th>Characteristic factor</th>
<th>Sub-factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Career</td>
<td>career, education level, duration/experience of work and status and number of children.</td>
</tr>
<tr>
<td>Education level</td>
<td>monthly revenue, monthly additional revenue, the expense of a child’s education, monthly household expense, history of being in debt, credit bureau history and debt balance.</td>
</tr>
<tr>
<td>Duration/experience of work and status and number of children.</td>
<td>capital rate per total liability, real estate for guarantee and the objective of loan request for real estate.</td>
</tr>
</tbody>
</table>

Factors are categorized and the questionnaire is developed, using the 5C credit principle. The content is validated by experts. For this research, IOC is an acceptable level at 0.67-1. Then, the questionnaire is tested by the sample group containing 20 samples. It has a Cronbach’s alpha coefficient of 0.726. This study uses multinomial logistic regression to study the factors influencing the distribution of approval. The data used were collected during the period of 1 January 2015–31 December 2017. Questionnaires are for the customers coming to use the service of the case study leasing company.

4.1. Model Used in Predicting the Loan Approval Results

This section describes the development of a model for credit approval. In the research, the results of the model are divided into three categories, i.e., approval, disapproval and less approval. This is shown in the form of probability. If the results of the prediction are disapproval or less approval, the model will show the reasons for disapproval and recommendations. The model is divided into three groups.
4.1.1. NN with Full Factors

The structure of the model comprises 1 input layer, 55 input nodes, 1 output layer, 3 output nodes, 1 hidden layer and 10 hidden nodes. The structure of the model is shown in Figure A5.

4.1.2. NN with Cutting Factors by Pareto (80:20)

The structure of the model comprises 1 input layer, 55 input nodes, 1 output layer, 3 output nodes, 1 hidden layer and 10 hidden nodes. The structure of the model is shown in Figure A6.

4.1.3. NN with Cutting Factors 50%

The structure of the model comprises 1 input layer, 30 input nodes, 1 output layer, 3 output nodes, 1 hidden layer and 10 hidden nodes. The structure of the model is shown in Figure A7.

After the structural design of each model has been determined, the accuracy of the model and error value (MSE) are tested. They are summarized in Table 6.

Table 6. Summarized models predicting the structure.

<table>
<thead>
<tr>
<th>Model</th>
<th>Accuracy (%)</th>
<th>Prediction Results</th>
<th>EPOC</th>
</tr>
</thead>
<tbody>
<tr>
<td>NN</td>
<td>48</td>
<td>0.00765</td>
<td>500</td>
</tr>
<tr>
<td>NN with cutting factors by Pareto (80:20)</td>
<td>26</td>
<td>0.00814</td>
<td>500</td>
</tr>
<tr>
<td>NN with cutting factors 50%</td>
<td>30</td>
<td>0.00774</td>
<td>500</td>
</tr>
</tbody>
</table>

4.2. Prediction Improvement

From Table 6, to improve the efficiency of the prediction, EPOC number, number of hidden nodes, number of hidden layers and the value of the sigmoid function are increased. There are four hypotheses, similar to those of the preference model. After proving the hypothesis above, the model predicting the results of approval is summarized below in Table 7.

Table 7. Summary of model predicting the results of approval model.

<table>
<thead>
<tr>
<th>Model</th>
<th>Input Nodes</th>
<th>Output Nodes</th>
<th>Hidden Layers</th>
<th>Hidden Nodes</th>
<th>Acc</th>
<th>EPOC</th>
<th>Sigmoid Function</th>
<th>MSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>NN with full factors</td>
<td>55</td>
<td>3</td>
<td>1</td>
<td>10</td>
<td>55</td>
<td>3000</td>
<td>0</td>
<td>0.00956</td>
</tr>
<tr>
<td>NN with cutting factors by Pareto (80:20)</td>
<td>32</td>
<td>3</td>
<td>1</td>
<td>40</td>
<td>40</td>
<td>8000</td>
<td>0.2</td>
<td>0.03264</td>
</tr>
<tr>
<td>NN with cutting factors by 50%</td>
<td>30</td>
<td>3</td>
<td>2</td>
<td>18</td>
<td>40</td>
<td>4000</td>
<td>0.2</td>
<td>0.03905</td>
</tr>
</tbody>
</table>

From the above table, it can be seen that the NN with full factors before the change was accurate at 48%. After improved prediction by four hypotheses, the best result was 55% with 1 input layer, 1 output layer and 1 hidden layer, 10 hidden nodes and 3 output nodes. NN with cutting factors by Pareto before the change had an accuracy of 26%. After improved prediction by four hypotheses, the best result was 40% with 1 input layer, 1 output layer and 1 hidden layer, 40 hidden nodes and 3 output nodes. The NN with cutting factors by 50% before the change had an accuracy rate of 30 and MSE of 0.00774%. After improved prediction by four hypotheses, the best result was 30% and MSE was 0.03905% with 1 input layer, 1 output layer and 2 hidden layers, 18 hidden nodes and 3 output nodes.
4.3. Validation

To validate the model, it was found that NN with full factors gives the best result. This was tested on the web with 100 questionnaires. The accuracy of prediction is 65%. When tested on the web with 100 answered questionnaires with the same training set, the accuracy of prediction is significantly higher at 90–100%. To compare the prediction between humans and the model, the error of humans is 53%, and the error of model prediction is 35%. The difference error of 18% suggests that the model can predict considerably better than humans. In the future, if a model is to provide a better prediction, it should use a large amount and variety of data for the training model, which is a requirement of NN tools.

5. Hybrid Decision Model

This section covers both the criteria a customer uses to choose a leasing provider and the criteria a leasing provider uses to authorize a loan. Two groups of factors are used as input data of the model to obtain efficient factors. Ranking of preference models and approval models was applied. PEST is a tool used for analyzing market trends and providing a company overview based on information about how external factors are changing. The company cannot be controlled. It consists of the four following criteria.

Political (P) has a negative effect such as fiscal policy, government-issued loans to people at very low interest rates and labor law.

Economic (E) is significant. Economic expansion also resulted in the expansion of credit of financial institutions such as interest rate, GPP and wage rate.

Social (S) is significant. Today, Thai people have more meticulousness in choosing financial services. Analysis and evaluation are more cost-effective alternatives including the change in social and cultural factors. Communication of customers makes acknowledgment and transmitting information quicker. Society and changing culture affect the decisions of people to choose services, including social attitude and cultural trends.

Technology (T) represents changes in technology that affect the leasing businesses such as social media.

The model was established after external elements had been analyzed. The objective of this model is to examine a leasing business’s capability to generate a profit by using the system dynamics to simulate and forecast the profit over the following three years. STELLA Version 9.1 was employed in this research.

5.1. Model Used in Predicting the Profit Results

This section has divided the model into four models. These are the expense model, the income model, the appraisal model and the profit model.

5.1.1. Expense Model

This model considers the expense costs of a leasing company. Factors and sub-factors are received by operations of the leasing company. However, some factors are the external factors and received by experts. They can be divided into four main sections. Factors are shown in Table 8.

After receiving the compilation of all relevant factors, system dynamics are used to draw relationships for each factor by a stock and flow diagram, as shown in Figure 5.
Table 8. Expense factors for hybrid decision model.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Sub-Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head office expense</td>
<td>office rental, building tax, public utilities, public relations, office expense, maintenance cost, other costs and stationery cost.</td>
</tr>
<tr>
<td>Branch office expense</td>
<td>office rental, signage tax charge, building tax, public utilities, maintenance costs and other costs.</td>
</tr>
<tr>
<td>Other expenses</td>
<td>account book, legal activity, tax, commercial rate, borrowed money and non-performing loan.</td>
</tr>
<tr>
<td>Salary factors</td>
<td>housekeeper department factors composed of minimum wage by law, working days per month and housekeeper rate, financial department factors</td>
</tr>
<tr>
<td></td>
<td>composed of employee’s salary cost, social security cost, overtime cost, incentive cost, working hours per month and leave days per month.</td>
</tr>
<tr>
<td>Salary factors</td>
<td>general manager department factors composed of employee’s salary cost, social security cost, commission cost, overtime cost.</td>
</tr>
<tr>
<td></td>
<td>incentive cost, working hours per month and leave days per month.</td>
</tr>
</tbody>
</table>

Figure 5. Expense model by system dynamics.
5.1.2. Revenue Model

This model demonstrates the revenue of the company. We consider the factors of customers as follows.

1. The consideration preference factors. Factors of this model are reviewed and some factors are further added from [41]. All the factors are considered to find the main factors that lead to revenue regarding the score of the customers’ rating. Factors are considered to be decision markers and analyzed by the SPSS program. Factors are shown in Table 9.

<table>
<thead>
<tr>
<th>Table 9. Preference factors for hybrid decision model.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factors</strong></td>
</tr>
<tr>
<td><strong>Product</strong></td>
</tr>
<tr>
<td><strong>Price</strong></td>
</tr>
<tr>
<td><strong>Place</strong></td>
</tr>
<tr>
<td><strong>Promotion</strong></td>
</tr>
<tr>
<td><strong>People</strong></td>
</tr>
<tr>
<td><strong>Process</strong></td>
</tr>
<tr>
<td><strong>Physical and evidence</strong></td>
</tr>
</tbody>
</table>

After that, to find the revenue model, which affects the leasing company, a summary relation is drawn from above, as shown in Figure 6.

2. Other revenues from other operations. Factors composed of amount of money to close, monthly installment payment, fee charge which is received by the operation of the leasing company and GPP are the external factors and are received by experts. The revenue model is summarized below in Figure 6.

5.1.3. Appraisal Model

Factors of this model are reviewed and some factors are further added from [41]. All the factors are considered to find the main factors that lead to revenue regarding the score of the customers’ rating. Factors are considered to be decision markers and analyzed by the SPSS program. This model demonstrates factors used in the assessment of securities.
that affect approval. Factors comprised duration of debt payment, criteria for evaluation of approval, approved interest rate, fee of contract, district, characteristics of land, utilization, transportation, environment, tendency of growth, number of buildings and size of road.

Figure 6. Revenue model by system dynamics.

After receiving the compilation of all relevant factors, system dynamics are used to draw relationships for each factor by a stock and flow diagram, as shown in Figure 7.
of approval, approved interest rate, fee of contract, district, characteristics of land, utilization, transportation, environment, tendency of growth, number of buildings and size of road.

After receiving the compilation of all relevant factors, system dynamics are used to draw relationships for each factor by a stock and flow diagram, as shown in Figure 7.

**Figure 7.** Appraisal model by system dynamics.

### 5.1.4. Profit Model

This model represents the profit performance. Factors comprised revenue, expense costs, remaining money in leasing company and profit. After receiving the compilation of all relevant factors, system dynamics are used to draw relationships for each factor by a stock and flow diagram, as shown in Figure 8.

**Figure 8.** Profit model by system dynamics.

### 5.2. Model Results

As shown above, the factors’ relationship is defined, which affect the profits of the leasing company. All models have been developed by system dynamics. Equations for forecasting have been developed by using the SPSS program. They are divided into four groups as follows.
Expense Model
To validate the expense model, input data of this model were taken from real expense cost data which were collected from the leasing company for three years. The employees related to this field calculated input costs. Forecast expense costs used the same input data but they were calculated by the model. Errors between real expense costs and forecast expense costs were calculated by the difference between real expense costs and forecast expense costs. The researchers used SPSS techniques to consider which factors had significance, and which factors were insignificant. After running the SPSS program, no factors were significant. To measure forecast error, MAPE was used. MAPE was 48.14%.

Revenue Model
To validate the revenue model, input data of this model were taken from real revenue cost data which were collected from the leasing company for three years. The employees related to this field calculated input revenue and the other revenue (preference factors) was calculated by the SPSS program. Forecast revenue used the same input data but it was calculated by the model. The researchers used SPSS techniques to consider which factors were significant. To measure forecast error, MAPE was used and was 46.55%.

Appraisal Model
To validate the appraisal model, input data of this model were taken from real appraisal data which were collected from the leasing company for three years. The employees related to this field calculated input approval and the other approval (approval factors) was calculated by the SPSS program. The researchers used SPSS techniques to consider which factors were significant. To measure forecast error, MAPE was used and was 66.58%.

5.3. Validation and Forecasting
To validate the profit model, input data of this model were taken from real profit data which were collected from the leasing company for three years. The employees related to this field calculated input approval. Forecast profit used the same input data but it was calculated by a model. MAPE was 78.33%. To forecast, the model forecasted profit for 36 months, and the result has shown that the average forecasted profit per year would be approximately THB 20,000. It was demonstrated that the anticipated profits would be quite small. The strategy has changed as a result. The following part will demonstrate this.

5.4. Model Simulation
The company’s profit table has not been satisfied because some months have shown little profit. To help the company increase profits, the analysis has been divided as follows.
- Increase profit by increasing employees.
- Increasing by one financial employee (from 2 to 3).
- Increasing by one official employee (from 3 to 4).
- Increasing one by financial employee (from 2 to 3) and one official employee (from 3 to 4).
- Increase profit by decreasing employees.
- Decreasing by one financial employee (from 2 to 1).
- Decreasing by one official employee (from 3 to 2).
- Decreasing one by financial employee (from 2 to 1) and one official employee (from 3 to 2).
- Increase profit by increasing branches.
- Increasing by one branch (from 2 to 3).
- Increasing by one branch (from 2 to 3) and one financial employee (from 2 to 3).
- Increasing by one branch (from 2 to 3) and one official employee (from 3 to 4).
- Increasing by one branch (from 2 to 3), one financial employee (from 2 to 3) and one official employee (from 3 to 4).
- Increase profit by decreasing branches.
- Decreasing by one branch (from 2 to 1).
- Decreasing by one branch (from 2 to 1) and one financial employee (from 2 to 1).
- Decreasing by one branch (from 2 to 1) and one official employee (from 3 to 2).
- Decreasing by one branch (from 2 to 1), one financial employee (from 2 to 1) and one official employee (from 3 to 2).
- Increase profit by increasing advertisement (20%).

After that, this research forecasted three years by model simulation. Profit ratio (percentage) means the difference between increased forecasted profit (THB) and forecasted profit (fundamental) (THB) by forecasted profit (fundamental) (THB). The result is shown in Table 10.

Table 10. Result of model simulation.

<table>
<thead>
<tr>
<th>Increase Forecasted Profit by</th>
<th>Profit Ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamental Employees</td>
<td></td>
</tr>
<tr>
<td>Increasing financial employees</td>
<td>less than fundamental</td>
</tr>
<tr>
<td>Increasing official employees</td>
<td>less than fundamental</td>
</tr>
<tr>
<td>Increasing financial employees and official employees</td>
<td></td>
</tr>
<tr>
<td>Decreasing financial employees</td>
<td>7.48</td>
</tr>
<tr>
<td>Decreasing official employees</td>
<td>6.1</td>
</tr>
<tr>
<td>Decreasing financial employees and official employees</td>
<td>13.59</td>
</tr>
<tr>
<td>Branches</td>
<td></td>
</tr>
<tr>
<td>Increasing branches</td>
<td>less than fundamental</td>
</tr>
<tr>
<td>Increasing branches and financial employees</td>
<td></td>
</tr>
<tr>
<td>Increasing branches and official employees</td>
<td>16.49</td>
</tr>
<tr>
<td>Increasing branches, financial employees and official employees</td>
<td>less than fundamental</td>
</tr>
<tr>
<td>Decreasing branches</td>
<td>10.39</td>
</tr>
<tr>
<td>Decreasing branches and financial employees</td>
<td>16.49</td>
</tr>
<tr>
<td>Decreasing branches and official employees</td>
<td>14.16</td>
</tr>
<tr>
<td>Decreasing branches, financial employees and official employees</td>
<td>23.98</td>
</tr>
<tr>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>Increasing advertisement</td>
<td>1.82</td>
</tr>
</tbody>
</table>

From the table above, the result of model simulation shows many choices for increasing profit by suggestions such as increasing profit by increasing advertisement. However, decision makers should therefore discuss whether actions should be taken or not.

6. Conclusions

The preference model forecasts the possibility of customers’ selection of financial institutions. The model displays the top factors of selection for every financial institution to compare them. The decision maker can evaluate the factors for planning or policy development. The result is divided into four classes: commercial banks, credit unions, other leasing companies, and our leasing company. The questionnaire was composed of 68 factors which were categorized by the market mixed theory. The model was developed using an NN, categorized into four types. The best model that has the highest accuracy of prediction was the NN with cutting 50% technique. The structure model has 1 input layer, 1 hidden layer, 1 output layer, 36 input nodes, 8 hidden nodes and 4 output nodes at EPOC 100. The accuracy of prediction was 58%.

The approval model is for forecasting the approval result. The objective is to assist in loan approval with more efficiency and fewer risks. The result is divided into three classes: approval, disapproval and less approval. The questionnaire was composed of 55 factors
which were categorized by the 5Cs of credit. The model was developed using an NN, categorized into three types. The best model that has the highest accuracy of prediction was the NN with full factors. The final structure of the model has 1 input layer, 1 hidden layer, 1 output layer, 55 input nodes, 10 hidden nodes and 3 output nodes at EPOC 3000. The accuracy of prediction was 65%. When tested on the web with 100 answered questionnaires, the accuracy of prediction was 90–100%. Compared with the error of humans, the model can predict better than humans by an impressive 18%.

The hybrid decision model is the model used to find the operating result of a leasing company in Chiang Mai. The directors of the company could plan the development or change their strategy for gaining a greater market share and improve the operating result. The input data came from preference factors and approval factors. The two types of factors were applied in consideration with external factors, to find all relationships of factors that influence the operation of a leasing company in Chiang Mai. The model was divided into four models (expense model, revenue model, appraisal model and profit model). MAPE of the profit model is 78.33%. It was demonstrated that the anticipated profits would be quite small. The strategy has changed as a result. The result of model simulation shows many choices for increasing profit by suggestions such as increasing profit by increasing advertisement. However, decision makers should therefore discuss whether actions should be taken or not.

7. Discussion

The preference model can predict the customer's choice and there has not been any research like this before. This model has many benefits, i.e., helping financial institutions (boards or those related to this field) to make decisions or plan strategies for the future, offering real-time decision making.

The approval model integrates published factors and practical factors which have been used in some commercial and non-commercial banks. This model has many benefits, i.e., offering real-time decision making, giving advice or obtaining reasons for disapproval. Both the preference model and approval model had the same limitations in that the amount of data used to develop the model was insufficient and diverse. So, it makes the performance unsatisfactory because usually an NN needs to use sufficient data for learning and developing.

From model validation of the hybrid decision model, the result has some errors from sub-models which comprised an expense model, revenue model, appraisal model and profit model. This is because:

1. The tool for creating the model for forecasting was multiple linear regression but some data were not suitable for using this technique.
2. Data from the revenue model which comprised factors from the preference model have not been used to evaluate revenue before so system dynamics were first used to forecast the revenue. Then, it was used again to create an equation for forecasting. The appraisal model had some errors similar to that of the revenue model. So, in future forecasting, advance statistical tools can be used to give more accuracy.

In this research study, the results were compared, and can be compared with other research, namely the results of Model 2. Other research [23] has a higher percentage of accuracy (93%) than this research (65%). It is noteworthy that although this research has a lower accuracy than other research, its lower accuracy may be due to a greater number of approval variables being utilized in practical decision-making, and a lack of sufficient data to train the neural network. There is no prior study that matches this research for Models 1 and 3.

Author Contributions: Conceptualization, S.R. and N.J.; methodology, S.R. and N.J.; writing-original draft preparation, N.J.; writing-review and edition, S.R. All authors have read and agreed to the published version of the manuscript.

Funding: This research work was partially supported by Chiang Mai University, Thailand.
Acknowledgments: This research work was partially supported by the Graduate Program in Industrial Engineering, Department of Industrial Engineering, Faculty of Engineering, Chiang Mai University and the Supply Chain and Engineering Management Research Unit, Chiang Mai University, Chiang Mai, Thailand.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A Preference Model

Figure A1. Structure of the NN by considering only the basic feature model used for predicting.

Figure A2. Structure of the NN model used for predicting.
Figure A3. Structure of the NN by using Pareto technique (80:20) model used for predicting.

Figure A4. Structure of the NN by using cutting 50% technique model used for predicting.
Appendix B Approval Model

Figure A5. Structure of the NN by full factor model used for predicting.

Figure A6. Structure of the NN by using Pareto technique (80:20) model used for predicting.
Figure A7. Structure of the NN by using cutting 50% technique model used for predicting.

**Appendix C Questionnaire**

1. Preference questionnaire

Dear customers,

Considering that Ph.D. students in industrial engineering, faculty of Engineering at Chiang Mai University would like to research “Hybrid Decision Models of Leasing Business for Thailand using Neural Network.” In order to use the research findings for additional educational benefits, we respectfully ask that you complete all surveys honestly and in accordance with your opinions. We promise to keep all information confidential. Only a broad overview of the results will be presented.

The researcher sincerely thanks each and every one of you.

Explanation for completing the questionnaire

This questionnaire aims to investigate

Part 1 General information for customers who opt to use leasing services. The questionnaire is in checked-list format.

Part 2 Questionnaire on the opinions of customers in the selection of services broken down by marketing mix. The importance of marketing factors is divided into 5 levels as follows:

5 means strongly agree
4 means very agree
3 means moderately agree
2 means somewhat agree
1 means least agree
Part 1 General information of customers

Explanation: Customers, please mark √ in the blanks according to the message that best matches you.

1. Gender
   - Male
   - Female

2. Age
   - Lower than 25
   - 26–40
   - 41–60
   - over 60

3. Education Level
   - Lower elementary School
   - Middle School
   - Voc. Cert./High Voc.
   - Cert.BA
   - Higher than BA

4. Career
   - State Officers
   - Company employee
   - Student
   - Self-Employed
   - Military/Police/Avocat
   - Seller
   - Contractor
   - Money Exchange
   - Entrepreneur

5. Monthly Revenue
   - Lower THB 10,000
   - THB 10,001–20,000
   - THB 20,001–30,000
   - Over THB 30,000

6. Household Revenue/Month
   - Lower THB 30,000
   - THB 30,001–45,000
   - THB 45,001–60,000
   - Over THB 60,000

7. Status
   - Single
   - Married
   - Widowed
   - Divorced

8. Are you a debtor of any financial institutions?
   - No
   - Yes, one.
   - Yes, More than one.

Part 2 Marketing Mix Questionnaire (7P)

Explanation: Customers, please mark √ in the blanks according to the message that best matches you.

2.1. Product

<table>
<thead>
<tr>
<th>Factors Affecting Service Selection</th>
<th>Rating of Marketing Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td>1. Service Quality</td>
<td></td>
</tr>
<tr>
<td>2. Loan Credit</td>
<td></td>
</tr>
<tr>
<td>3. Duration of Payment, e.g., 1 year, 10 years</td>
<td></td>
</tr>
<tr>
<td>4. Assets for guarantee</td>
<td></td>
</tr>
<tr>
<td>5. No guarantor</td>
<td></td>
</tr>
<tr>
<td>6. Non-complex conditions such as documents</td>
<td></td>
</tr>
<tr>
<td>8. Variety of installment payment method, e.g., pay interest or reduction of principal and interest</td>
<td></td>
</tr>
<tr>
<td>9. The ratio of loan credit per guarantee</td>
<td></td>
</tr>
<tr>
<td>10. Lowest salary criteria for applicants</td>
<td></td>
</tr>
<tr>
<td>11. Method of evaluating the guarantee that is standardly appropriate and reliable.</td>
<td></td>
</tr>
<tr>
<td>12. Have additional products such as credit protection plan</td>
<td></td>
</tr>
<tr>
<td>13. Allow proxy</td>
<td></td>
</tr>
<tr>
<td>14. Inspection of Credit Bureau</td>
<td></td>
</tr>
</tbody>
</table>
### 2.2. Price

<table>
<thead>
<tr>
<th>Factors Affecting Service Selection</th>
<th>Rating of Marketing Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Approved rate of interest</td>
<td>5</td>
</tr>
<tr>
<td>2. Charge Rate</td>
<td>4</td>
</tr>
<tr>
<td>3. Expense for evaluation</td>
<td>3</td>
</tr>
<tr>
<td>4. Various interest types</td>
<td>2</td>
</tr>
<tr>
<td>5. Appropriate duration of installment payment</td>
<td>1</td>
</tr>
<tr>
<td>6. Calculation of principal and interest reduction</td>
<td></td>
</tr>
<tr>
<td>7. Charge for payment in advance</td>
<td></td>
</tr>
<tr>
<td>8. Sum of every installment</td>
<td></td>
</tr>
<tr>
<td>9. Appropriate Interest charge when payment delayed</td>
<td></td>
</tr>
</tbody>
</table>

### 2.3. Place

<table>
<thead>
<tr>
<th>Factors Affecting Service Selection</th>
<th>Rating of Marketing Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Location is close to the community</td>
<td>5</td>
</tr>
<tr>
<td>2. Easy travel</td>
<td>4</td>
</tr>
<tr>
<td>3. Convenience for car parking</td>
<td>3</td>
</tr>
<tr>
<td>4. Duration of Operation Hour</td>
<td>2</td>
</tr>
<tr>
<td>5. Contact channels, number of branches, for example</td>
<td>1</td>
</tr>
<tr>
<td>6. Easy for application, everywhere application, online application, easy/convenient</td>
<td></td>
</tr>
</tbody>
</table>

### 2.4. Promotion

<table>
<thead>
<tr>
<th>Factors Affecting Service Selection</th>
<th>Rating of Marketing Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Data transfer e.g., sending letter regularly</td>
<td>5</td>
</tr>
<tr>
<td>2. Advertisement via media such as radio and newspaper.</td>
<td>4</td>
</tr>
<tr>
<td>3. Allow refinancing</td>
<td>3</td>
</tr>
<tr>
<td>4. Inform privileges to customers, e.g., free of charge</td>
<td>2</td>
</tr>
<tr>
<td>5. Receive additional privilege for the loan applicant, e.g., special care, fast beneficial information</td>
<td>1</td>
</tr>
</tbody>
</table>
### 2.5. People

#### Factors Affecting Service Selection

<table>
<thead>
<tr>
<th>Rating of Marketing Mix</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The staff gives easy advice, be attentive</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. The staff has knowledge and ability and are reliable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Have a good human relation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Have a good and polite manner.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Follow-up (notice statement of payment)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Treat all customers equally.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Staff is responsible for their errors.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Listen to customers’ opinions, be open-minded.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Solve customers’ problem rapidly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Have personal contact/be a friend or a relative</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2.6. Process

#### Factors affecting service selection

<table>
<thead>
<tr>
<th>Rating of Marketing Mix</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Fast service</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Fast approval</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Easy steps</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. No error service</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Provide documents for loan application</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Sufficient employees</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Allow checking progress through internet/telephone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2.7. Presentation

#### Factors Affecting Service Selection

<table>
<thead>
<tr>
<th>Rating of Marketing Mix</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Stable, good organizational image, good reputation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Modern office tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Provide conveniences for customers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Space is large, clean, and modern (Office).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Worth for using the service</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Participate in society</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. The executives have a good reputation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Security system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Always develop the organization.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Thank you all for spending your time to answer the questionnaire for the benefit of the researcher’s research.

2. Approval Questionnaire

Research questionnaire

Dear appraisal staff,

Considering that Ph.D. students in industrial engineering, faculty of Engineering at Chiang Mai University would like to research “Hybrid Decision Models of Leasing Business for Thailand using Neural Network.” In order to use the research findings for additional educational benefits, we respectfully ask that you complete all surveys honestly and in accordance with your opinions. We promise to keep all information confidential. Only a broad overview of the results will be presented.

The researcher sincerely thanks each and every one of you.

Explanation for answering the questionnaire

This questionnaire intends to study

Part 1 Foundation information of leasing service customers

Part 2 Approval information using the 5C principle

Part 1 Foundation information

Explanation: The appraisal staff please mark √ in the blank.

1. Gender
   - Male
   - Female

2. Age
   - Lower 25
   - 26–40
   - 41–60
   - Over 60

3. Type of loan (single/joint)
   - Single
   - Joint with other stakeholders in the assets

4. Duration of debt payment
   - 3 Months
   - 6 Months
   - 1 Year
   - 2 Years
   - 3 Years
   - 4 Years
   - 5 Years

5. Type of customers
   - Former customer
   - New customer
   - Current customer

6. The request money amounts THB ..................

7. Model feedback
   - Approved
   - Denied
   - Approved but the loan is lower than the customer expected.

8. Received amount THB ..................

9. Criteria for evaluation of approval ................. %

10. Approved interest rate
    - 1.00–1.50 THB Per month
    - 1.51–2.00 THB Per month
    - 2.01–2.50 THB Per month
    - 2.51–3.00 THB Per month
    - 3.01–3.50 THB Per month
    - Over 3.50 THB Per month

11. Fee of contract
    - Free
    - 0.5% of approved credit limit
    - 1% of approved credit limit
    - 1.5% of approved credit limit
    - Over 1.5% of approved credit limit

Part 2 Approval information using the 5C principle

Explanation: The appraisal staff please mark √ in the blank.

1. Qualifications of Debtor

1.1. Career
   - State Officers
   - Company employee
   - Student
     - Self-Employed
     - Military/Police/Avocat
     - Seller
     - Contractor
     - Money Exchange
     - Entrepreneur
1.2 Education Level
☐ Lower elementary School  ☐ Middle School
☐ Voc. Cert./High Voc. Cert.  ☐ BA
☐ Higher than BA

1.3 Duration/experience of work
☐ None  ☐ Less than 5 years
☐ 5-10 years  ☐ More than 10 years

1.4 Marital Status
☐ Single  ☐ Married
☐ Widowed  ☐ Divorced

1.5 Number of children
☐ None  ☐ 1
☐ 2  ☐ More than 2

2. Capability of paying debt
2.1 Monthly revenue
☐ Lower THB 10,000  ☐ THB 10,001–20,000
☐ THB 20,001–30,000  ☐ Over THB 30,000
☐ None

2.2 Monthly Additional Revenue
☐ None  ☐ Lower than THB 10,000
☐ THB 10,001–20,000  ☐ More than THB 20,000

2.3 Expense for child’s education
☐ None  ☐ Lower than THB 10,000
☐ THB 10,001–20,000  ☐ More than THB 20,000

2.4 Monthly Household Expense
☐ Lower than THB 30,000
☐ THB 30,001–45,000
☐ THB 45,001–60,000  ☐ More than THB 60,000

2.5 History of being debt
☐ Never being debt  ☐ Average (50%)
☐ Good (75%)  ☐ Very good (100%)

2.6 Debt balance
☐ None  ☐ Lower than THB 20,000
☐ THB 20,001–50,000  ☐ THB 50,001–100,000
☐ More than THB 100,000

2.7 Credit Bureau History
☐ None  ☐ Found name

3. Capital of debtor
3.1 Capital rate per total liability
☐ Lower double  ☐ Double
☐ More than double

3.2 Real estate for guarantee
☐ Mortgage/consignment  ☐ Frozen
☐ Unable to do any legal activity until the date scheduled by Department of Land
☐ No liability

3.3 Objective of loan request of real estate
☐ For working capital
☐ Invest in permanent assets e.g., building, etc.
☐ Invest in commercial shop for dept
☐ for child’s education

4. Economic and general situation
<table>
<thead>
<tr>
<th>Program</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Inverse of raw material price</td>
<td></td>
</tr>
<tr>
<td>2. Inverse of petroleum price</td>
<td></td>
</tr>
<tr>
<td>3. Wage</td>
<td></td>
</tr>
<tr>
<td>4. State policy</td>
<td></td>
</tr>
<tr>
<td>5. laws about loan</td>
<td></td>
</tr>
<tr>
<td>6. Election</td>
<td></td>
</tr>
<tr>
<td>7. Change of currency rate</td>
<td></td>
</tr>
</tbody>
</table>

5. Guarantee
   3.1 Land details
   Title deed no..............................................................
   Area .......................................................... Rai..........................Ngan..................Sq.Wah
   District (For the case of locating in Chiang Mai)
   □ Mueang       □ Sansai
   □ Doi saket    □ Maerim
   □ Maetaeng     □ Sankamphaeng
   □ Saraphi      □ Hangdong
   □ Sanpatong    □ Chaiprakan
   □ Chomthong    □ Phrao
   District (For the case of locating in Lumphun)
   □ Mueang       □ Banthi
   □ Wiangnonglong
   Price evaluated by Department of Landamounting ........THB

3.2 Location of site
   □ Correct and matched the and title
   □ Unmatched the land title

3.3 Characteristics of land
   □ Square       □ Rectangle
   □ Trapezoid    □ Triangle
   □ Polygon      □ Curve
   □ Others

3.4 Land condition
   □ Fill the entire land   □ Fill some plots
   □ Unfilled          □ Deep hole
   □ Fish pond        □ Digging
   □ Pool             □ Slove
   □ Others

3.5 Land utilization
   □ Residence        □ Commerce
   □ Factory          □ Farm
   □ Farm             □ Rice farm
   □ Garden           □ Others

3.6 Land transportation
   □ Concrete road    □ Pavement
   □ Dirt road        □ Soil road
   □ Concrete soi     □ Pavement soi
   □ Personal road    □ Servitude road
   □ Land soi         □ Large walk way
   □ No entrance

3.7 Size of road/soi
- Less than 1 m  □ 1.01-2 m
- 2.01-3.00 m  □ More than 3 m

3.8 Two-way road
□ Yes  □ No

3.9 Land environment
□ Commercial area  □ Residence area
□ Factory area  □ Slum
□ Near/next to temple  □ Near/next to tomosque
□ Near/next to shrine  □ Near/next to cemetery
□ Near/next to dirt  □ Near/next to educational
□ Near/next to high voltage  □ Near/next to large billboard
□ Near/next to military camp  □ Near/next to airport

3.10 Tendency of land growth
□ Very growing  □ Already grown
□ Average  □ Going to grow
□ Non-growing

Type of building (In the case of building)

3.11 Number of floors
□ 1 floor  □ 2 floors
□ 3 floors  □ More than 3 floors

3.12 Lower floor (first floor)
□ Concrete  □ Parque
□ Wood

3.13 Top floor (other floors)
□ Concrete  □ Parque
□ Wood

3.14 Wall type
□ Bricks  □ Bricks/woods

3.15 Roof structure
□ Concrete  □ Steel
□ Wood

3.16 Roof
□ Concrete  □ Roof top
□ Galvanized iron/Tile

3.17 Number of building
□ 1  □ 2
□ More than 2

3.18 Progress of building
□ 25%  □ 50%
□ 75%  □ 100%

3.19 Duration of construction
□ Less than 5 years
□ More than 5 years but not over 10 years
□ More than 10 years

Thank you all for spending your time to answer the questionnaire for the benefit of the researcher's research.

References
2. Booms, B.; Bitner, M. Marketing Strategies and Organization Structures for Service Firms; Marketing of Service: Chicago, IL, USA, 1981.


