

BANK ACCOUNT FRAUD DETECTION MODEL

THAGOON PICHITSURAKIJ

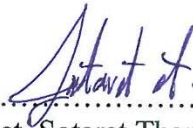
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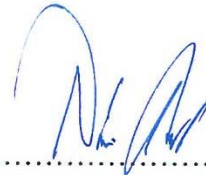
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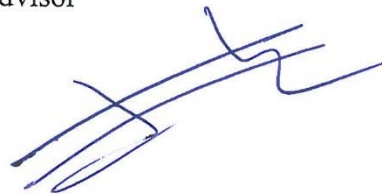
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ABSTRACT

The research is to determine the bank account fraud detection models by a sequential rule-based approach based on the 2015-2016 historical fraud data. There were 4 scammer behavior formats: Juristic Trading Email Scam, Personal Trading Email Scam, Personal Non-Delivery Advance Free Scam and Personal Romance Scam. To determine the significant factors for analysis, the following information were considered: the customer profiles and the transaction behaviors under 3 stages of the behavior (open bank accounts, deposit money to account and withdrawal of the money). All the significant factors considered in the study matched more than 70% of the account fraud.

The analysis result found that the account fraud behavior related to Juristic Trading Email Scam showed 12 significant factors. The main behaviors of scammers were to withdraw the money (deposited from overseas) via a branch in Thailand and their initial amount in opening an account was less than or equal to 2,000 baht. The account fraud behavior related to Personal Trading Email Scam showed 14 significant factors. The main behaviors of scammers were to withdraw the money (deposited from overseas) via the branch and ATM in Thailand, deposited a certain amount (which is more than the individual's monthly income) every month and their educational level is below Bachelor's degree. The account fraud behavior related to Personal Non-Delivery Advance Free Scam showed 16 significant factors. The main behaviors of scammers were to withdraw the money (deposited from overseas) via ATM and branch in Thailand, deposited a certain amount (which is more than the individual's monthly income) every month and their educational level is below Bachelor's degree. The account fraud behavior related to Personal Romance Scam showed 13 significant factors. The main behaviors of scammers were to withdraw the money (deposited from domestic and overseas) via ATM in Malaysia, deposited a certain amount (which is more than the individual's monthly income) every month and their educational level is below Bachelor's degree.

**KEY WORDS: ACCOUNT FRAUD / NIGERIA SCAM / RULE-BASED MODEL / FRAUD
DETECTION / SWIFT TRANSFER**

56 pages

แบบจำลองการตรวจจับการเปิดบัญชีเพื่อรองรับการทุจริต

BANK ACCOUNT FRAUD DETECTION MODEL

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บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อกำหนดรูปแบบการตรวจจับพฤติกรรมมิฉฉาชีพที่ใช้บัญชีของธนาคารเพื่อเป็นเครื่องมือในการทำทุจริต โดยใช้ข้อมูลบัญชีที่ได้รับการยืนยันเป็นบัญชีทุจริตที่พบโดยธนาคารพาณิชย์ตัวอย่างในปี 2558 – 2559 นำมาวิเคราะห์พฤติกรรมตามลักษณะการทุจริต 4 รูปแบบ ดังนี้ 1.Trading Email Scam กรณีเปิดบัญชีในนามนิติบุคคล 2.Trading Email Scam กรณีเปิดบัญชีในนามบุคคล 3.Non-Delivery Advance Fee Scam กรณีเปิดบัญชีในนามบุคคล และ 4.Romance Scam กรณีเปิดบัญชีในนามบุคคล โดยกำหนดเป็นปัจจัยหลักในการวิเคราะห์ คือ ช่องทางการทำธุรกรรมถอนเงิน สถานที่ที่ทำธุรกรรมถอนเงิน จำนวนเงินที่ทำธุรกรรมถอนเงิน ช่องทางการทำธุรกรรมฝากเงิน สถานที่ที่ทำธุรกรรมฝากเงิน จำนวนเงินที่ทำธุรกรรมฝากเงิน รายได้ การศึกษา ยอดเงินเปิดบัญชี และสถานที่เปิดบัญชี ภายใต้ว 3 ขั้นตอนการใ้บัญชี คือ ขั้นตอนเปิดบัญชี ขั้นตอนฝากเงินเข้าบัญชี ขั้นตอนถอนเงินจากบัญชี ด้วยวิธีการวิเคราะห์ผลปัจจัยที่มีนัยสำคัญที่ละปัจจัยด้วยเปอร์เซ็นต์ความสอดคล้องไปในทิศทางเดียวกันของทุกบัญชีภายใต้รูปแบบเดียวกันมากกว่า 70% ขึ้นไป

ผลการวิจัยสรุปได้ว่า Trading Email Scam กรณีเปิดบัญชีในนามนิติบุคคลมีปัจจัยที่มีนัยสำคัญจำนวน 12 ปัจจัย และมีรูปแบบพฤติกรรมหลักคือ ถอนเงินผ่านทางสาขาในประเทศไทย ก่อนหน้ามีเงินฝากเข้าจากต่างประเทศ เปิดบัญชีด้วยยอดเงินน้อยกว่า 2,000 บาท Trading Email Scam กรณีเปิดบัญชีในนามบุคคลมีปัจจัยที่มีนัยสำคัญจำนวน 14 ปัจจัย และมีรูปแบบพฤติกรรมหลักคือ ถอนเงินผ่านช่องทางสาขาและ ATM ในประเทศไทย ก่อนหน้ามีเงินฝากเข้าจากต่างประเทศ ด้วยยอดฝากต่อเดือนมากกว่ารายได้ต่อเดือน และเปิดบัญชีด้วยวุฒิการศึกษาต่ำกว่าปริญญาตรี Non-Delivery Advance Fee Scam กรณีเปิดบัญชีในนามบุคคลมีปัจจัยที่มีนัยสำคัญจำนวน 16 ปัจจัย และมีรูปแบบพฤติกรรมหลักคือ ถอนเงินผ่านช่องทาง ATM ในประเทศไทย ก่อนหน้ามีเงินฝากเข้าจากต่างประเทศ ยอดเงินฝากต่อเดือนมากกว่ารายได้ต่อเดือน และการศึกษาต่ำกว่าปริญญาตรี Romance Scam กรณีเปิดบัญชีในนามบุคคลมีปัจจัยที่มีนัยสำคัญจำนวน 13 ปัจจัย และมีรูปแบบพฤติกรรมหลักคือ ถอนเงินผ่านช่องทาง ATM ในประเทศมาเลเซีย มีเงินฝากเข้าจากประเทศไทย และจากต่างประเทศ ยอดเงินฝากต่อเดือนมากกว่ารายได้ต่อเดือน การศึกษาต่ำกว่าปริญญาตรี

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CHAPTER I

INTRODUCTION

1.1 Principle and Rationale

In Thailand, the Financial Industry has been considered as a significant sector to drive national economic development, because it is the intermediary to mobilize the capitals from investors or capitalists. They provide the beneficial savings interest to the investors who will have to pay loan capital interest. This will affect financial stability and national economic growth ultimately. Banking businesses are the main business of financial industry in Thailand. The main products and services consist of:

- 1) Credit products: such as credit card, personal loan, mortgage loan, SME loan, and corporate loan.
- 2) Non-credit products and services: such as savings and current accounts, international money transfer, and debit cards.

However, banking businesses, as the main business of Thailand's financial industry, struggle and affects financial industry on the whole. Particularly, the fraud by the professional thievery affects the banks financial and the organizational reputation. The customers will also be affected, and the national financial stability that is controlled by Bank of Thailand, as well as the national security that the banks might be perceived as money laundry sources and terrorism support by Anti-Money Laundering Office (AMLO).

The fraud occurred by commercial banks are normally products of the bank which primarily are;

- 1) Bank account fraud
- 2) Card issuing fraud
- 3) Digital banking fraud
- 4) Lending fraud
- 5) Merchant acquiring fraud

The bank account fraud is currently carried out by an African professional thievery group called Nigeria Scams [1,2] that are not being necessarily on the lookout for by many Thai commercial banks because the banks themselves are not direct victims. Direct victims are the ones who are scammed to transfer money to fraudulent bank account at specific banks. That may cause distrust to customers. Nevertheless if the victims complain to AMLO and they inspect and find out that the fraudulent account has suspicious transactions according to Anti-Money Laundering Office Act (5th edition) 2015 [3] and the bank has not reported the suspicious transactions according to Anti-Money Laundering Office 1-03 to AMLO, it will result in a finable offence by AMLO as of not following the regulation which causes direct loss to the banks.

Therefore, this research is to study about customer profile at open bank account stage and fraudulent account's transaction behavior at deposit and withdraw stage by using Sequential Rule-based Fraud Detection Model which is easy-to-understand and step-by-step for set the rule-based in Fraud Detection System to reduce risk of the banks to be fined or sued by Anti-Money Laundering Office and to reduce fraud loss in account fraud category. The analysis of the causes will improve the monitoring scheme to suspicious transactions and to increase customers' trust. The result of this study can also be knowledge for financial industry in terms of preventing this type of fraud.

1.2 Objective of study

To determine the Sequential Rule-based Fraud Detection Models from the historical data at bank account fraud.

1.3 A scope of study

- 1) This study is to observe the beneficial bank accounts fraud only.
- 2) This study is to observe the opening bank account stage, deposit to bank account stage, and withdraw from bank account stage only.

3) This study is to observe the bank account fraud behavior of Nigeria Scams only.

1.4 Expected benefit

1) To detect thievery transaction by Nigeria Scams in order to prevent and reduce bank account fraud loss.

2) To act upon Anti-Money Laundering Office's policies.

3) To produce knowledge that can guide an operational improvement to reduce other types of fraud loss to the bank.

CHAPTER II

LITERATURE REVIEW

This chapter will be discussed about the theory and related research. For the theory is divided into four parts. There are the commercial banks in Thailand, the behavior of Nigeria Scams Account Fraudulent and Rule-based expert systems. And at the end of the research is the part of related research which can be summarized as the following details:

2.1 Information and details of the bank's operations in Thailand.

This section discusses the background of the demand (Need) of commercial bank, responsibility, business structure and products of commercial bank in Thailand.

2.1.1 The evolution and history of commercial bank in Thailand

Period 1 from year 1855 to year 1941, [4,5,6].The banking system in Thailand started after Thailand made the trade treaty with the Great Britain called “Bowring Treaty” in year 1855, included with continuing to do the same trade treaty with France, Portugal, Netherland and Russia. After that there are 300 – 400 Break-bulk carriers from aboard came to Thailand, the European merchant used their coins for purchasing item. However Thai merchant did not accept their coins, so they took the coins from other country exchange to Bullet coin at Treasury. When there was a lot of business in Thailand, Handmade Bullet coin was not enough. Then the King Rama 5 ordered the machine for producing flat round coins from Great Britain and used it instead of Bullet coin. It becomes lower in the Economy system and finally was missing.

During the reign of King Rama 5, the country turned into a civilization in all aspects. Such as the country management, health, education, transportation, law,

Emancipation Proclamation, improve the taxation system, separate the royal wealth of kings out of the drive and replacing the levy system is drafted. These were effected to the economy and trade of the country which growth up rapidly. As a result, there were many demands for the currency in the country, including with the demand for financial institutions to facilitate the trade for both domestic and international business in the areas of lending, transferring and billing of exchange. When the demands increased, then the European asked the permission to establish Royal Bank of Siam for processing the financial instead of Thai government to collect the tax and print the bank note for others organization. However the Minister of Foreign Affairs presented the proposal that such a proposal is not beneficial in many respects for the country, so the Royal Bank of Siam was not established at that time. In the same year, private banks or commercial banks have filed for operation. This was not about financial for the government, but it would set up to facilitate the currency exchange and billing of exchange and deposit money and loan for international business. The HSBC from Great Britain was the first Commercial Bank in Thailand, they provided the service such as money deposit-withdraw, loan, currency exchange and transfer the money to other countries. After that there were many bank opened in Thailand, in 1894 established Charter Bank of India Australia and China from Great Britain and in 1896 established Banque de l'Indo-China from France. These banks were opened only in Bangkok or only the province where the bank interested, so the banking system is not designed to spread lending, investment and other services to local. After that in the year 1897, Mr. Duke Marie de Jong has submitted the proposal for establishing the Royal State Bank of Siam. And in year 1898, the bank executives in Denmark (Copenhagen) have submitted the proposal for establishing the Siam Commercial Bank as well. However, they were refused. In year 1906 established The Siam Commercial Bank Public Company Limited. It was the first Thai commercial bank and there were many banks opened at that time total 7 banks without any branch.

Moreover, in the business of commercial bank provided the new services such as saving money or Deposit reserve assets in year 1910 which encouraged the people to save the money for their necessary situation. The bank also had the money manage their business.

Until the year 1912, the Siam Commercial Bank opened the branch in the same place and later changed to be the Bank of China Siam Ltd. at Ratchawat pier. The Siam Commercial Bank Public Company Limited was the first Thai commercial bank who brought the banking system into the country.

During the year 1909 to 1912, there were no consecutive productivity from rice farming of Thailand, so many rice mills and rice trading in Thailand had to be closed. The volumes of rice exported to overseas decreased sharply as well as the economic recession continued in Thailand many years. In addition, the newly established commercial banks had to be closed also. These situations were increased and impacted to all concerns, and then King Rama VI purposed to find a saving money place for helping his people to save their money for necessary situations. Finally the savings bank was set up for focusing on saving money at March 26, 1912 and controlled by a Financial Ministry of the Treasury.

Period 2 from year 1941 to year 1950, [4,5,6]. During the year 1941, the World War II happened, the Japanese troops moved into Thailand and impacted to the bank branches of Europe. They were temporarily closed because Great Britain, France and America were belligerent with Japan. During that time, there were many banks established in Thailand such as Bangkok Bank (in 1944), Bangkok Bank of Commerce (in 1944), Bank of Ayudhya (in 1945), and Bank of Thailand (in 1945) and there was a long period of expansion in the commercial banking system in Thailand.

Period 3 from year 1950 to year 1994, [4,5,6]. In this era, there was the new commercial banking system in Thailand. The bank's management was efficient and stable, so the people trusted them more. The government used the currency exchange only one rate. There was also issued the Emergency Decree amending the commercial banking Act B.E. 1962 and amending Act B.E. 1985 to allow the operation of a commercial company. For the new bank establishment, the government was very strict, so the banks had expanded the number of stores quickly.

2.1.2 The main function of the commercial bank in Thailand.

The Banks that accept deposits from the public, then take the money to provide loans to those who need funds for business to create growth for the national economy. The banks are unique from other businesses because their product is money as well as the banks must get permission from the Ministry of Finance and the Bank of Thailand before does the business. In addition, they also provide the debit card, billing to exchange, letters of credit issued and etc. when they are allowed by Bank of Thailand [7]

2.1.3 Type of commercial bank in Thailand

The commercial bank in Thailand can divide by 3 major groups [7]

1. Group one; there are 16 commercial banks registered in Thailand as show in the following details:

- Bangkok Bank
- Krung Thai Bank
- Siam Commercial Bank
- Kasikorn Bank
- TMB Bank
- Thanachart Bank
- Bank of Ayudhya
- Tisco Bank
- Kiatnakin Bank
- United Overseas Bank (Thai)
- Standard Chartered Bank (Thai)
- Industrial And Commercial Bank Of China (Thai)
- CIMB Thai Bank
- Land and Houses Bank
- The Thai Credit Retail Bank
- Mega International Commercial Bank

2. Group two; there are 14 commercial banks from other countries which open in Thailand as show in the following details:

- Citibank Thailand
- Deutsche Bank Thailand
- BNP Paribas Thailand
- Mizuho Bank
- JP Morgan Chase Bank
- The Hongkong and Shanghai Banking Corporation (HSBC) Thailand
- Sumitomo Mitsui Banking Corporation (SMBC)
- RHB Bank
- Bank of Tokyo-Mitsubishi UFJ (BTMU)
- Indian Overseas Bank
- Bank of China (Thai)
- The Royal Bank of Scotland N.V.
- OCBC Bank (Thailand)
- Bank of America, N.A.

3. Group three; there are 6 commercial banks which set up for a special responsibility by the government's policy as show in the following details:

- Government Housing Bank
- Islamic Bank of Thailand
- Export-Import Bank of Thailand
- Bank for Agriculture and Agricultural Cooperatives (BAAC)
- Small and Medium Enterprise Development Bank of Thailand

2.1.4 The regulation of commercial banks in Thailand

Banks must be regulated strictly under the rules and regulations of Ministry of Finance and the Bank of Thailand who are responsible for regulating commercial banks by defining policies and guidelines for regulating financial institutions and payment systems to be in concert with the international standard in order to support financial institutions and payment systems to be stable, strong, credible for people, and able to compete in the market, while regulating, auditing,

analyzing the phase of operation, and managing risks of the financial institutions and payment systems effectively and in accordance with the international standards to stabilize the systems of the financial institutions and payment systems. Commercial banks must also comply with the anti-money laundering act (No. 5) B.E. 2558 when reporting transactions in order to prevent terrorist organizations from using commercial banks to launder money or thieves from using commercial banks to violate basic rules. [3,8]

2.1.5 The products of commercial banks

Commercial banks produce a variety of products and financial services in order to serve all groups of customers, which includes credit products and non-credit products and services as follow; [9]

1. Credit products include:

- Credits for individual customers i.e. loans for housing and consumer loans, etc.
- Credits for small enterprises for customers with small businesses with sales volume not more than 100 million Baht per year and total credit facilities not more than 20 million Baht
- Credits for medium enterprises, serving customers with total facilities more than 20 million Baht but not more than 500 million Baht
- Credits for large enterprises, classified into 2 groups; 1) customers with large businesses with sales volume more than 1,000 million Baht and credit facilities more than 500 million Baht, 2) customers with exclusively large businesses who are registered in the stock market in the SET100 group, customers who are multinational companies, and business customers who need more complex credit services and financial services

2. Non-credit products and services

- Financial services, receiving deposits of all kinds, including saving accounts, current accounts, and fixed deposit accounts, from general customers, including individuals, corporations, government sectors, state enterprises, and financial institutions, through a variety of branches and means.
- Financial management is a service to facilitate financial management,

including payment, payment collection, account liquidity management, and information management. This includes guaranteeing and financial consultancy for customers in the government sectors, state enterprises, large businesses, financial institutions, medium businesses, and networks, including individuals through branches and electronic means by unique products and services.

- Supply Chain Financing services, financial management that facilitates in making financial transactions between buyers and suppliers through the bank's electronics in order to increase efficacy and decrease business cost for entrepreneurs who require linking partners in the supply chain.

- International trading services, for customers who import and export, with products and services relating to import, export, and international guarantee, while giving advices in preparing trade documents.

- International money transfer service, for individual customers, corporations, government sectors, and state enterprises, by giving Inward Remittance transfer, Outward Remittance transfer, upon the customer's request.

- Capital market transaction products, immediate and in advance currency trading, government bonds, and private debt instruments, financial derivatives to prevent risks from trading and long-term and short-term interest rates.

- Exchange business services, giving consult in money exchange, answering to all the customer's requirements.

- Investment banking business products, services relating to distribution and guaranteeing arranging and underwriting debt instruments for customers in the private sectors and the government sectors.

- Private banking services are services in complete personal financial planning for customers.

- Bank card services that are used as means for goods/services payments and withdrawing cash from financial accounts through ATM. The banks are alliances of leading card servers, such as VISA, International MasterCard, Union Pay International, etc.

2.2 Bank account fraud pattern of Nigeria Scams gang

Nigeria Scams, known as 419 Scams, are a group of thieves that has created worldwide damages, in a value of hundreds of million US dollars, operating via various means from past to present. The popular means used in nowadays can be summarized as follow: [1,2]

1. Trading Email Scam: The African thieves bought business communication information of import-export companies via email form hackers and watch their prey through emails, sending fake emails about product payments to the import-export partner company to change the account of payment to the account that was registered for the fraud.

2. Non-Delivery Advance Fee Scams: The African thieves made a trading website via E-Commerce, selling products of double a paper, Red Bull drinks, etc., naming the company after the fraud account's owner. When the customer transfers deposit money to the account for fraud, the customer will not receive the products and will no longer be able to contact the website.

3. Romance Scam: The African thieves live in Malaysia while sending chats through emails or social media to Thai or foreign women. They will pretend to be a middle-aged white man and tell a variety of stories, mostly about romance, greed, sympathy, etc. When the prey becomes open to them, they will create a situation that requires the prey to transfer money through a Thai nominee account, withdraw the money in Malaysia, and then terminate any communication with the prey.

2.3 Rule-based expert systems

Rule-based expert system is a problem solving computer program that provides expert level solution, the computer program should be solving for many characteristic of the problem with the knowledge in computer program and the capability should equal to expertise in each field. A rule based expert system consists of the following components: **Figure 2.1**

1. Knowledge Base for collect the knowledge of the require field.
2. Interface Engine is a part of program to analyst the logic by using knowledge base.

3. User Interface is a part for communicate between user and system.
4. Knowledge Acquisition Module is a unit of program for defines the knowledge base.
5. Explanation Module is a part of explant to user for how the final answer can come.

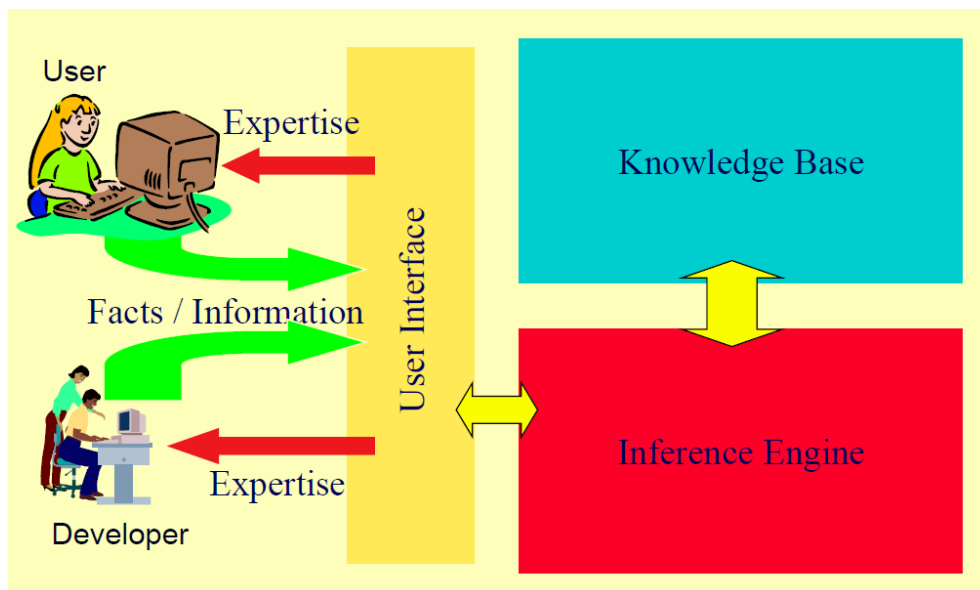


Figure 2.1 Component of Rule-base expertise system [10]

2.4 Related Research

The study of related research about Commercial Bank Nigeria Scams and Decision Tree Model can be summarizing by following.

Aphiranee Theeranantakun [6] The Impact of Financial Free Trade Under World Trade Scope. This research was study of the impact of financial free trade under world trade scope and it shown that economic crisis in 1998 financial institutions in Thailand are weak. It will be an opportunity for foreigner bank to take the operation in Thailand in 2 patterns. Frist, they come to shareholder in Thai commercial bank and come to open foreigner bank branch in Thailand. In term of, the financial ratios of foreigner branch in Thailand are much better than Thai bank because of they use the international standard for management. In the other way, Thailand commercial bank which has foreigner shareholder are in high progress of

liquidity ratio credit quality and higher fund because of they use the international standard for management same as foreigner branch. The result of free trade under WTO was shown that they impact in positive way to foreigner branch more than Thai bank especially the debt management and Thailand commercial bank that has foreigner shareholder are much stronger in fund management.

This research has shown the evolution of banking in Thailand for understand that why all people need the bank and how they are establish.

Jelena Isacenkova, Olivier Thonnard, Andrei Costin, Davide Balzarotti, Aurelien Francillon [1] Inside the SCAM Jungle: A Closer Look at 419 Scam Email Operations. This research study of Nigeria Scam pattern that what and how they use the trick. Especially sending message to the victims by phone number. The result also found that business email and phone number are used in cybercrime.

This research has shown the pattern of Nigeria Scam that what and how they trick the victims.

Supot Pongswatkul [11] The Establishment of Knowledge Management Models for Service Desk by Data Mining Technique Case Study: ABC ICT Solutions. This research study of how to not kept the knowledge by agent centric helpdesk to knowledge sharing. This research using data mining and wage tool for determine the decision tree model for manage the knowledge. The results show that they can reduce 50% of time to answer the client question.

This research has shown that how to determine the decision tree model.

CHAPTER III

RESEARCH METHODOLOGY

This chapter discusses about the methodology and the whole of banking business. There are the history, business structure, and products. Including with the Significance of the research as well as the research methodology and the factors related to the creation of patterns to detect the problems under evaluation and time frame as shown in Figure 3.1.

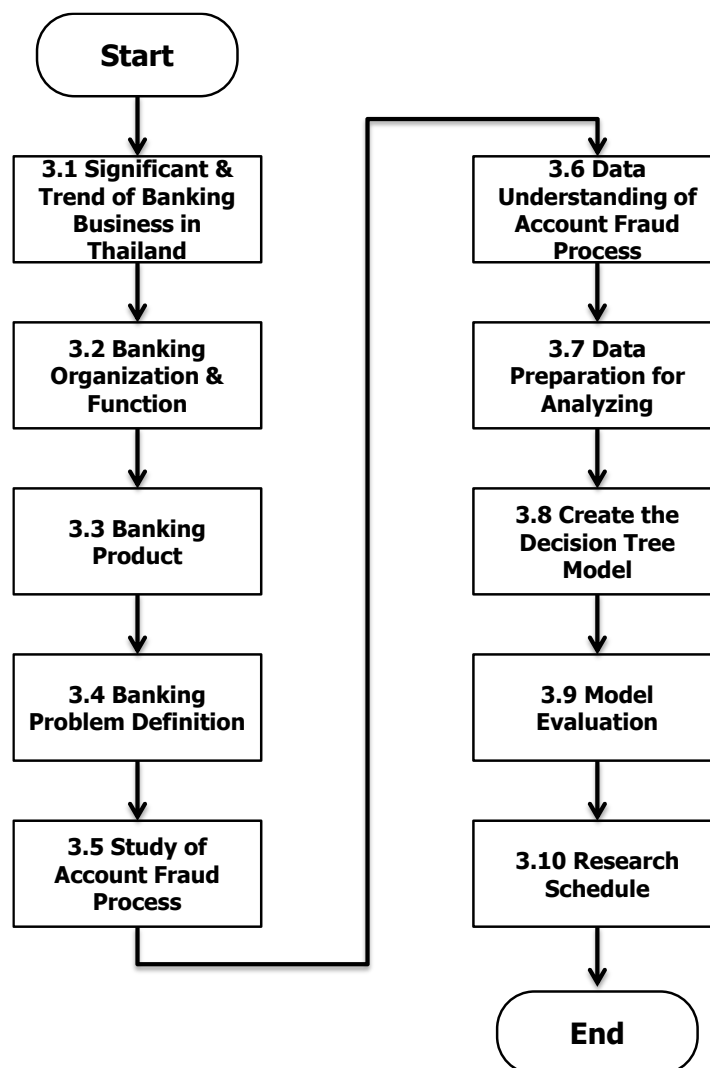


Figure 3.1 Research Methodology.

3.1 Significance & Trend of Banking Business in Thailand

3.1.1 The evolution and significance of commercial bank in Thailand

In topic 2.2.1 the evolution and history of commercial bank in the country can summarize the key events and the needs of commercial bank as shown in **Table 3.1 [1, 2, and 3]**

Table 3.1 The key events and outcomes.

Year	Key events	Outcomes
Before 1855	<ul style="list-style-type: none"> • Domestic Trade • Only 20 Break-bulk carriers from aboard • Used handmade Bullet coin for Barter • People did not accept coins from other countries 	<ul style="list-style-type: none"> • The coins from other countries cannot use in Thailand • Take the coins from other country exchange to Bullet coin at Treasury
In 1855	<ul style="list-style-type: none"> • Thailand made the trade treaty with the Great Britain called “Bowring Treaty” • Continued the trade treaty with France, Portugal, Netherland and Russia • Extended the trade with other countries • 300 – 400 Break-bulk carriers from aboard • Handmade Bullet coin was not enough. 	<ul style="list-style-type: none"> • Purchased the machine for producing flat round coins from Great Britain and used it instead of Bullet coin. The Bullet coin becomes lower in the Economy system and finally was missing

Table 3.1 The key events and outcomes (cont.).

Year	Key events	Outcomes
In 1888 – 1906	<ul style="list-style-type: none"> • Thailand turned into a civilization in all aspects • Economy and Trade of Thailand grew rapidly • Effected to a lot of demands in the currency. • Included a requirement of financial institutions to facilitate the trade, both domestic and international in the areas of lending the money, transferring and billing of exchange 	<ul style="list-style-type: none"> • HSBC from Great Britain was the first Commercial Bank in Thailand, established in 1888 • In 1894 established Charter Bank of India Australia and China from Great Britain • In 1896 established Banque de l'Indo-China from France • In 1906 established The Siam Commercial Bank Public Company Limited. It was the first Thai commercial Bank.
In 1909 - 1912	<ul style="list-style-type: none"> • There were no consecutive productivity from rice farming of Thailand • Many rice mill and rice trading in Thailand need to be closed • The volume of rice exported to overseas decrease sharply. • An Economic recession happened in Thailand • International trade dull in several years. • International trade declined in several years. 	<ul style="list-style-type: none"> • The newly established commercial banks need to be closed • In 1912 the savings bank was set up for focusing on saving money

Table 3.1 The key events and outcomes (cont.).

Year	Key events	Outcomes
In 1941 – 1950	<ul style="list-style-type: none"> • World War II was happened, the Japanese troops moved into Thailand • The Bank Branches of Europe were temporary closed because of Great Britain, France and America were the belligerent with Japan 	<ul style="list-style-type: none"> • Many Banks was established in Thailand such as Bangkok Bank (In 1944), Bangkok Bank of Commerce (In 1944), Bank of Ayudhya (In 1945), Bank of Thailand (In 1945) and there were a long period of expansion in the commercial banking system in Thailand

3.1.2 The analysis of trend in commercial banking business of Thailand

Figure 3.2 found that the total income of the commercial bank in Thailand [12] since year 2011 – 2015 has been increased especially in the year 2011 total revenue 687,076 million Thai Baht, in Year 2012 total income 806,928 million Thai Baht, in the year 2013 total revenue 885,058 million Thai Baht, in the year 2014 total revenue 917,544 million Thai Baht and in the year 2015 total revenue 915,457 million Thai Baht, respectively. While the profits of the banks increase in the same direction. However, in the year 2015, the net profit decline approximately 11% from the year 2014 because of the Non-Performing Loan more increase. This situation happen not only for the borrowers can not settle their account, it is because there are more Fraud protection groups who intend to cheat by loans with the commercial bank. However, if we look at the overall revenue and profits of commercial banks in the Thailand are still in a hundred million baht per year. This shows the strength of the business and the potential to grow in the future.

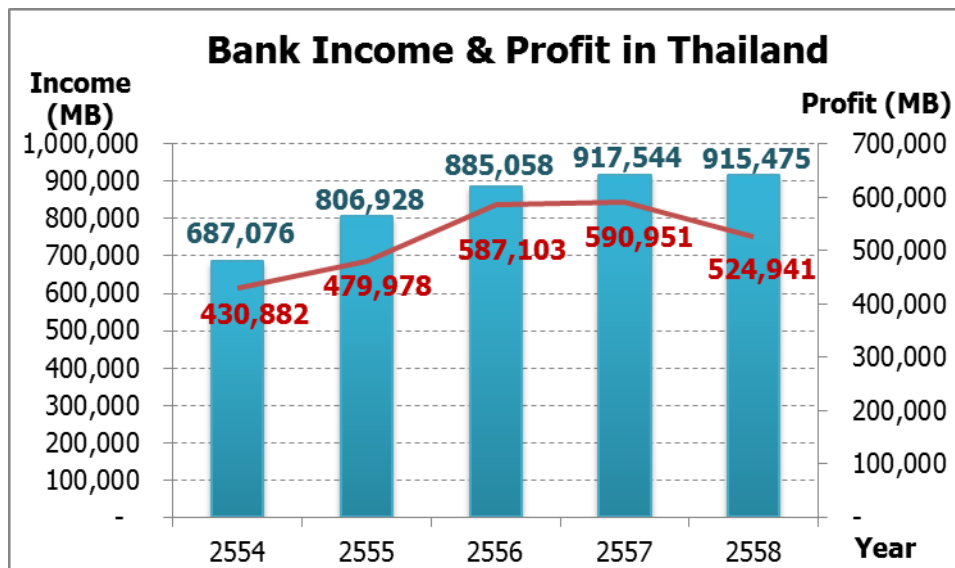


Figure 3.2 The total income of Thailand's commercial bank on the 2011 – 2015.

3.2 Banking Organization & Function

From **Figure 3.3** most of commercial banks divide the administration and management into 9 fields as following detail;

1. Retail Business Division is responsible for providing the service to retail customers such as business transaction service through the branches and loan service.
2. Small and Medium Business Division is responsible for providing loan for SME customers.
3. Corporate Business Division is responsible for providing loan for Large-scale business customers.
4. Audit Division is an independent department who monitor other departments within the bank.
5. Compliance Division is responsible for communicating and controlling the bank process to compliance with the regulator.
6. Risk Division is responsible for managing in every risk aspects of bank such as Operational Risk, Market Risk, Credit Risk, and Fraud Risk.
7. Legal Division is responsible as a lawyer for the bank in case of litigation against the bank.

8. Financial Division is responsible for managing cash flow of the bank and managing the bank account

9. Human Resource Division is responsible for recruiting high potential staffs as well as managing the salary and career path of bank's staffs.

10. Information Technology Division is responsible for servicing the technology to other departments in the bank and ensuring that they can use the effectively technology.

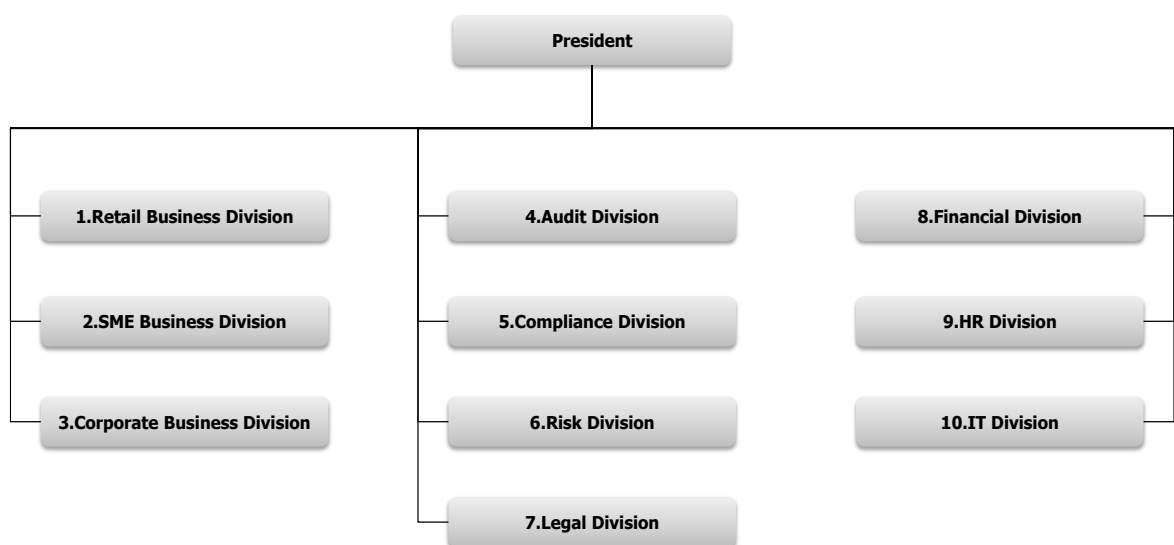


Figure 3.3 Banking Organization & Function.

3.3 Banking Products

From topic 2.1.5 the core product of commercial banks can summarize into products and financial service in the following detail

1. Card Issuing provide the financial services (ATM / EDC / E-Commerce) through debit or credit cards to customers of the bank.

2. Merchant acquiring provide the financial services (ATM / EDC / E-Commerce) through debit or credit cards to merchant.

3. Digital Banking provide the financial services (Deposit / withdrawal / transfer) through the Internet or Mobile Application to customers who have bank account or credit card with the bank.

4. Bank Account provides the financial services to the customers who prefer to deposit money with the bank and they can earn the interests from the bank.

5. Lending provide personal loans, home loans, business loans, small and medium businesses and corporate loans to the customer who prefer.

3.4 Banking Problem Definition

Now there are a lot of competitors for commercial banks, even they provide the same financial services however they did not focus at this point. It is depend on the customer's expectation, especially the customer who concern with the safety and security. Nowadays, the customer start compliant about the security because the rapid growth of technology. Then there is gab during this time for a fraudulent. This research study on fraud problem of the commercial bank by focus on five main products as mentioned earlier.

3.4.1 The Fraud in each banking product

From 5 banking products can summarize the fraud in Thailand as shown in **Table 3.2**.

Table 3.2 Fraud in each banking product.

No.	Product	Fraud
1	Bank Account	419 Scams / Nigeria Scams, Call Center Scams, Russian Hacker, Nominee bank account, online gambling bank account, <i>Money Laundering/ Terrorism</i>
2	Card Issuing	Lost/stolen card, card skimming, the cards were hack data and apply credit card with fake documents

Table 3.2 Fraud in each banking product (cont.).

No.	Product	Fraud
3	Digital Banking	Malware / Trojan, Phishing Email, Phishing Web, Hacking
4	Lending	Loan fraud documents, fraud company using nominee, Application Fraud and Fraud real estate
5	Merchant Acquiring	Merchant collusive, counterfeit card attack, breach of EDC contract

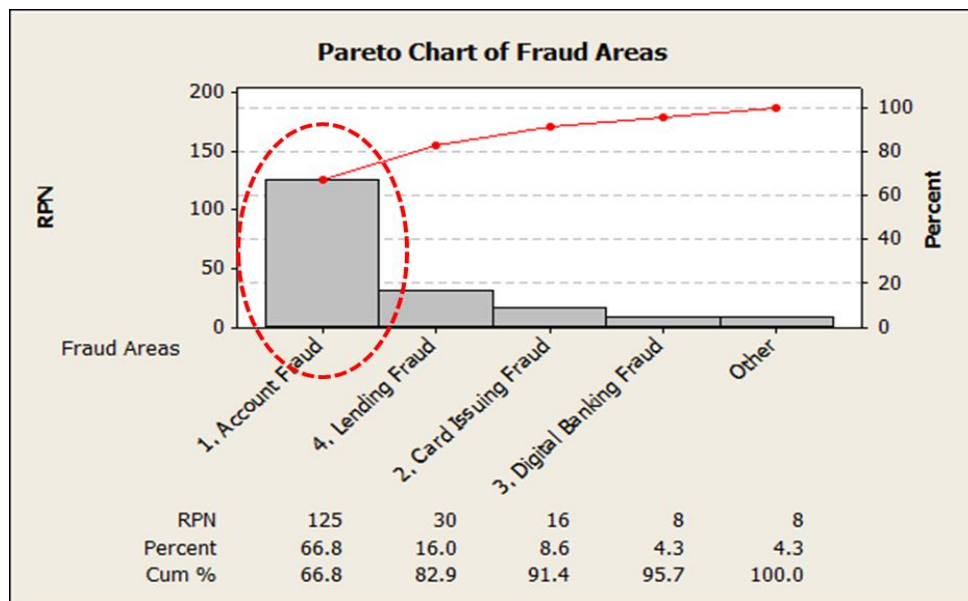
3.4.2 Risk Assessment of fraud in each banking product

The problems of the fraud in each banking product in the Table 3.2 when assessing the risk through the Risk Priority Number by scoring follow the conditions (Appendix). In Table 3.3 showed Account Fraud with the highest risk at 125 score, next one is Lending Fraud 30 score, Card Issuing Fraud 16 score, Digital Banking Fraud 8 score and Merchant Acquiring Fraud 4 score. In the current, Account Frauds damage to the bank customers. The bank has not yet made a monitoring system to detect the problem. However, if there is a complaint to the Anti-Money Laundering, the bank may be fined one million baht per transactions. For the Card Issuing Fraud and Digital Banking Fraud Severity Score has been reduced from 3 score to 2 score because there is the remedy cases of fraud by professional criminals and the customers more be careful, so the score has been reduced.

Table 3.3. Risk Priority Number of fraud for each banking product.

Fraud Problem	Severity	Occurrence	Detection	RPN
1. Account Fraud	5	5	5	125
2. Card Issuing Fraud	3 >> 2	4	1	16
3. Digital Banking Fraud	3 >> 2	2	1	8
4. Lending Fraud	2	5	3	30
5. Merchant Acquiring Fraud	2	2	1	4

Using the score from the Risk Priority Number Assessment to verify by Pareto diagram as shown in **Figure 3.4**, the main fraud problems 66.8% are the Account Fraud. The results conform to the principle of Pareto, the vital few from the trivial many.

**Figure 3.4** Analysis the banking products by Pareto diagram

3.4.2 Type of bank account fraud problem

From Topic 2.2, in Thailand nowadays can summarize the format and number of cases for opening an account for fraudulent activity which study from the sample bank in year 2015 as per the **Table 3.4**

Table 3.4. The number of case for Account Fraud in 2015.

No.	Fraudulent	Fraudulent Activity	Number
1	Nigeria Scams (419 Scams)	Trading Email Scams	251
		Non-Delivery Advance Fee Scams	
		Romance Scams	
2	Call Center Fraud	Call Center Fraud	1
3	Russian Hacker	Hack Internet Banking	2
4	Indian underground banking gang	Underground banking	3

From **Table 3.4** and **Figure 3.4**, the number of cases from Nigeria Scam Fraudulent occurs 251 cases from total 257 cases or 97.7% of Account fraud cases. The results conform to the principle of Pareto, the vital few from the trivial many. There are a lot of Nigeria Scam Fraudulent which are damageable in worldwide move to Thailand by using gap of Immigration Bureau and bank regulation for easy to come to Thailand and using only identification card for open new account. They move here for being the Football Player or English Teacher in order to deceive the victim through the Social Media.

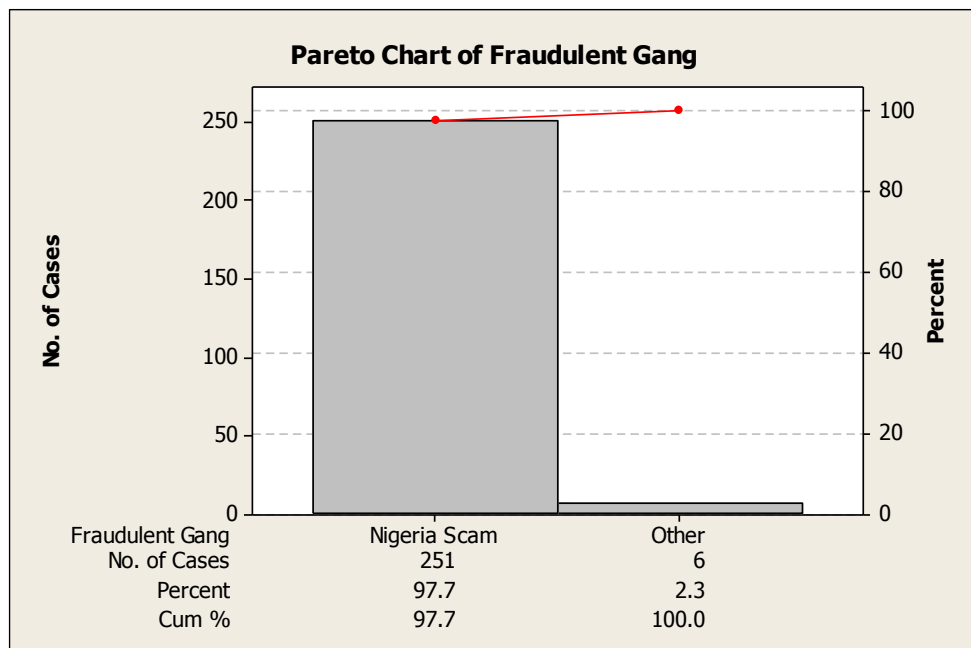


Figure 3.5 Analysis the opening account of fraudulent by Pareto diagram

3.5 Study of bank account fraud tactic by Nigeria Scam gang

The opening an account for fraudulent activity can define by 3 type of bank account fraud, there are 1.Trading Email Scam (Juristic and Personal account) 2.Non-Delivery Advance Fee Scam (Personal Account) 3.Romance Scam (Personal Account) as **Table 3.4**.

The step of Nigeria Scam tactic can be shown in 3 stages. There is open bank account mostly by Thai female nominee, get deposit money from victims who were deceived by a fraudulent and withdraw money from bank account fraud as per **Figure 3.6**

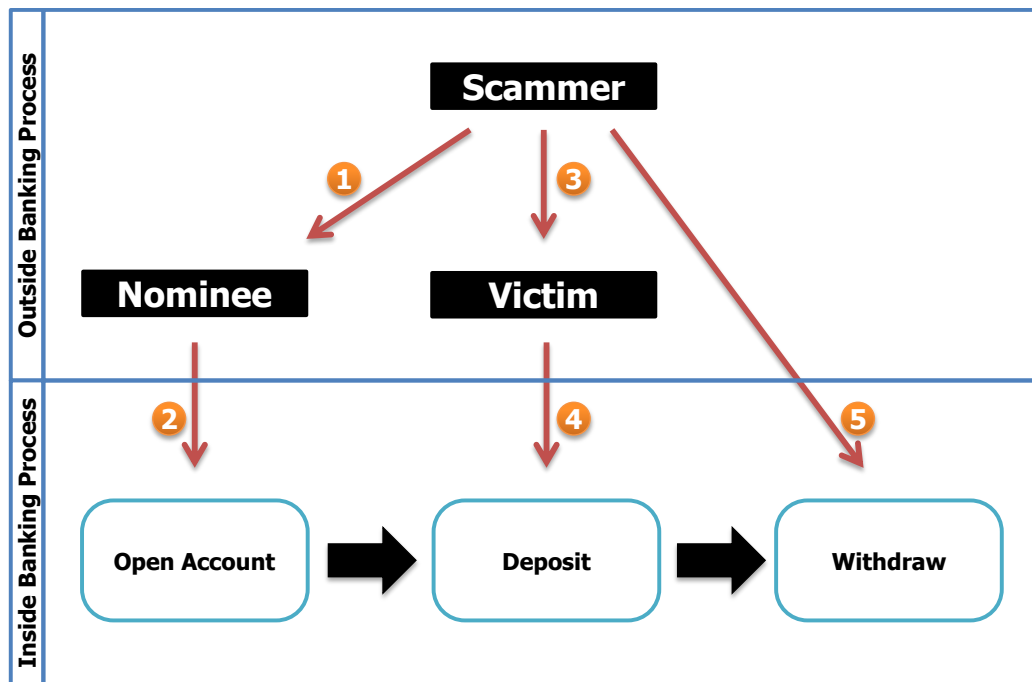


Figure 3.6 Step of Nigeria Scam tactic by 3 stages.

3.6 Data understanding of bank account fraud stage and primary factors

There are 3 stages of Nigeria Scam tactic in the topic 3.5, found that there are main factors in each stage as shown in the **Figure 3.7** and all primary factors of each stage as shown in **Table 3.5, 3.6 and 3.7**

To separate the type of data to 3 parts, there are customer profiles data, transaction data (Txn.) in Thailand and transaction from oversea (Society for Worldwide Interbank Financial Telecommunication; SWIFT).

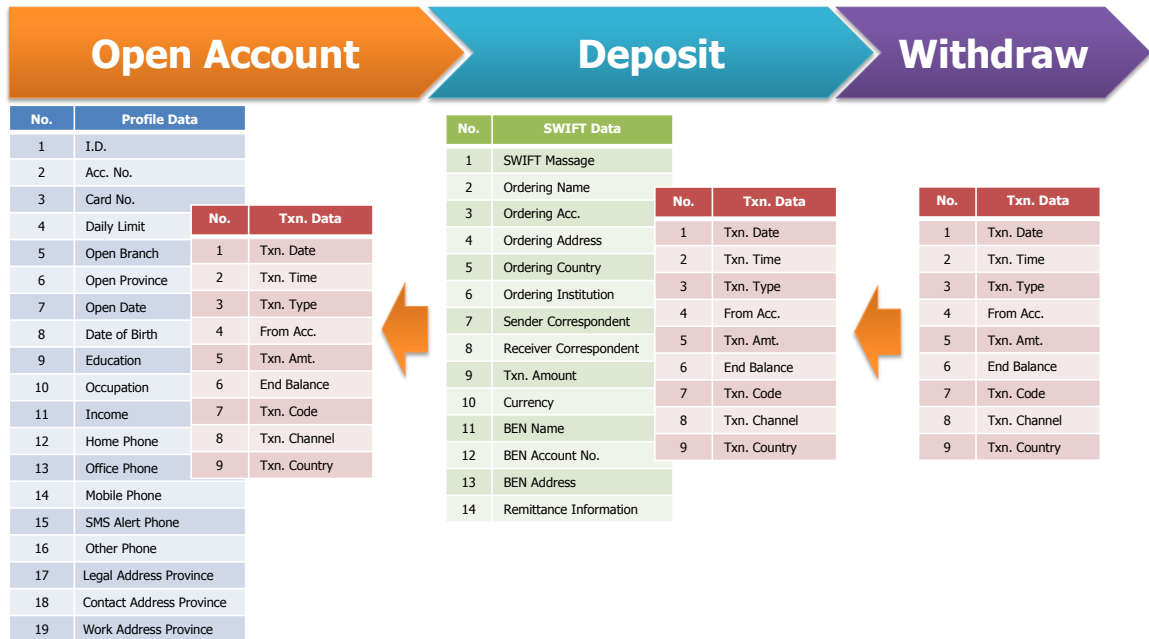


Figure 3.7 Primary factors in each bank account stage.

Table 3.5 Primary factors of the open bank account stage.

No.	Data	Type	Factors
1.	Profile	Non-Financial	I.D.
2	Profile	Non-Financial	Account No.
3	Profile	Non-Financial	Card No.
4	Profile	Non-Financial	Daily Limit
5	Profile	Non-Financial	Open Branch
6	Profile	Non-Financial	Open Province
7	Profile	Non-Financial	Open Date
8	Profile	Non-Financial	Date of Birth
9	Profile	Non-Financial	Education
10	Profile	Non-Financial	Occupation
11	Profile	Non-Financial	Income

Table 3.5 Primary factors of the open bank account stage (cont.).

No.	Data	Type	Factors
12	Profile	Non-Financial	Home Phone
13	Profile	Non-Financial	Office Phone
14	Profile	Non-Financial	Mobile Phone
15	Profile	Non-Financial	SMS Alert Phone
16	Profile	Non-Financial	Other Phone
17	Profile	Non-Financial	Legal Address Province
18	Profile	Non-Financial	Contact Address Province
19	Profile	Non-Financial	Work Address Province
20	Transaction	Financial	Transaction Date
21	Transaction	Financial	Transaction Time
22	Transaction	Financial	Transaction Type
23	Transaction	Financial	Form Account
24	Transaction	Financial	Transaction Amount
25	Transaction	Financial	End Balance
26	Transaction	Financial	Transaction Code
27	Transaction	Financial	Transaction Channel
28	Transaction	Financial	Transaction Country

Table 3.6 Primary factors of the deposit stage.

No.	Data	Type	Factors
1	Transaction	Financial	Transaction Date
2	Transaction	Financial	Transaction Time
3	Transaction	Financial	Transaction Type
4	Transaction	Financial	Form Account
5	Transaction	Financial	Transaction Amount
6	Transaction	Financial	End Balance
7	Transaction	Financial	Transaction Code
8	Transaction	Financial	Transaction Channel

Table 3.6 Primary factors of the deposit stage (cont.).

No.	Data	Type	Factors
9	Transaction	Financial	Transaction Country
10	SWIFT	Financial	SWIFT Message
11	SWIFT	Financial	Ordering Name
12	SWIFT	Financial	Ordering Account
13	SWIFT	Financial	Ordering Address
14	SWIFT	Financial	Ordering Country
15	SWIFT	Financial	Ordering Institution
16	SWIFT	Financial	Sender Correspondent
17	SWIFT	Financial	Receiver Correspondent
18	SWIFT	Financial	Transaction Amount
19	SWIFT	Financial	Currency
20	SWIFT	Financial	BEN Name
21	SWIFT	Financial	BEN Account No.
22	SWIFT	Financial	BEN Address
23	SWIFT	Financial	Remittance Information

Table 3.7 Primary factors of the withdraw stage.

No.	Data	Type	Factors
1	Transaction	Financial	Transaction Date
2	Transaction	Financial	Transaction Time
3	Transaction	Financial	Transaction Type
4	Transaction	Financial	Form Account
5	Transaction	Financial	Transaction Amount
6	Transaction	Financial	End Balance
7	Transaction	Financial	Transaction Code
8	Transaction	Financial	Transaction Channel
9	Transaction	Financial	Transaction Country

3.7 Data preparation & secondary factors for analyzing

Studying of the factors in bank account fraud stage as summarize in the primary factors, then prepare the secondary factors for analyzing the rule-based fraud detection models by focus on customer profile (education, occupation, income and open branch etc.) at open bank account stage and fraudulent account's transaction behavior (channel, location and transaction amount) at deposit and withdraw stage, so can summarize the secondary factors in open bank account stage is 13 factors, deposit stage is 31 factors and withdraw stage is 29 factors, all totally 73 factors for analyzing the rule-based fraud detection models that shown in **Table 3.8, 3.9 and 3.10.**

Table 3.8 Secondary Factors of the open bank account stage.

No.	Dimension	Factors	Formula
1	Profile	Same Open Branch	Sum of same open branch all account
2	Profile	Same Branch Province	Sum of same branch province allaccount
3	Profile	Account Owner Age	N/A
4	Profile	Account Age	N/A
5	Profile	Education	N/A
6	Profile	Income	N/A
7	Profile	Same Legal Address Province	Sum of same legal address province all account
8	Profile	Same Contact Address Province	Sum of same contact address Province all account
9	Profile	Same Office Address Province	Sum of same office address province all account
10	Profile	Same Mobile Phone	Sum of same mobile phone all account
11	Profile	Same Office Phone	Sum of same office phone all account
12	Profile	Same SMS Alert Phone	Sum of same sms alert phone all account
13	Profile	1 st Open Account Amount	N/A

Table 3.9 Secondary Factors of the deposit stage.

No.	Dimension	Factors	Formula
1	Amount	Average Deposit Amount per Month	Sum of deposit amount / no. of month
2	Amount	Average Deposit Amount per Month more than Income or Not	Sum of deposit amount / no. of month compare with income
3	Location	% Deposit Txn. From TH	(Sum of deposit txn. From Thailand / sum of all deposit txn.) x 100
4	Location	% Deposit Txn. From Inter	(Sum of deposit txn. From Inter / sum of all deposit txn.) x 100
5	Location	Deposit from TH or Inter	Show TH or Inter Or Both
6	Channel	% Deposit Txn. Via ATM	(Sum of deposit txn. Via ATM / sum of all deposit txn.) x 100
7	Channel	% Deposit Txn. Via Branch	(Sum of deposit txn. Via branch / sum of all deposit txn.) x 100
8	Channel	% Deposit Txn. Via Internet Bank	(Sum of deposit txn. Via Internet Bank / sum of all deposit txn.) x 100
9	Channel	% Deposit Txn. Via SWIFT & BAHTNET	(Sum of deposit txn. Via SWIFT & BAHTNET / sum of all deposit txn.) x 100
10	Channel	% Deposit Txn. Via SWIFT	(Sum of deposit txn. Via SWIFT / sum of all deposit txn.) x 100
11	Channel	% Deposit Txn. Via BAHTNET	(Sum of deposit txn. Via BAHTNET / sum of all deposit txn.) x 100
12	Channel	% Deposit Amount Via ATM	(Sum of deposit amount Via ATM / sum of all deposit amount) x 100

Table 3.9 Secondary Factors of the deposit stage (cont.).

No.	Dimension	Factors	Formula
13	Channel	% Deposit Amount Via Branch	(Sum of deposit amount Via branch / sum of all deposit amount) x 100
14	Channel	% Deposit Amount Via Internet Bank	(Sum of deposit amount Via internet bank / sum of all deposit amount) x 100
15	Channel	% Deposit Amount Via SWIFT & BAHTNET	(Sum of deposit amount Via SWIFT & BAHTNET / sum of all deposit amount) x 100
16	Channel	% Deposit Amount Via SWIFT	(Sum of deposit amount Via SWIFT / sum of all deposit amount) x 100
17	Channel	% Deposit Amount Via BAHTNET	(Sum of deposit amount Via BAHTNET / sum of all deposit amount) x 100
18	Channel	% Deposit Amount Via ATM & Branch & SWIFT & BAHTNET	(Sum of deposit amount Via ATM & Branch & SWIFT & BAHTNET / sum of all deposit amount) x 100
19	Amount	Average Deposit Amount per Day All Channel	Sum of all deposit amount / no. of day
20	Amount	Average Deposit Amount per Day Via ATM	Sum of deposit amount via ATM / no. of deposit day via ATM
21	Amount	Average Deposit Amount per Day Via Branch	Sum of deposit amount via branch / no. of deposit day via branch
22	Amount	Average Deposit Amount per Day Via Internet Bank	Sum of deposit amount via internet bank / no. of deposit day via internet bank

Table 3.9 Secondary Factors of the deposit stage (cont.).

No.	Dimension	Factors	Formula
23	Amount	Average Deposit Amount per Day Via SWIFT & BAHTNET	Sum of deposit amount via SWIFT & BAHTNET / no. of deposit day via SWIFT & BAHTNET
24	Amount	Average Deposit Amount per Day Via SWIFT	Sum of deposit amount via SWIFT / no. of deposit day via SWIFT
25	Amount	Average Deposit Amount per Day Via BAHTNET	Sum of deposit amount via BAHTNET / no. of deposit day via BAHTNET
26	Amount	Average Deposit Amount per Day from TH	Sum of deposit amount in Thailand / no. of deposit day in Thailand
27	Amount	Average Deposit Amount per Day from Inter	Sum of deposit amount from inter / no. of deposit day from inter
28	Remittance	"Paper" in Remittance Information	There is paper in Remittance Information
29	Remittance	"Oil" in Remittance Information	There is oil in Remittance Information
30	Remittance	"Frozen" in Remittance Information	There is frozen in Remittance Information
31	Remittance	"Redbull" in Remittance Information	There is redbull in Remittance Information

Table 3.10 Secondary Factors of the withdraw stage.

No.	Data	Factors	Formula
1	Channel	% Withdraw Txn. Via ATM	(Sum of withdraw txn. Via ATM / sum of all withdraw txn.) x 100
2	Channel	%Withdraw Txn. Via ATM Inter	(Sum of withdraw txn. Via ATM inter / sum of all withdraw txn.) x 100
3	Channel	% Withdraw Txn. Via ATM TH	(Sum of withdraw txn. Via ATM TH / sum of all withdraw txn.) x 100
4	Channel	% Withdraw Txn. Via EDC	(Sum of withdraw txn. Via EDC / sum of all withdraw txn.) x 100
5	Channel	%Withdraw Txn.Via E-Commerce	(Sum of withdraw txn. Via E- Commerce / sum of all withdraw txn.) x 100
6	Channel	% Withdraw Txn. Via Branch	(Sum of withdraw txn. Via branch / sum of all withdraw txn.) x 100
7	Channel	% Withdraw Txn. Via Internet Bank	(Sum of withdraw txn. Via internet bank / sum of all withdraw txn.) x 100
8	Channel	% Withdraw Txn. Via ATM & Branch	(Sum of withdraw txn. Via ATM & brabch / sum of all withdraw txn.) x 100
9	Channel	% Withdraw Amount Via ATM	(Sum of withdraw amount Via ATM / sum of all withdraw amount) x 100
10	Channel	% Withdraw Amount Via ATM Inter	(Sum of withdraw amount Via ATM inter / sum of all withdraw amount) x 100
11	Channel	% Withdraw Amount Via ATM TH	(Sum of withdraw amount Via ATM TH / sum of all withdraw amount) x 100
12	Channel	% Withdraw Amount Via EDC	(Sum of withdraw amount Via EDC / sum of all withdraw amount) x 100

Table 3.10 Secondary Factors of the withdraw stage (cont.).

No.	Data	Factors	Formula
13	Channel	% Withdraw Amount Via E-Commerce	(Sum of withdraw amount Via E-Commerce / sum of all withdraw amount) x 100
14	Channel	% Withdraw Amount Via Branch	(Sum of withdraw amount Via branch / sum of all withdraw amount) x 100
15	Channel	% Withdraw Amount Via Internet Bank	(Sum of withdraw amount Via internet bank / sum of all withdraw amount) x 100
16	Amount	Average Withdraw Amount per Day All Channel	Sum of all withdraw amount / no. of withdraw day
17	Amount	Average Withdraw Amount per Day Via ATM	Sum of withdraw amount via ATM / no. of withdraw day via ATM
18	Amount	Average Withdraw Amount per Day Via ATM Inter	Sum of withdraw amount via ATM inter/ no. of withdraw day via ATM inter
19	Amount	Average Withdraw Amount per Day Via ATM TH	Sum of withdraw amount via ATM TH / no. of withdraw day via ATM TH
20	Amount	Average Withdraw Amount per Day Via EDC	Sum of withdraw amount via EDC / no. of withdraw day via EDC
21	Amount	Average Withdraw Amount per Day Via E-Commerce	Sum of withdraw amount via E-Commerce / no. of withdraw day via E-Commerce
22	Amount	Average Withdraw Amount per Day Via Branch	Sum of withdraw amount via Branch / no. of withdraw day via Branch

Table 3.10 Secondary Factors of the withdraw stage (cont.).

No.	Data	Factors	Formula
23	Amount	Average Withdraw Amount per Day Via Internet bank	Sum of withdraw amount via internet bank / no. of withdraw day via Internet bank
24	Amount	Average Withdraw Amount per Day All Channel TH	Sum of withdraw amount in Thailand / no. of withdraw day in Thailand
25	Amount	Average Withdraw Amount per Day All Channel Inter	Sum of withdraw amount from inter / no. of withdraw day from inter
26	Location	% Withdraw in TH	(Sum of withdraw txn. In TH / sum of all txn.) x 100
27	Location	% Withdraw in Inter	(Sum of withdraw txn. from inter / sum of all txn.) x 100
28	Location	Withdraw Country Rank 1	Count no. 1 withdraw country
29	Location	Withdraw Country Rank is TH or Not	There are TH in withdraw country or not

3.8 Sequential Rule-based Fraud Detection Model

The secondary data which are provided by the assumptions can identify the bank account fraud and build the Nigeria Scam bank account fraud pattern by using sequential rule-based fraud detection model as per the concept as shown in **Figure 3.8**.

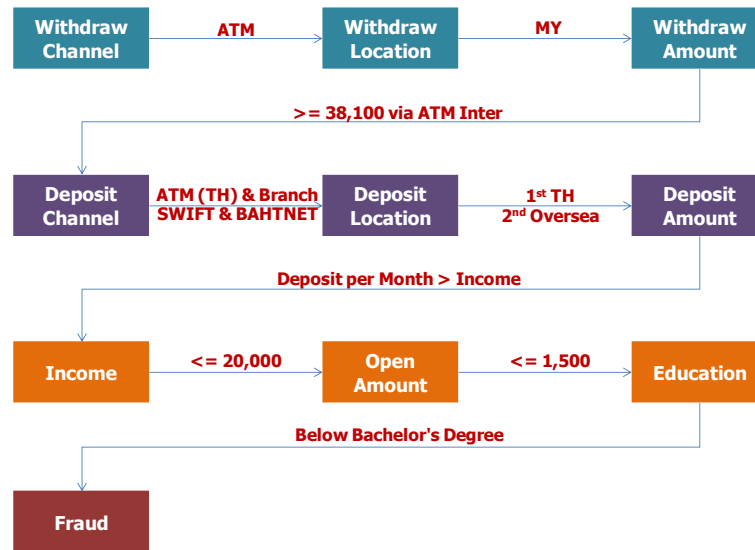


Figure 3.8 Example of Sequential Rule-based Fraud Detection Model.

3.9 Model Evaluation

This research will evaluate the model by expertise in bank account fraud.

3.10 Research Schedule

The researchers plan to take six months from July - December 2016 as shown in Figure 3.9.

No.	Activities	Jul				Aug				Sep				Oct				Nov				Dec			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	Study of Significant & Trend of Banking Business in Thailand	█	█	█	█																				
2	Study of Banking Organization & Function			█	█																				
3	Study of Banking Product					█	█	█	█																
4	Banking Problem Definition									█	█	█	█												
5	Study of bank account fraud tactic by Nigeria Scam gang													█	█	█	█								
6	Data understanding of bank account fraud stage and primary factors																	█	█	█	█				
7	Data preparation & secondary factors for analyzing																					█	█	█	█
8	Create the Sequential Rule-based Fraud Detection Model																								
9	Model Evaluation																								

Figure 3.9 Research plan.

CHAPTER IV

MODELING RESULTS

This chapter discusses about data pre-processing for analysis, analyzing modeling result for each bank account fraud type and discussion of the modeling result.

4.1 Data Pre-Processing

After determine the secondary factors for model analyzing as shown in topic 3.7, then using the data from 73 factors of the bank account which already checked and confirmed that they are bank accounts fraud during year 2015-2016 of the sample bank and plan for data analysis. The data was separated to 4 sets from 73 factors of account fraud type by depends on the hypotheses which are different behavior as following detail:

1. The data for account fraud Juristic Trading Email Scam type, there are 10 sample accounts which were confirmed during year 2015-2016.
2. The data for account fraud Personal Trading Email Scam type, there are 13 sample accounts which were confirmed during year 2015-2016.
3. The data for account fraud Personal Non -Delivery Advance Free Scam type, there are 36 sample accounts which were confirmed during year 2015-2016.
4. The data for account fraud Personal Romance Scam type, there are 152 sample accounts which were confirmed during year 2015-2016.

Analysts 73 factors by 3 stages, there are withdraw stage, deposit stage and open bank account stage. The sample data of secondary factors shown in **Table 4.1**, in the analysis use 211 accounts by separate as above mentioned and focus on the factors that concern with channel, location and transaction amount for transaction data in withdraw stage and deposit stage, while the customer profile data for open bank

account stage such as 1st open account amount, income, education, branch and province.

Table 4.1 The sample data of secondary factors from data preparation.

No.	Stage	Factors	A/C 1	A/C 2	A/C 3	A/C 4
1	Open	Same Open Branch	1	7	1	2
2	Open	Same Branch Province	33	53	1	4
3	Open	Account Owner Age	13,537	11,370	15,621	11,685
4	Open	Account Age	85	29	55	300
5	Open	Education	Below Diploma	Below bachelor's degree	Below Diploma	Below Diploma
6	Open	Income	5,000	60,000	0	60,000
7	Open	Legal Address Province	14	6	1	2
8	Open	Same Contact Address Province	30	8	7	2
9	Open	Same Office Address Province	29	12	7	2
10	Open	Same Mobile Phone	1	1	1	1
11	Open	Same Office Phone	1	#N/A	#N/A	#N/A
12	Open	Same SMS Alert Phone	1	1	1	1
13	Open	1st Open Account Amount	2000	800	800	1000
14	Deposit	Average Deposit Amount per Month	150,395.97	317,870.00	100,562.50	75,881.63
15	Deposit	Average Deposit Amount per Month more than Income or Not	Deposit/Moth > Income	Deposit/Moth > Income	Deposit/Moth > Income	Deposit/Moth > Income
16	Deposit	% Deposit Txn. From TH	50%	88%	100%	94%
17	Deposit	% Deposit Txn. From Inter	50%	13%	0%	6%
18	Deposit	Deposit from TH or Inter	Both	Both	TH	Both
19	Deposit	% Deposit Txn. Via ATM	38%	63%	60%	59%
20	Deposit	% Deposit Txn. Via Branch	13%	25%	30%	34%
21	Deposit	% Deposit Txn. Via Internet Bank	0%	0%	10%	0%
22	Deposit	% Deposit Txn. Via SWIFT & BAHTNET	50%	13%	0%	6%
23	Deposit	% Deposit Txn. Via SWIFT	25%	13%	0%	3%
24	Deposit	% Deposit Txn. Via BAHTNET	25%	0%	0%	3%
25	Deposit	% Deposit Amount Via ATM	31%	5%	25%	23%
26	Deposit	% Deposit Amount Via Branch	0%	1%	66%	45%
27	Deposit	% Deposit Amount Via Internet Bank	0%	0%	9%	0%
28	Deposit	% Deposit Amount Via SWIFT & BAHTNET	69%	95%	0%	33%
29	Deposit	% Deposit Amount Via SWIFT	29%	95%	0%	24%

Table 4.1 The sample data of secondary factors from data preparation. (cont.).

No.	Stage	Factors	A/C 1	A/C 2	A/C 3	A/C 4
30	Deposit	% Deposit Amount Via BAHTNET	40%	0%	0%	9%
31	Deposit	% Deposit Amount Via ATM & Branch & SWIFT & BAHTNET	100%	100%	91%	100%
32	Deposit	Average Deposit Amount per Day All Channel	75,197.99	136,230.00	50,281.25	26,266.72
33	Deposit	Average Deposit Amount per Day Via ATM	139,000.00	8,822.00	20,290.00	8,669.44
34	Deposit	Average Deposit Amount per Day Via Branch	2,000.00	2,900.00	88,600.00	30,481.50
35	Deposit	Average Deposit Amount per Day Via Internet Bank	-	-	35,000.00	-
36	Deposit	Average Deposit Amount per Day Via SWIFT & BAHTNET	77,546.98	903,700.00	-	111,034.82
37	Deposit	Average Deposit Amount per Day Via SWIFT	65,973.99	903,700.00	-	160,742.14
38	Deposit	Average Deposit Amount per Day Via BAHTNET	89,119.98	-	-	61,327.50
39	Deposit	Average Deposit Amount per Day from TH	47,000.00	3,907.33	47,963.33	13,050.31
40	Deposit	Average Deposit Amount per Day from Inter	77,546.98	903,700.00	-	111,034.82
41	Deposit	"Paper" in Remittance Information	0	0	0	0
42	Deposit	"Oil" in Remittance Information	0	0	0	0
43	Deposit	"Frozen" in Remittance Information	0	0	0	0
44	Deposit	"Redbull" in Remittance Information	0	0	0	0
45	Withdraw	% Withdraw Txn. Via ATM	98%	76%	100%	100%
46	Withdraw	% Withdraw Txn. Via ATM Inter	68%	71%	97%	18%
47	Withdraw	% Withdraw Txn. Via ATM TH	31%	6%	3%	82%
48	Withdraw	% Withdraw Txn. Via EDC	0%	0%	0%	0%
49	ithdraw	% Withdraw Txn. Via E-Commerce	0%	0%	0%	0%
50	ithdraw	% Withdraw Txn. Via Branch	2%	0%	0%	0%
51	ithdraw	% Withdraw Txn. Via Internet Bank	0%	24%	0%	0%
52	ithdraw	% Withdraw Txn. Via ATM & Branch	100%	76%	100%	100%

Table 4.1 The sample data of secondary factors from data preparation. (cont.).

No.	Stage	Factors	A/C 1	A/C 2	A/C 3	A/C 4
53	Withdraw	% Withdraw Amount Via ATM	83%	96%	100%	100%
54	Withdraw	% Withdraw Amount Via ATM Inter	48%	96%	100%	19%
55	Withdraw	% Withdraw Amount Via ATM TH	35%	0%	0%	81%
56	Withdraw	% Withdraw Amount Via EDC	0%	0%	0%	0%
57	Withdraw	% Withdraw Amount Via E-Commerce	0%	0%	0%	0%
58	Withdraw	% Withdraw Amount Via Branch	17%	0%	0%	0%
59	Withdraw	% Withdraw Amount Via Internet Bank	0%	4%	0%	0%
60	Withdraw	Average Withdraw Amount per Day All Channel	58,716.45	43,520.47	56,728.12	21,116.41
61	Withdraw	Average Withdraw Amount per Day Via ATM	55,448.02	41,735.47	56,728.12	18,853.94
62	Withdraw	Average Withdraw Amount per Day Via ATM Inter	55,959.03	55,480.63	66,099.47	20,422.04
63	Withdraw	Average Withdraw Amount per Day Via ATM TH	54,766.67	500.00	500.00	18,513.04
64	Withdraw	Average Withdraw Amount per Day Via EDC	-	-	-	-
65	Withdraw	Average Withdraw Amount per Day Via E-Commerce	-	-	-	-
66	Withdraw	Average Withdraw Amount per Day Via Branch	81,595.50	-	-	-
67	Withdraw	Average Withdraw Amount per Day Via Internet bank	-	7,140.00	-	-
68	Withdraw	Average Withdraw Amount per Day All Channel TH	27,272.43	1,528.00	100.00	3,702.61
69	Withdraw	Average Withdraw Amount per Day All Channel Inter	55,959.03	55,480.63	66,099.47	20,422.04
70	Withdraw	% Withdraw in TH	32%	29%	3%	82%
71	Withdraw	% Withdraw in Inter	68%	71%	97%	18%
72	Withdraw	Withdraw Country Rank 1	India	Malaysia	Malaysia	Malaysia
73	Withdraw	Withdraw Country Rank is TH or Not	Not TH	Not TH	Not TH	TH

4.2 Modeling Result

After collection data align with the determining factors of 4 sets from 3 types and 4 formats of bank account fraud, filter by one factor at a time from the total 73 factors. All the significant factors consider in the study match at least 70% of the account fraud or it is the highest percentage in each group of fraudulent behaviors in case of less than 70%. Using all significant factors determine the rule-based fraud detection models.

4.2.1 Juristic Trading Email Scam

This study uses 73 factors of the confirming account fraud Juristic Trading Email Scam type total 10 accounts to find the significant factors. The results show by behavior sequences, starting from the withdrawal, depositing and opening bank account as shown in Table 4.2.

Table 4.2 The significant factors of Juristic Trading Email Scam.

No.	Factor	Condition	%Matching	Dimension
1	% Withdraw Txn. Via Branch	100%	100%	Channel
2	% Withdraw in Thailand	100%	100%	Location
3	Withdraw Country Rank 1	TH	100%	Location
4	Withdraw Country Rank is Thailand or Not	Yes	100%	Location
5	Average Withdraw Amount per Day Via Branch	$\geq 250,000$	70%	Amount
6	Deposit from Thailand or Inter	Both	100%	Location
7	Average Deposit Amount per Month more than Income or Not	Deposit/Moth > Income	90%	Amount
8	% Deposit Amount Via SWIFT & BAHTNET	$\geq 96\%$	60%	Channel
9	% Deposit Amount Via SWIFT	$\geq 94\%$	60%	Channel
10	Income/Capital Registered	1,000,000	90%	Profile
11	1st Open Account Amount	$\leq 2,000$	90%	Profile
12	Same Branch Province	≥ 2 (BKK)	80%	Profile

The results of this analysis show 12 significant factors for the model of Juristic Trading Email Scam sequential rule-based fraud detection. The Nigeria Scams withdraw the money via the branch in Thailand. They withdraw the money at least 250,000 baht/day, deposit from oversea via SWIFT, deposit amount more than the company's capital, the company's capital equal to 1,000,000 Baht, 1st opening account amount less than or equal to 2,000 baht, and opening account at Bangkok branches as shown in the rule-based fraud detection model in **Figure 4.1**.

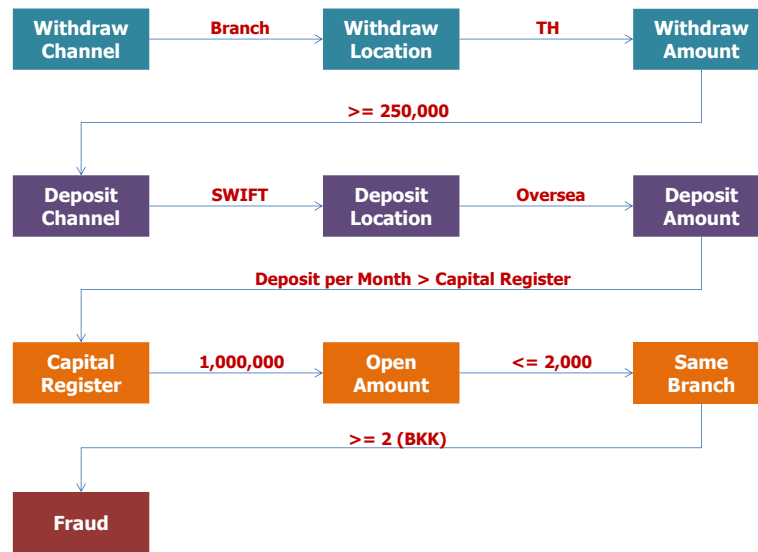


Figure 4.1 Juristic Trading Email Scam sequential rule-based fraud detection model.

4.2.2 Personal Trading Email Scam

This study uses 7 3 factors of the confirming account fraud Personal Trading Email Scam type total 13 accounts to find the significant factors. The results show by behavior sequence, starting with withdrawal, depositing and opening bank account as shown in **Table 4.3**

Table 4.3 The significant factors of Personal Trading Email Scam.

No.	Factor	Condition	%Matching	Dimension
1	% Withdraw in Thailand	100%	92%	Location
2	Withdraw Country Rank 1	TH	92%	Location
3	Withdraw Country Rank is Thailand or Not	Yes	92%	Location
4	% Withdraw Amount Via ATM Thailand & Branch	>=93%	92%	Channel
5	% Withdraw Txn. Via ATM Thailand	>=66%	69%	Channel
6	% Withdraw Amount Via Branch	>=53%	54%	Channel
7	Average Withdraw Amount per Day Via ATM Thailand	>=4,100	77%	Amount
8	Average Withdraw Amount per Day Via Branch	>=5,800	69%	Amount
9	Average Deposit Amount per Month more than Income or Not	Deposit/Moth > Income	100%	Amount
10	Deposit from Thailand or Inter	Both	92%	Location
11	% Deposit Amount Via SWIFT & BAHTNET	>=75%	77%	Channel
12	Income	>= 20,000	92%	Profile
13	Education	Below Bachelor's Degree	85%	Profile
14	1st Open Account Amount	<=1,530	77%	Profile

The results of this analysis show 14 significant factors for the model of Juristic Trading Email Scam sequential rule-based fraud detection. The Nigeria Scams withdraw the money via the branch and ATM in Thailand. They withdraw the money via ATM at least 4,100 baht/day, withdraw the money via the branch at least 5,800 baht/day, deposit from oversea via SWIFT& BAHTNET, deposit amount per month more than the income, income less than or equal to 20,000 baht and their educational level is below Bachelor’s degree, and 1st opening account amount less than our equal to 1,530 baht as shown in the rule-based fraud detection model in **Figure 4.2**

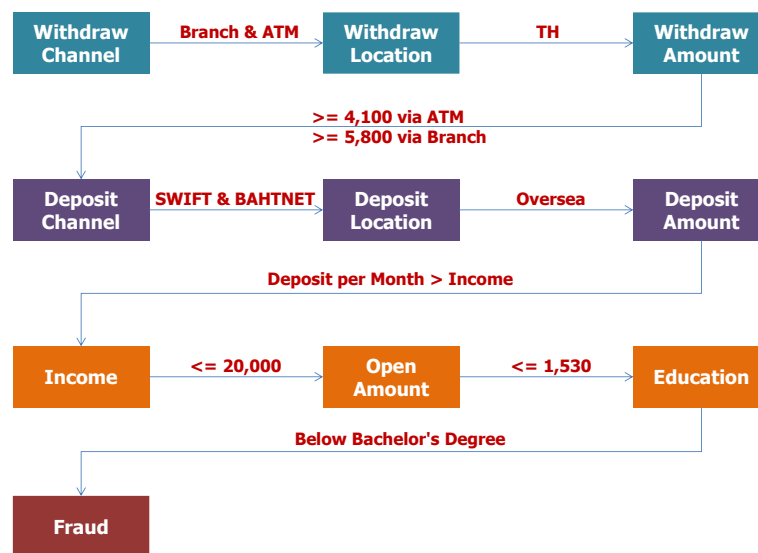


Figure 4.2 Personal Trading Email Scam sequential rule-based fraud detection model.

4.2.3 Personal Non-Delivery Advance Fee Scam

This study uses 7 3 factors of the confirming account fraud Personal Trading Email Scam type total 3 6 accounts to find significant factors. The results show by behavior sequence, starting with withdrawal, depositing and opening bank account as shown in **Table 4.4**

Table 4.4 The significant factors of Personal Non -Delivery Advance Free Scam.

No.	Factor	Condition	%Matching	Dimension
1	Withdraw Country Rank is Thailand or Not	TH	97%	Location
2	Withdraw Country Rank 1	TH	92%	Location
3	% Withdraw in Thailand	> 96%	89%	Location
4	% Withdraw Amount Via ATM & Branch	> 97%	83%	Channel
5	% Withdraw Txn. Via ATM & Branch	> 92%	72%	Channel
6	% Withdraw Amount Via ATM	> 88%	75%	Channel
7	% Withdraw Txn. Via ATM	> 89%	72%	Channel
8	Average Withdraw Amount per Day Via ATM Thailand	$\geq 8,070$	72%	Amount
9	Average Deposit Amount per Month more than Income or Not	Deposit/Moth > Income	100%	Amount
10	Deposit from Thailand or Inter	Both	89%	Location
11	%Deposit Amount Via SWIFT & BAHTNET	> 61%	61%	Channel
12	Average Deposit Amount per Day Via SWIFT & BAHTNET	> 28,000	72%	Amount
13	Same Branch Province	≥ 3 (BKK, Khon kaen, Chonburi, Roi et)	75%	Profile
14	1st Open Account Amount	$\leq 1,500$	81%	Profile
15	Education	Below Bachelor's Degree	75%	Profile
16	Income	$\leq 20,000$	75%	Profile

The results of this analysis show 16 significant factors for the model of Personal Non -Delivery Advance Free Scam sequential rule-based fraud detection. The Nigeria Scams withdraw the money via ATM and branch in Thailand. They withdraw the money via ATM at least 8,070 baht/day, deposit from oversea via SWIFT& BAHTNET average amount less than or equal to 28,000 baht/day, deposit amount per month more than the income, income less than or equal to 20,000 baht and their educational level is below Bachelor's degree, and 1st opening account amount less than our equal to 1,500 baht as shown in the rule-based fraud detection model in **Figure 4.3**

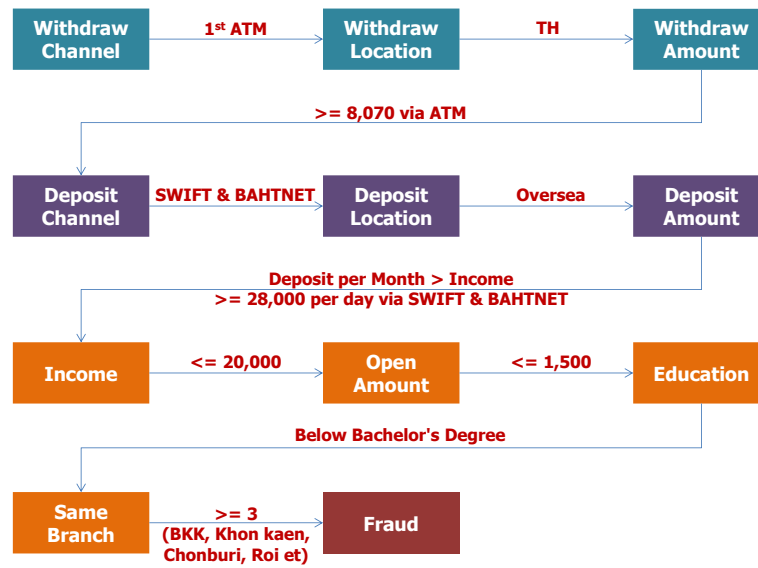


Figure 4.3 Personal Non-Delivery Advance Free Scam sequential rule-based fraud detection model.

4.2.4 Personal Romance Scam

This study uses 73 factors of the confirming account fraud Personal Trading Email Scam type total 152 accounts to find the significant factors. The results show by behavior sequence, starting with withdrawal, depositing and opening bank account as shown in Table No.4.5

Table 4.5 The significant factors of Personal Romance Scam.

No.	Factor	Condition	%Matching	Dimension
1	% Withdraw Txn. Via ATM & Branch	>=98%	89%	Channel
2	% Withdraw Amount Via ATM	>=94%	88%	Channel
3	% Withdraw Txn. Via ATM	>=96%	84%	Channel
4	% Withdraw Amount Via ATM Inter	>= 81%	74%	Channel
5	Average Withdraw Amount per Day Via ATM Inter	>= 38,100	70%	Amount
6	Withdraw Country Rank 1	MY	88%	Location
7	Withdraw Country Rank is Thailand or Not	Not TH	86%	Location
8	Average Deposit Amount per Month more than Income or Not	Deposit/Moth > Income	98%	Amount
9	% Deposit Amount Via ATM & Branch & SWIFT & BAHTNET	>= 90%	91%	Channel
10	% of Deposit Txn. From Thailand	>= 86	73%	Location
11	Education	Below Bachelor's Degree	88%	Profile
12	Income	<= 20,000	86%	Profile
13	1st Open Account Amount	<= 1,500	70%	Profile

The results of this analysis show 13 significant factors for model of Personal Romance Scam sequential rule-based fraud detection. The Nigeria Scams withdraw the money via ATM in Malaysia. They withdraw the money via ATM at least 38,100 baht/day, major deposit from domestic and follow with the deposit from overseas via ATM & Branch & SWIFT & BAHTNET. In addition, the deposit amount per month more than the income, income less than or equal to 20,000 baht and their educational level is below Bachelor’s degree and 1st opening account amount less than or equal to 1,500 baht as shown in the rule-based fraud detection model in **Figure 4.4**

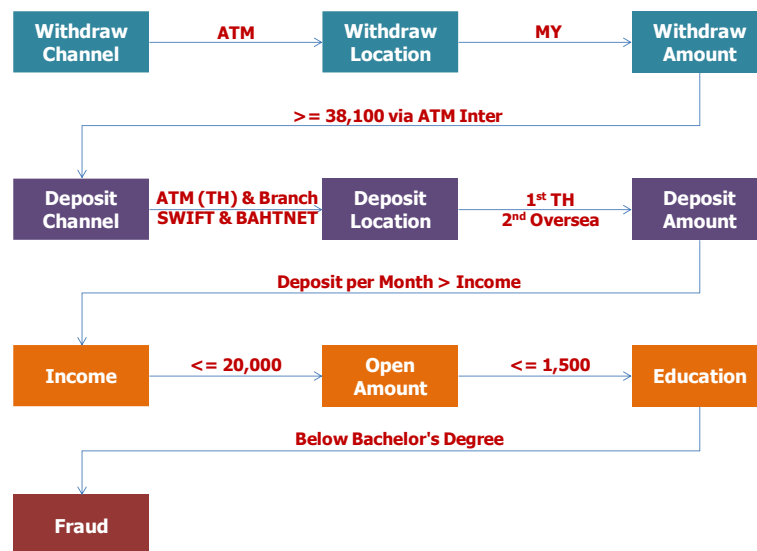


Figure 4.4 Personal Romance Scam sequential rule-based fraud detection model.

4.3 Discussion

The 4 rule-based fraud detection models from analysis are created by significant factors of transaction and customer profile behaviors by focus on channel, location and amount. These models are easy when using for the detection. If the behavior match as above mentioned, it will be the high potential for bank account fraud. In term of the performance of models, the results of significant factors align with Nigeria Scams behavior. In the study match at least 70% of the account fraud or it is the highest percentage in each stage.

In this studying, use only the bank account fraud data. There is no any data for non-account fraud, so cannot summarize the percentage fraud, percentage non-fraud, percentage false positive and percentage false negative of models by using the data science. In addition, this studying did not cut the trial withdrawn and deposit behavior before using as an account fraud, the trial amount are lower than usual so the result in amount aspect for withdraw and deposit are incorrect from fact as well as effect to channel aspect for withdrawn because of the trial always use the ATM channel.

The format behavior of the account fraud owner can be the victims were deceived for using the bank account, can be the nominee to open bank account or can be part of Nigeria Scam, so the some part results of profile data are incorrect from fact. The Nigeria Scam contact them by online, the victims who were deceived are always the people who have good education. While the nominees for opening bank account are the people who have low education.

In some scenario the detection criteria may not be align with all 3 step, it can align with 2 step in depositing and opening new bank account step for preventing of bank account fraud loss but percent of matching fraud might be less than 3 step.

CHAPTER V

SUMMARY & SUGGESTION

This chapter discusses about the research summary of bank account fraud problem that causes by 419 Scam or Nigeria Scam and how to detect their behavior by determine bank account fraud models. Also the suggestion and research limitation.

5.1 Research Summary

This research study about the background of commercial bank in Thailand that now they facing with fraud problems in their 5 major products, there are Bank Account Fraud, Card Issuing Fraud, Digital Banking Fraud, Lending Fraud and Merchant Acquiring Fraud.

From the fraud risk assessment, found that now the highest risk priority number is Bank Account Fraud which have a combination of severity, occurrence and detection totally is 125 scores. If the commercial bank which was regulate by the regulator (AMLO, BOT) cannot check, control and detect bank account fraud from the fraudulent then they might need to pay for a fine. Moreover, the commercial bank might be loss their reputation when the receive complaint from victims.

Now, the commercial bank found that they are 4 group of account fraud. There are Nigeria Scam, Chinese Call Center Scam, Russian Hacker and Underground Banking. For the data in year 2015-2016, the top group of bank account fraud is Nigeria Scam which is 97.7%, so this research focuses on the Nigeria Scam behavior. By studying their using bank account behavior, found that they have 3 steps of the behavior, there are open bank accounts, deceit the victim deposit or transfer the money and withdrawn the money. As mentioned, then design the analyzing data through their behavior. In the open bank account stage study the profile of person who opens bank account like education, income, 1st open account amount, deposit amount, branch and province. In part of the bank transaction, study about channel, location and transaction

amount in deposit and withdraw stage which can summarize to 73 significant factors. Using the confirm Nigeria scam's bank account fraud by separate to 4 formats behavior, there are Juristic Trading Email Scam type 10 accounts, Personal Trading Email Scam type 13 accounts, Personal Non -Delivery Advance Free Scam type 36 accounts and Personal Romance Scam type 152 accounts to analyst for finding the factors that match with channel, location and amount in each format behavior. Addition, match withdrawn stage and deposit stage as well as the profile data for open bank account stage, by consider the significant factors matching percentage of account fraud. If the percentage is more than or equal to 70% or less than 70% however, they are the highest percentage in group of channel or location and it is not lower than 50%, so we can summarize as they are significant factors for Nigeria Scam behavior as show in **Table 5.1**.

From **Table 5.1** found that there are 12 significant factors of account fraud behavior Juristic Trading Email Scam type, the Nigeria Scam withdrawing the money via the branch in Thailand. They withdraw the money more than or equal to 250,000 baht/day, deposit from oversea via SWIFT, deposit amount more than the company's capital. The company's capital equal to 1,000,000 Baht, 1st open account amount less than or equal to 2,000 baht and most of the branches located in Bangkok.

From **Table 5.1** found that there are 14 significant factors of account fraud behavior Personal Trading Email Scam type, the Nigeria Scam withdrawing the money via the branch and ATM in Thailand. They withdraw the money via ATM more than or equal to 4,100 baht/day, withdraw the money via the branch more than or equal to 5,800 baht/day, deposit from oversea via SWIFT& BAHTNET, deposit amount per month more than the income, income less than or equal to 20,000 baht with education lower than bachelor's degree and 1st open account amount less than our equal to 1,530 baht.

From **Table 5.1** found that there are 13 significant factors of account fraud behavior Personal Non -Delivery Advance Free Scam type, the Nigeria Scam withdraw the money mainly via ATM in Thailand. They withdraw the money via ATM more than or equal to 8,070 baht/day, deposit from oversea via SWIFT& BAHTNET average amount less than or equal to 28,000 Baht and the deposit amount per month more than income, income less than or equal to 20,000 Baht, 1st open

account amount less than our equal to 1,500 baht with the education lower than bachelor's degree and most of them open accounts in Bangkok, Khonkaen, Chonburi and Roiet.

From **Table 5.1** found that there are 13 significant factors of account fraud behavior Personal Romance Scam type, the Nigeria Scam withdrawing the money via ATM in Malaysia. They withdraw the money via ATM more than or equal to 38,100 baht/day, deposit in domestic via ATM & branch and follow with the deposit from oversea via SWIFT & BAHTNET. In addition, the deposit amount per month more than income, income less than or equal to 20,000 baht and 1st open account amount less than our equal to 1,500 baht with education lower than bachelor's degree.

Table 5.1 Sequential rule-based fraud detection model.

No.	Account Fraud type	No. of Factors	Withdraw			Deposit			Open Account			
			Channel	Location	Amount	Channel	Location	Amount	Income / Capital Registered	Open Amount	Education	Same Branch Province
1	Juristic Trading Email Scam	12	Branch	TH	>= 250,000 per Day	SWIFT	Oversea	Deposit per Mth > Capital Registered	1 M	<= 2,000	>= 2 (Bkk)	
2	Personal Trading Email Scam	14	Branch & ATM	TH	>= 4,100 @ ATM per Day or >= 5,800 @ Branch per Day	SWIFT & BAHTNET	Oversea	Deposit per Mth > Income	<= 20,000	<= 1,530		Below Bachelor's Degree
3	Personal Non-Delivery Advance Fee Scam	13	ATM	TH	>= 8,070 per Day	SWIFT & BAHTNET	Oversea	Deposit per Mth > Income & >= 28,000 per Day	<= 20,000	<= 1,500	>= 3 (Bkk, Khonkean, Chonburi, Ro-iet)	Below Bachelor's Degree
4	Personal Romance Scam	13	ATM	MY	>= 38,100 per Day	ATM (TH) & Branch & SWIFT & BAHTNET	1st TH 2nd Oversea	Deposit per Mth > Income	<= 20,000	<= 1,500		Below Bachelor's Degree

5.2 Contribution

This research can use the rule-based fraud detection models to be a guideline for detect the Nigeria Scam who use the bank account for fraudulent activities as per it is predicate offences by the Anti-Money Laundering Act. Including with the bank can reduce the number of customer who will be the victims. Moreover, the bank also can manage their business follow with the regulation of regulator (AMLO and BOT) as well as reduce the opportunity to pay a fine when found big number of bank account fraud.

For the process after detect the Nigeria Scam behavior by technically fraud detection system can be automatic block the bank account but under the BOT regulation the bank cannot block customer bank account before acknowledge for the abnormal behavior to the customer first.

5.3 Limitation and Suggestion

There are quite limited amount of confirmed account fraud in term of Juristic Trading Email Scam and Personal Trading Email Scam in year 2015-2016 from sample bank for studying the behavior and creating the model, it is only 10 and 13 accounts accordingly. Even though, the percentage of matching fraud in each significant factor, the average is more than 70%.

The only fraud data were used for this bank account fraud analysis model, there is no not-fraud data so cannot summarize the percentage fraud, percentage non-fraud, percentage false positive and percentage false negative of models by using the data science.

This research did not cut the trial withdrawn and deposit behavior before using as an account fraud, the trial amount are lower than usual so the result in Amount aspect for withdrawn and deposit are incorrect from fact as well as effect to channel aspect for withdrawn because of the trial always use the ATM channel.

The format behavior of the account fraud owner can be the victims were deceived for using the bank account, can be the nominee to open bank account or can be part of Nigeria Scam, so the some part results of profile data are incorrect from fact. The Nigeria Scam contact them by online, the victims who were deceived are

always the people who have good education. While the nominees for opening bank account are the people who have low education.

Besides, this research determined only the format behavior of Nigeria Scam. If can add the similar behavior account data but it is not the fraud account data to analyst in the model, it will help more to identify the behavior between Criminal gang and Non-criminal gang. Example, the personal account of the people who work in Malaysia in case of Personal Romance Scam, general account which is open for export and import business in case of Juristic or Personal Trading Email Scam and general account which is open for personal online business in case of Non-Delivery Advance Free Scam. In addition, if can add more sample account, the model will get more trust. Lastly, also can use the significant factors about channel, location and Amount for analysis criminal behavior in others commercial bank's products in case of cheating by transaction.

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APPENDIX

Appendix A.1 Criteria of severity score for RPN.

Severity	Level
Fine or law enforce by the regulator	5
Warring by the regulator	4
Impact to the customer	3
Impact to the bank	2
No significant impact	1

Appendix A.2 Criteria of occurrence score for RPN.

Occurrence	Level
Occur more than 101 time/year	5
Occur 31 – 100 time/year	4
Occur 11 – 30 time/year	3
Occur 4 – 10 time/year	2
Occur 0 – 3 time/year	1

Appendix A.3 Criteria of detection score for RPN.

Detection	Level
No Detection	5
Detect manually by human	4
Detect manually by human with equipment and tools	3
Detect by batch alert system and human	2
Detect by real time or near real time alert system and human	1

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