PROCESS IMPROVEMENT OF HOUSING LOAN PRODUCT IN THAILAND COMMERCIAL BANK

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เนื่องจากการปฏิรูปหรือเปลี่ยนแปลงที่เกิดจากการประยุกต์ใช้เทคโนโลยีดิจิตอลและโมเดลธุรกิจแบบใหม่ (Digital Disruption)ได้กลายเป็นปัจจัยสำคัญที่กระตุ้นการเปลี่ยนแปลงของธุรกิจในปัจจุบันรวมถึงธุรกิจธนาคาร เพื่อตอบสนองต่อการเปลี่ยนแปลงพฤติกรรมของลูกค้าอย่างรวดเร็วและสามารถแข่งขันได้ระหว่างคู่แข่ง งานวิจัยนี้มีวัตถุประสงค์เพื่อปรับปรุงกระบวนการธุรกิจของผลิตภัณฑ์สินเชื่อเพื่อที่อยู่อาศัยในธนาคารพาณิชย์แห่งหนึ่งในประเทศไทย ซึ่งดำเนินกระบวนการแบบดำเนินด้วยตนเองและกระบวนการกระดาษซึ่งถือว่าเป็นสาเหตุหลักของคอขวดในกระบวนการสินเชื่อ และมีวัตถุประสงค์เพื่อลดระยะเวลาดำเนินการในกระบวนการ โดยเจาะลึกถึงรายละเอียดของกระบวนการเพื่อแสดงให้เห็นความสูญเสียหรือกิจกรรมที่ไม่เพิ่มมูลค่าด้วยการนำเอาแนวคิดและเครื่องมือแบบลีน (Lean) ที่เหมาะสมและหาแนวทางที่เป็นไปได้ในการประเมินเพื่อปรับปรุง

เครื่องมือแบบลีนที่เรียกว่าการวิเคราะห์แผนภูมิสายธารแห่งคุณค่า (Value Stream Mapping) ถูกใช้เป็นเครื่องมือหลักในแนวทางปฏิบัติของงานวิจัยนี้ โดยหลังจากที่มีการนำแผนภูมิดังกล่าวมาปรับใช้ในการวิเคราะห์สถานะปัจจุบันของกระบวนการ พบว่าของเสียส่วนใหญ่เกิดจากการรอคอยที่ยาวนานและเวลาในการสืบค้นที่ยาวนานซึ่งเกิดจากงานที่ไม่เป็นระเบียบและกระบวนการแบบเดิมที่ไม่มีความต่อเนื่อง ดังนั้นจึงมีการพิจารณาวิธีแก้ปัญหาจากแนวคิดแบบลีนด้วยการลดความซับซ้อนและเพิ่มความคล่องตัวของกระบวนการ การทำให้กระบวนการเป็นมาตรฐาน อีกทั้งการนำแนวคิดของการเปลี่ยนแปลงทางดิจิทัลในอุตสาหกรรมการธนาคารในรูปแบบของการเสนอระบบใหม่ที่เป็นระบบอัตโนมัติ

หลังจากที่มีการนำเสนอระบบใหม่ในกระบวนการสินเชื่อที่อยู่อาศัย พบว่าระยะเวลารอคอยสินค้าสั้นลงด้วยความสามารถหลักจากระบบใหม่ที่มีการตรวจสอบเครดิตบูโรอิเล็กทรอนิกส์ และการจัดการกับการตัดสินใจของสินเชื่อแบบอัตโนมัติที่สามารถปรับปรุงและลดรอบเวลาได้ดีกว่าเดิม 62.3% ในขั้นตอนคัดกรองของกระบวนการซึ่งส่งให้ระยะเวลารอคอยสินค้าสั้นลงจากเดิม 11 วันเหลือ 6 วัน จึงบ่งบอกได้ว่าการปรับปรุงกระบวนการให้เป็นดิจิทัลสามารถส่งผลให้กระบวนการมีประสิทธิภาพ ราบรื่น และตอบสนองต่อการเปลี่ยนแปลงอย่างรวดเร็วของธุรกิจธนาคารได้อย่างเหมาะสม

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According to digital disruption has become key factor that stimulates changing in business nowadays including banking business. To respond through rapid change in customer behavior and become competitive among rivals, this research is aimed to improve business process of housing loan product in one of commercial banks in Thailand which is mainly operated in manual operation and paper process and believed to be main symptoms of bottleneck in lending process.

The main objective of this research is to reduce lead time of housing loan business by going through the detail of business process to reveal wastes or non-value-added activities using appropriate lean tools and find possible solution to assess for improvement. By approach of lean tool known as Value Stream Mapping that being used as a key tool in research methodology, it revealed that majority of wastes were from long waiting time and long query time causing from unneccesary tasks and noncontinuous of traditional process. Therefore, possible solution from lean concept including method of simplifying and streamling of process and standardization were considered.

In addition, gathering with the concept of digital transformation in banking industry which were also revealed as the final solution in the form of new system implementation that was conducted in the studied bank, it showed improvement in shorter lead time by contribution of key capabilities from the new system implementation including electronic credit bureau check, automated credit decision management. The result revealed 62.3% improvement from reduction of cycle time in pre-screening stage that contributed lead time to reduce from 11 days to 6 days which can imply that by enhancement of transforming the process to be digitalized, it can contribute the process to be more efficient, seamless, and respond to the rapid changing in banking business decently.

Field of Study:	Engineering Management	Student's Signature .....
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1. Introduction

1.1 Background of the research

To respond in the big changing step of technology advancement in banking business, moving towards to digital banking has become the main objective to enhance better customer experience and offer flexible and efficient of product and service in banking industry. Consideration in transformation legacy system of housing loan business in the studied bank that was mainly based on manual operation and paper process and was main causes of bottleneck in lending process to be digitalized has become the key focus to alleviate the problem of bottleneck in this research. In addition, to succeed in reduction of non-value-added activities and lead time in the focused business process using the concept from Lean management and approach from technological development in digital transformation that currently evolving in banking business are considered relevant.

1.2 Company Background

The studied commercial bank has businesses classified into three main types including Corporate business, SME business, and Retail business which can divide customer segment into eight segments based on size of business as can be seen in Table 1.1. The focus product of this research is housing loan product which defined as a secured loan product under retail business group that majority of the customer are private individual including customer segments of high net worth individual, affluent, middle income, and mass using existing products and services of the bank such as deposit accounts, debit cards, credit cards, personal loans, including the housing loans. When considering of Company's Lending Portfolio which is an asset of banks where the value of a loan portfolio depends not only on the interest rates earned on the loans but also on the quality or likelihood that interest and principal will be paid (Scott,2003), Housing Loan has proportion around 14.92% of the total company's lending portfolio as can be seen in Figure 1.1.

Table 1.1 Classification of business and customer segment of the studied commercial bank

(Source: derived by author)

Type of Business	Customer Segment	Detail of Customer Segment
Corporate Business	Multi-Corporate Business	Company with annual sales > 5,000 Million Baht
	Large Corporate Business	Company with annual sales > 400- to 5,000 Million Baht
SME Business	Medium Business	Individual or company with annual sales > 50 to 400 Million Baht
	Small& Micro business	Individual or company with annual sales <= 50 Million Baht, and with credit limit <= 15 Million Baht
Retail Business	High Net Worth Individual	Individual wealth with studied bank and its wholly-owned subsidiaries >= 50 Million Baht
	Affluent	Individual wealth with studied bank and its wholly-owned subsidiaries >= 10 to <50 Million Baht
	Middle Income	Individual wealth with studied bank and its wholly-owned subsidiaries >= 15,000 Baht to <10 Million Baht
	Mass	Individual wealth with studied bank and its wholly-owned subsidiaries < 15,000 Baht

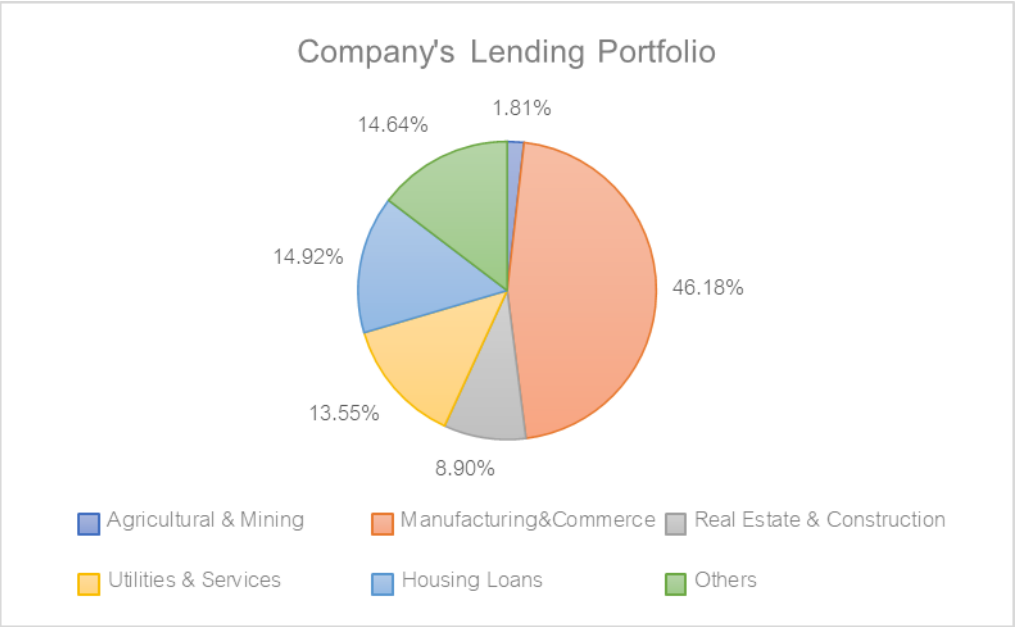

Figure 1.1 Company's Lending Portfolio

(Source: derived by author)

1.3 Product Overview

The product of housing loan in the studied bank can be categorized into various types of loan based on the purpose of loan such as buy either new or pre-owned home, re-finance, turning a lien-free home to cash and etc. The available products based on loan purpose in the studied bank consist of Home Loan, Home Loan Refinance, Home to Cash, and Home Loan Plus. Types of collateral that available for housing loan are house, townhouse, commercial building, condominium, vacant land, and house remodelling.

Home Loan is a generic product that supported purposes of buying either new or pre-owned home, house remodelling, buy vacant land, etc.

Home Loan Refinance is one bank to pay off a home loan from another bank to take advantage of lower interest rates and reduce one's debt burden by reducing monthly payments and/or shortening the loan term.

Home to Cash is a credit limit for personal loan secured by the borrower's own house, extended in the form of loans or overdrafts, or both.

Home Loan Plus is a loan with a payment schedule for existing Home Loan customers of bank with a good payment record whereby the borrower can use the loan for personal use.

In terms of qualifications, nationality, age, income, and duration of employment are being considered. While the required documents are composed of identity documents such as copy of national ID card, copy of house registration, income documents such as payslip, income certificate or bank statement, and collateral documents such as copy of land ownership documents and copy of the land sales contract. Lastly loan term is set to maximum of 30 years and credit limit shall be granted up to 90% of the home purchasing price and not exceeding 100% of the home's appraised value.

1.4 Process Overview

The process of housing loan business in the studied bank composes of two key stages including pre-screen and approval. Pre-screen stage is the initial stage that front-end staff or salesperson request customer basic information to fill in paper application and consent forms to submit for proceeding credit bureau check and internal verification of bank's policies known as pre-screen check. While approval stage occurs after all documents have submitted to back-end staff or underwriter to assess for risk assessment based on bank's regulation and policy before approval result can be granted.

Pre-screening stage

The first station of pre-screening process known as credit bureau check which is a process to verify customer's financial history from National Credit bureau (NCB), a credit data centre that gather customer's data to help reduce the risk and increase the efficiency of giving loans and to prevent bad debt or non-performing loan problems in the economic system.

The second station is pre-internal verification of bank's policies known as pre-screen check which is a verification process in the studied bank that basically verify

customer's data based on company's rules including common policy rules, home loan policy rules, and calculation rules such as summary income calculation, debt calculation, credit exposure. After all the rules have been verified then the process can continue to approval stage.

Approval stage

There are two main steps including credit appraisal and credit approval. Credit appraisal step is required for collateral appraisal which is a common step in all housing loan business process due to the natural type of secured loan is collateral based. While credit approval process is handled by credit underwriter or back-end staff which is known as risk assessment process or quality control before final loan can be granted to the customer.

To summarize, Overall steps of housing loan business process are composed of seven steps including:

Pre-screening stage

Step1: Fill in application and consent forms.

Step 2: Submit documents to pre-screen process.

Step 3: Credit bureau check.

Step 4: Pre-screen check.

Step 5: Submit documents to approval process.

Approval Stage

Step 6: Credit appraisal.

Step 7: Credit approval.

The process overview of housing loan business process is illustrated in Figure 1.2.

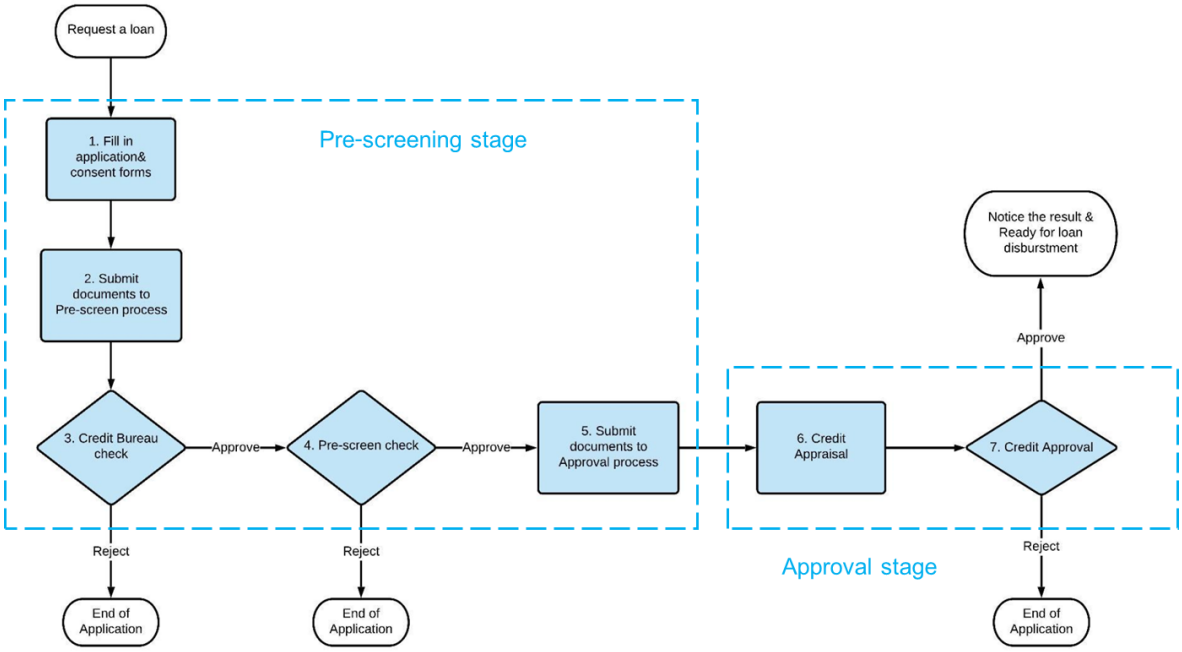

Figure 1.2 Process flow of housing loan business process

(Source: derived by author)

1.5 Statement of Problem

Bottlenecks of lending process

According to Bank of Thailand Symposium 2019, there are some inherent inefficiencies in the lending process that are mainly caused by key bottlenecks including manual process, paper document, and lack of data as shown in Figure 1.3. Presence of bottlenecks within the process can lead to information asymmetry and frictions in process that eventually result in higher costs and time-consuming which is one the main cause of long lead time in business operations. This has brought to a relevant consideration to Thailand banks to focus on improvement in lending processes to increase customer service efficiency using proper solutions.

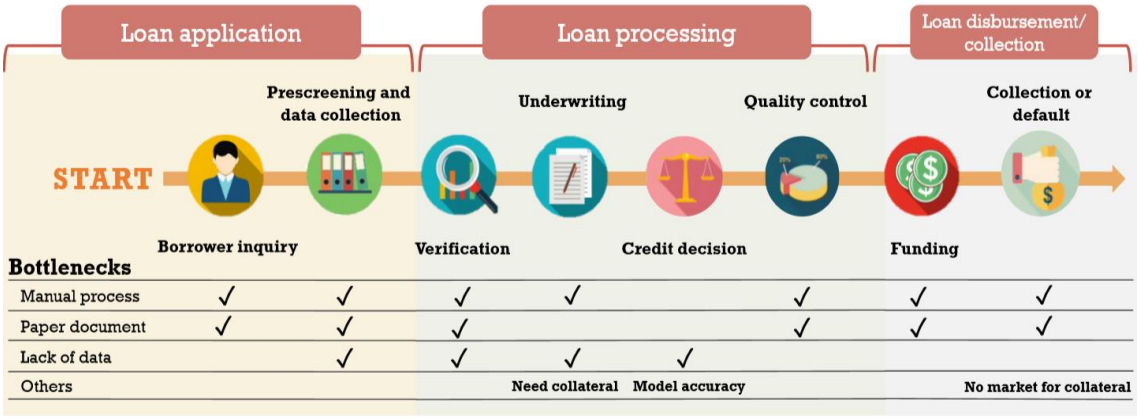

Figure 1.3 Bottlenecks of lending process

(Source: Bank of Thailand Symposium, 2019)

Considering on housing loan application process in the studied bank, the process is operated by manual and paper-based operation. It took approximately 11 days' lead time for customer to be noticed the result of requested loan in the current housing loan application process. Monthly lead time of housing loan business process in January to June 2020 is illustrated in Figure 1.4.

As shown in Figure 1.4, breaking down by key process stages of Pre-screening and Approval, it captures that majority of high average lead time was from pre-screen stage which took around 8 days' cycle time while approval process cycle time was about 3 days at average as shown in Table 1.2.

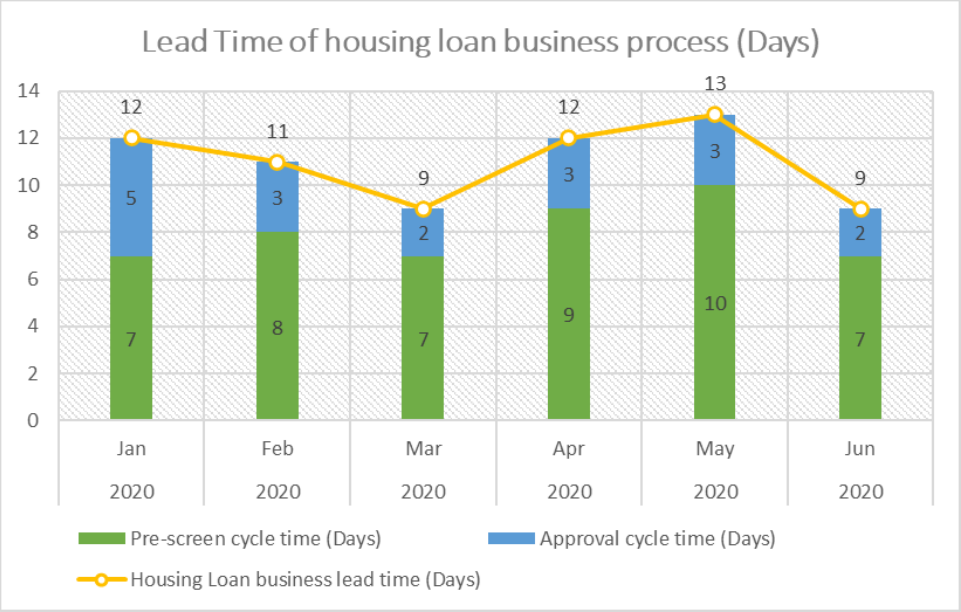

Figure 1.4 Average lead time of housing loan business process in year 2020

Table 1.2 Cycle time of pre-screening and approval stage

Year	Month	Cycle Time (Days)	
		Pre-screen	Approval
2020	Jan	7	5
	Feb	8	3
	Mar	7	2
	Apr	9	3
	May	10	3
	Jun	7	2
Average Cycle time (Days)		8	3

Long cycle time of pre-screening stage

When considering on business's target in the studied bank that used to monitor lead time in housing loan business process, the target of lead time and cycle time in the focused process are shown in Table 1.3.

Table 1.3 Target cycle time of pre-screening and approval stage

Process Stage	Average cycle time	Target cycle time
Pre-screen	8 days	5 days (Business Target)
Approval	3 days	3 days (Customer promise)
Total Lead Time	11 days	8 days

By comparing the current average cycle time with business target cycle time, it shows that the current cycle time was currently running out of target. While in the approval stage, average cycle time was still within the target. The target cycle time in approval stage is based on customer promise of approval within 3 days if all the documents have collected completely. The detail of customer promise in housing loan business is being identified according to business process stage as shown in Figure 1.5.

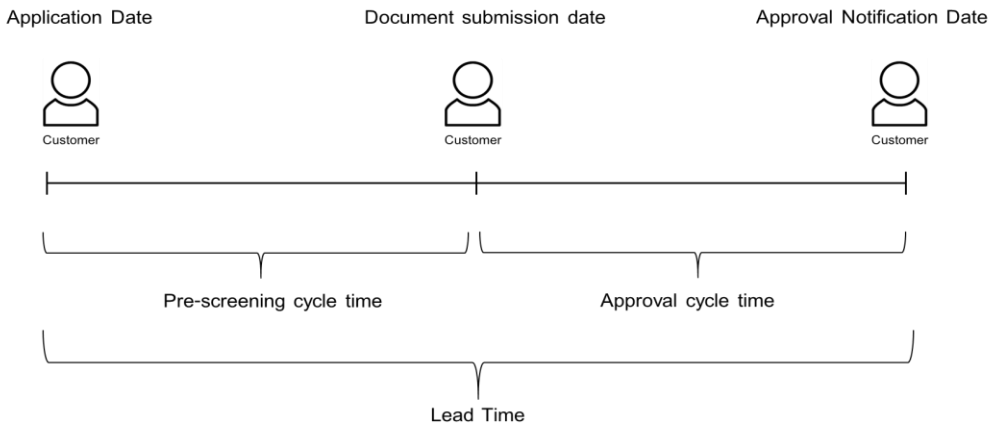

Figure 1.5 Customer promise in housing loan business process

(Source: Derived by author)

Analysis of competitor's lead time

As collection of competitor's lead time in Thailand banking business, there are several banks that revealed committed customer promise of loan approval including company A, B, C as shown in Table 1.4.

Table 1.4 Competitor's committed lead time

Metrics	Studied bank Actual Lead Time	Competitor's committed Lead time		
		Company A	Company B	Company C
Total Lead Time	11 days	3-10 days	5-7 days	7 days

By comparing with competitor's lead time, it resulted that with current average lead time 11 days of housing loan business process in the studied bank was still behind the competitors which need to significantly consider for improvement.

Therefore, the focus of research is aimed to identify the bottlenecks of housing loan business process especially in the stage of pre-screening that currently is one of the main causes of long lead time. To be able to identify the bottlenecks of process and

eventually deliver expected result in reduction of lead time, suitable tools and methods from Lean principle and other relevant solutions need to be conducted in this research.

1.6 Research Objective

The objective of this research is to improve lead time of housing loan business process by focusing on reduction of cycle time in pre-screening stage.

1.7 Scope of Research

The focus of this research is improvement of cycle time of pre-scree stage using appropriate solution from Lean principle and Digital transformation in banking business.

1.8 Proposed Methodology

1.8.1 Literature review of Lean principle and Digital Transformation concept being used in the lending process in banking industry.

1.8.2 Collection of relevant data of current housing loan pre-screen process including lead time, waiting time, process time.

1.8.3 Root cause analysis of the bottlenecks in current process using appropriate tool from lean principle.

1.8.4 Study and develop feasible solutions from project implementation plan in the studied bank.

1.8.5 Collect and analyse the data after implementing the new solutions.

1.8.6 Summary the result and recommend for future prospect.

1.8.7 Complete the thesis.

1.9 Expected benefits

1.9.1 Reduction of Lead time of housing loan business process.

1.9.2 Improvement of Process Cycle Efficiency of Housing loan business process.

1.9.3 Reduction of cycle time in pre-screening stage of housing loan business process.

2. Review of Literature

2.1 Lean Overview, Tools, and Methods

Lean is a system of operation employed to deliver value added products and services to customers (Taylor 2008) and a systematic approach to identifying and eliminating waste (non-value-added-activities) through continuous improvement by flowing the product only when the customer need it (NIST). There are five guiding principles for Lean practitioners based on Womack and Jones, 1996:

1) Determine value by product/service offering.
2) Identify value streams by each product and service offering.
3) Make value flow.
4) Let the customer pull value from the producer.
5) Pursue perfection.

Nowadays, not only manufacturing organizations implement lean, but also apply in service companies. The holistic approach is required to obtain successful implementation with application of appropriated methods and tools. In banking industry, superior efficiency and operational excellence from banks are required in the future. Considering in development robust, waste-free, flexible processes to finally offer product, service and process innovation that match customer needs is relevant for business to survive in the marketplace (Sarkar 2007).

2.1.1 Types of activities in a process

According to Sarkar 2007, three types of activities in a process are:

Value-added steps/activities: the activities that customer is willing to pay in which the qualifications of value-added activity are:

- Ability to change the form, feature, feeling, or function that customer desires.
- Being done correctly the first time.
- Customer must be willing to pay for it.

Business-value-added steps/activities: the activities that customer is not willing to pay but cannot be avoided which also called necessary non-value-add such as organizational policies.

Non-value-added steps/activities: the activities in a process for which the customers are not willing to pay and can be avoided.

The activities that considered to be waste in the process are illustrated in Figure 2.1.

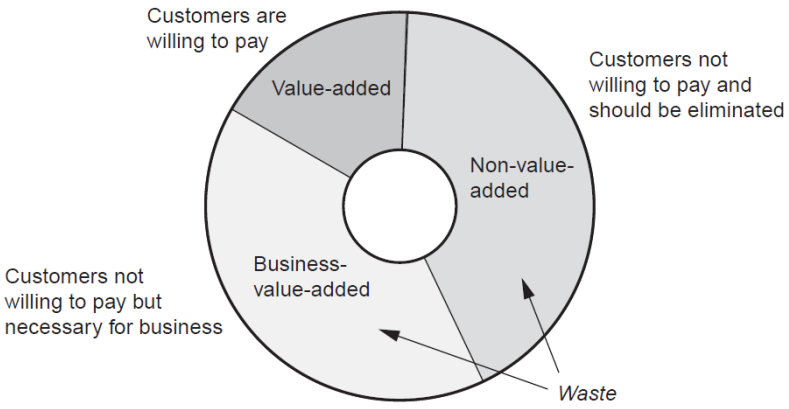

Figure 2.1 Type of activities in process

(Source: Sarkar 2007)

2.1.2 Eight wastes of Lean

There are eight wastes of lean including Overproduction, Motion, Inventory, Transportation, Waiting, Underutilized people, Defects, and Overprocessing. Example of each wastes that possibly exists in service processes according to Sarkar which is adapted from Taiichi Ohno illustrated in Table 2.1.

Table 2.1 Eight wastes of lean

(Source Sarkar 2007)

Type of wastes	Example of waste in service process
1. **Overproduction-** processing more or sooner than required.	-Purchasing items before they are needed. -Processing paperwork before the next person is ready for it. -Franked loan agreements lying unutilized. -More promotional materials printed than required. -Photocopied of forms used instead of printed booklets.
2. **Motion-** movement of individual that is unnecessary for completing a job in process.	-Customer service executive having to walk to get brochures and forms in a retail financial service branch. -Collection agency going to wrong address. -Multiple visits by salespeople to get the right documents from customers. -Scattered departments in an organization. -Walking to/from copier, central filing, fax machine while executing a process.
3. **Inventory-** items or suppliers in the process in excess of what is required for a single piece flow.	-Filled in-boxes (electronic and paper). -Excessive sales literature/brochures in retail bank branch.

	-Piles of loan files lying in branches/offices. -More stationery than required. -More IT equipment than required in a workplace. -Documents/records held beyond retention period.
4. **Transportation-** movement of materials which is more than just in time in processing.	-Multiple hand-offs. -Multiple approvals. -Files moving from one branch to another. -Movement of documents from hub to spoke. -Multiple movement of cash. -Couriering/express mail.
5. **Waiting-** individuals and items being idle between operations.	-Customers waiting in line at a bank branch or ATM. -Files and documents waiting for signatures or approval. -Associates in a process waiting for earlier process to finish. -New employer awaiting infrastructure/computer. -Customer waiting in phone banking/call centre queue. -Information technology system downtimes. -Time taken to respond to customer queries.

6. **Underutilized people**-The abilities of associates/employees in a process not being utilized to the fullest.	-Process associates being treated as robots by managers. -Not involving the associates in process improvements. -Not leveraging the qualities of individuals to the fullest. -Not using the creative brainpower of employees.
7. **Defects-** errors and not getting item or product right the first time out in a process.	-Errors made while filling out the application form of a mortgage customer. -Incorrect name printed on a credit card. -Incorrect data entry. -High rejection rates in saving account opening forms.
8. **Over processing-** efforts that add no value for the customer.	-Redundant steps in a process. -Multiple inspections in a process. -Lack of operator training. -Undefined or unclear customer requirements -Overdesigning a product or service for a customer. -New products are launched without adequate back-end processes. -Inadequate technology.

2.1.3 Value Stream Mapping *(VSM)*

Value stream mapping is an effective framework for depicting the process in a way that highlights wastes and negative effect and should be key part in any lean improvement (King 2017). The value stream mapping process are composed of key four stages including (Locher 2008) and shown in Figure 2.2:

1) Preparation: identifying the mapping team, the product or project to study, and how the project or product will be mapped.
2) Current state: agreeing on a well understood map of the current situation.
3) Future state: agreeing on a shared vision of a lean development process.
4) Planning & Implementation: developing a plan to achieve the future state.

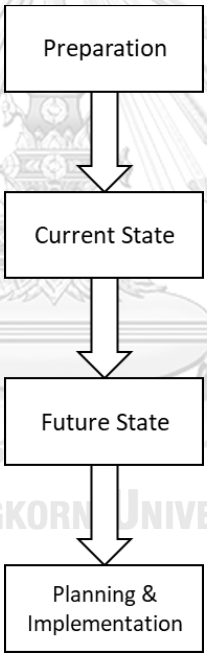

Figure 2.2 Value Stream Mapping process

(Source: Locher 2008)

To establish value stream mapping, Material flow, Information flow, and Timeline are key components. Material flow is used to indicate the flow of processing systems where groups of suppliers and customers are also shown as inputs. Information flow is the flow of all major types of information that govern what is to be made when it is to be

made. And timeline shows the value-add time and non-value-add time in the bottom of the VSM in the form of a square wave (King 2017).

Data boxes in VSM provide the numerical information required to understand how well material is flowing through the process, where bottlenecks or capacity constraints exist, where waste exists in the process, and to provide clue to the root cause (King 2017). Inside the data boxes, there are various of metrics that could be applied to value stream mapping including:

1. *Process Time (P/T):* refers to the actual time required to complete a task and is a measure of work content which usually be measured from observation of process or estimated by staff member (Locher 2008).
2. *Lead Time (L/T):* is the elapsed time associated with completing an activity, from the time it enters the box to the time the completed activity leaves the responsible employee (Locher 2008).
3. *Process cycle efficiency (PCE):* is another indicator that can be measured by analyzing VSM in detail on a time basis (Chiarini 2013):

   Process cycle efficiency = (time taken up by value added activities/ total lead time) x 100

According to Sarkar 2007, there are additional time metrics that could be considered in transactional environments which are:

4. *Takt time:* a measure of the pace of customer demand.
5. *Query time:* the time spent addressing the queries in a process and a symptom of a process bottleneck.
6. *Waiting time:* the time that the items in the process wait to be worked on such as inventory of materials, physical documents, and information.
7. *Travel time:* the time spent moving items, material, documents, and information.

8. *Transit time:* can be calculated by adding waiting and travel time in the value stream map.

Moreover, the icon that represents in value stream mapping is illustrated in Figure 2.3.

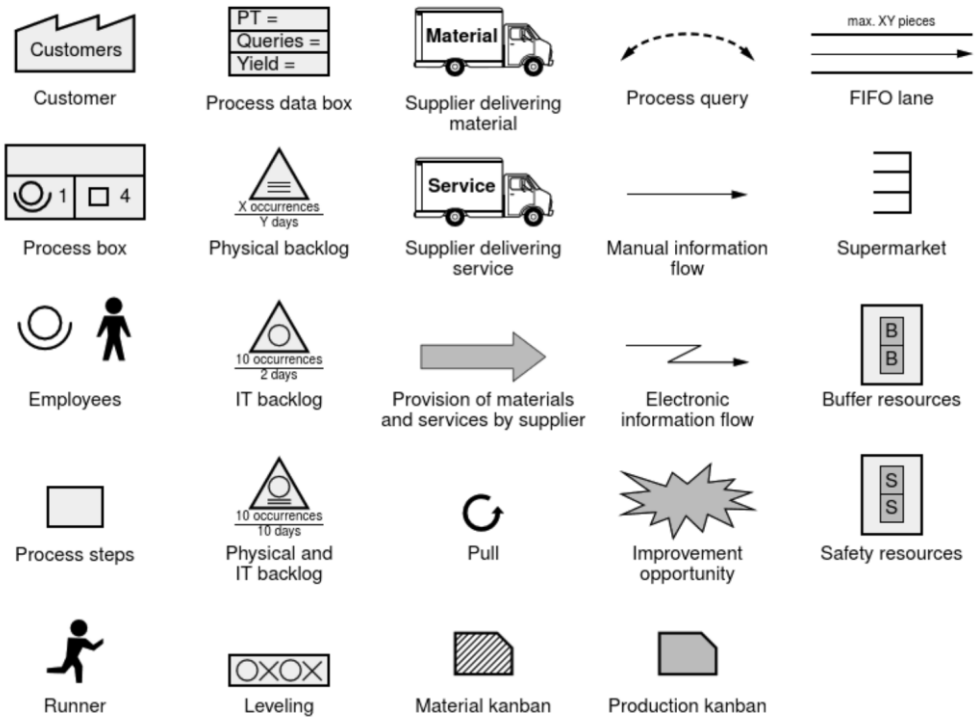

Figure 2.3 Value Stream Mapping Icon

(Source Sarkar 2007)

As the benefit of value stream mapping that highlights key areas of waste in the process, gives clues to the root causes for wastes, forms a templated for design of improvement plans and lead to starting point for future state VSM. There is successful case study of how value stream mapping can be used to reduce the lead time of a product development process (Tyagi, Choudhary, Cai, Yang, 2014) that established current statement to see the wastes and developing new future state map through the process of brainstorming and resulted in reduction of waiting time and steps in the process and increase of value added time and value-added steps.

Another case study from a manufacturing company (Chiarini & Associates's consultant 2013), an example of current state map is shown in Figure 2.4 contains process linked to product design and managing orders that has lead time of 78 days. After the current map was mapped out, the define strategic goal for improvement was set to reduce lead time. The introduction of supply chain, the supermarket, and a cell where SMED and TPM workshops from lean management concept have approached during development and finally the future state map is drafted and shown in Figure 2.5. The result of implementation according to the future state map has resulted in reduction of lead time to only 18 days with several financial benefits.

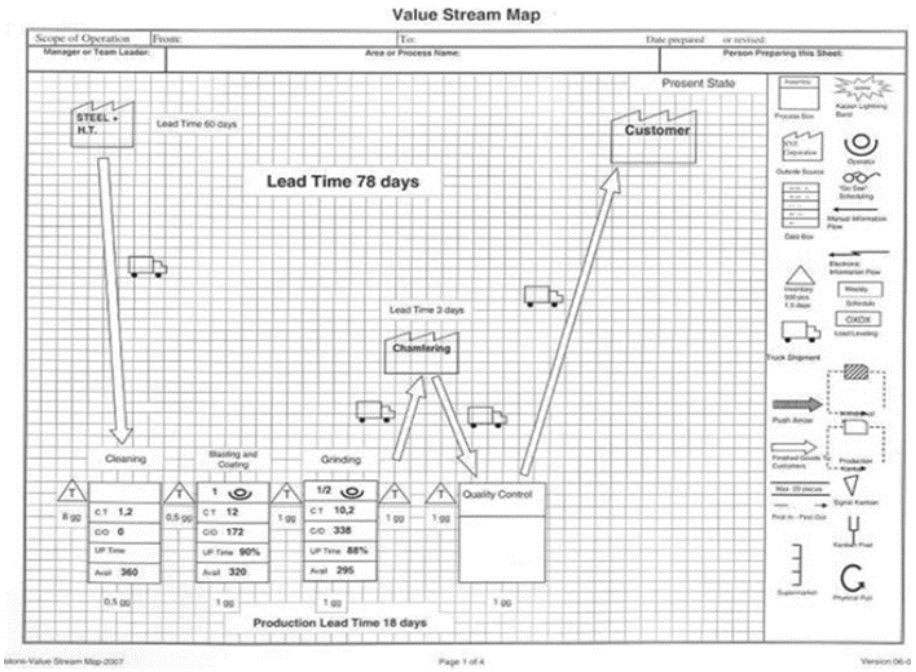

Figure 2.4 Current State Map

(Source Chiarini & Associates 2013)

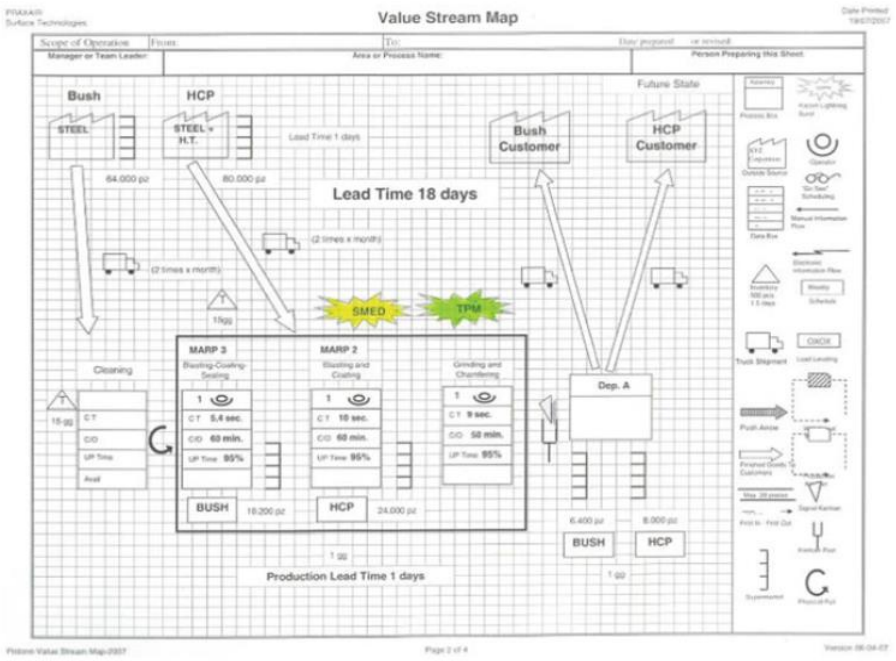

Figure 2.5 Future State Map

(Source Chiarini & Associates 2013)

2.1.4 Fishbone Diagram

The fishbone diagram was developed by Kaoru Ishikawa in the 1960s and is also known as an Ishikawa diagram or cause-and-effect diagram. It is an effective tool to identify potential causes of problems. The objective of diagram is to analyse the focused problem into categories to identify and organize input and possible causes. Categories that can be considered as input are people, process, technology, and information as shown in the example in Figure 2.6.

To establish effective fishbone diagram can be proceeded through the method of Brainstorming which is a problem-solving approach where a group defines a problem or goal and captures all possible ideas around the potential cause or solution (Bell, Orzen 2011). It is also known as a tool to envision potential improvement and finally lead to development of future state value stream map, prioritize efforts, and take action in process improvement.

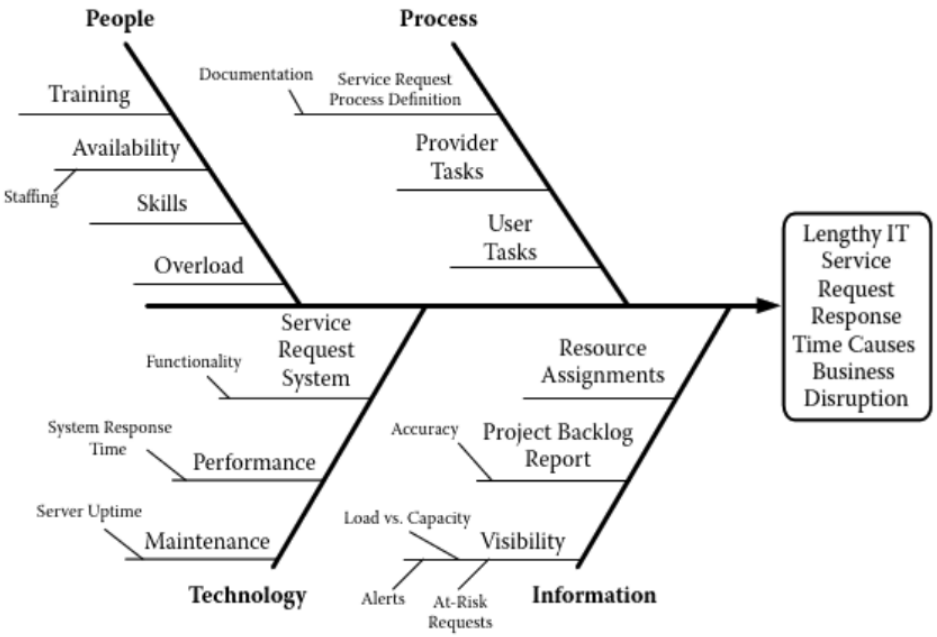

Figure 2.6 Fishbone Diagram

(Source Bell, Orzen 2011)

2.1.5 Pareto Chart

According to Andersan and Fagerhaug 2006, Pareto chart can be used to obtain a clearer picture of the set of causes by viewing them according to importance and understand which causes need further investigation. By the degree of seriousness, 80 percent of the causes of problem are stated as the most effect while the rest 20 percent is the “vital few”. And as most of the problem are basically caused by several root causes and are difficult to solve all the root causes at once, therefore, pareto chart can vitally be used as a tool to prioritize on which causes should be executed as a primary in process improvement.

The steps of establishing a pareto chart start with define the potential causes of problem, decide which quantitative measure to use when comparing the possible caused such as frequency of occurrence, costs, performance level, etc., use existing data or collect the necessary data, and then place the causes from left to right in descending relative importance. An example of general pareto chart with a line for cumulative importance is shown in Figure 2.7.

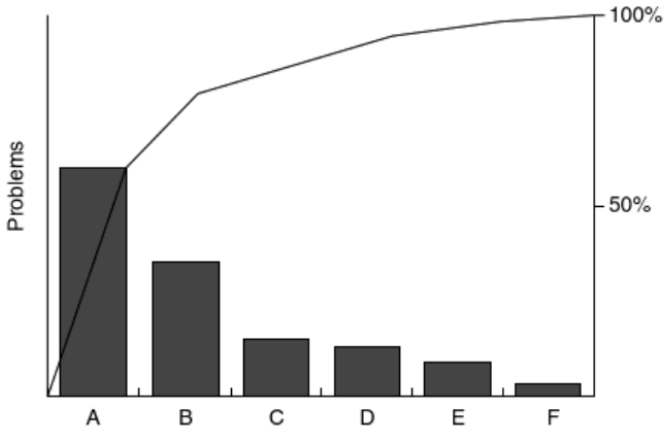

Figure 2.7 Example of general pareto chart

(Source Andersen 2007)

2.1.6 Simplify and Streamline process

According to Bradley 2015, there are several ways to simplify and streamline the process when consider in reduction of wasteful lead time including eliminating process a process step, creating and analyzing a spaghetti diagram, applying the 5S methodology, and simplifying tools, equipment, jigs, fixtures, and procedures.

In which, methods that could be applied for improvement of housing loan business process are Eliminating a process step and simplifying tools and procedures which brief explanation of method are described as follows:

Eliminating a process step

To be able to eliminate a process step, waste or non-value-added activities must be revealed in which the tool that can contribute in seeing the waste is Value Stream Mapping. Once waste, can be identified, then the elimination can be conducted. However, considering in combination of multiple process steps into one step can be conducted. An example of combining of process steps was from hiring process that affected by the reduction of travel time of job applicant that previously required three trips to company for interview to one trip by rearrangement of the process in which resulted in

improvement of reducing lead time from 8,282 minutes to 27 minutes when compared to traditional process. An example of hiring process VSM can be found in Figure 2.8.

Simplifying tools and procedures

This method can be considered to contribute in offering tools or procedures for operator to proceed and simplify task faster in which will result in giving shorter lead time of the process and better quality of product or service.

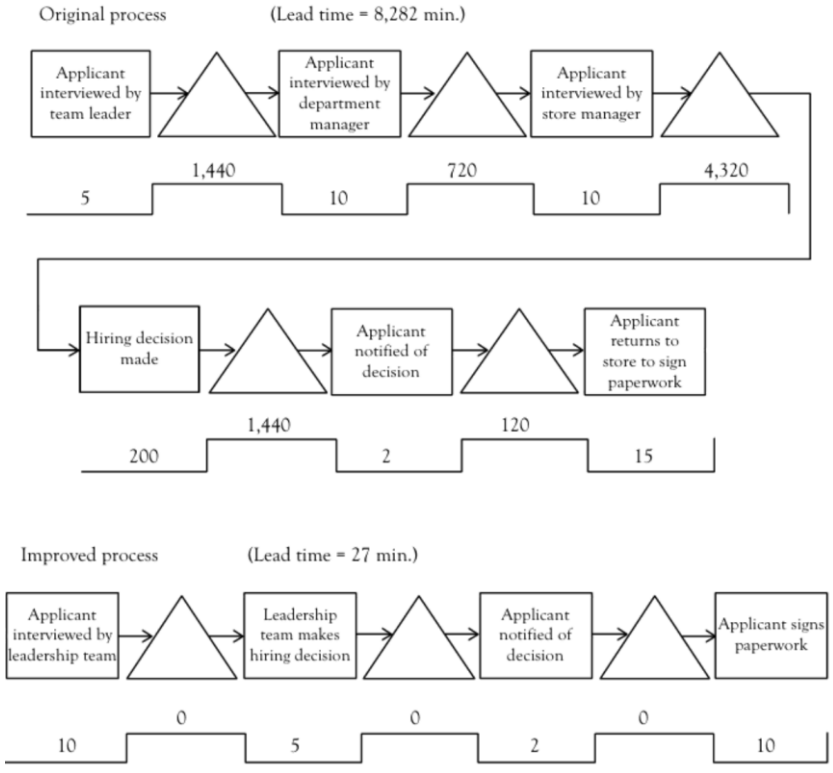

Figure 2.8 Hiring process VSM

(Source: Bradley 2015)

2.1.7 Standardization

There are several aspects of process that can be defined and standardized based on Bradley, 2015 which are composed of:

1) Order process step.
2) Order of tasks within each process step.
3) Tools and equipment.
4) Workstations where tasks are performed.
5) Materials used.
6) The environment in which the process is executed.
7) Specifications that define when a task is completed successfully.
8) Locations where materials, tools, and equipment can be found.
9) How materials are presented to operators.

In which, in the housing loan business process, related aspect that could be considered for standardization can be assessed after all detailed of process steps are revealed from Value Stream Mapping.

2.2 Digital Transformation in banking industry

Digital transformation leverages the opportunities presented by technology from IT to advanced analytics, sensors, robotics, and 3D printing to drive business forward (Swaminathan and Meffert 2017). The effect of digitization is including changes in structures, processes, and IT as well as the people who live and work in this new reality and happen in all industries depending on the severity and length of time until the old business model is rendered obsolete.

However, digitization not only affect the change among industries but also change in consumer behaviours that have major desires in getting everything, anywhere, anytime and spending more time on visual media like videos and doing digital activities than before using digital platform, in which the consequence of change in consumer behaviours also pressurize retailers and service providers to digitize their processes and offerings to respond on customer needs in the recent.

In addition, according to Forest and Rose 2015 from Deutsche Bank, digitalisation is about taking control of customer-experience ecosystem by managing entire business from customer's perspective and rethinking the legacy business model which is driven by three major forces including customer experience, technology push, and economic benefits. To achieve the opportunity to delight customers in banking industry, banks must conform the challenges of digital structural change and redesign their operating models. Considering in reduction of complexity and response times across all customer interactions, and development automated decision-making with regulatory compliance are crucial.

Digitalized credit process in Banking

In order to provide such a flexible and convenient financial service with cybersecurity protection, technologies including robotics, artificial intelligence *(*AI*)*, cloud computing, block chain and digital payment which are known as disruptive technologies are required to develop those needs of customers during digital transformation in banking industry which are the keys of moving to digital platform. Digitalizing the lending process

can be beneficial in terms of giving better decisions, improving customer experience, and significantly saving the cost.

Key elements that could be in digital credit process are*:*

1) Automated decision making
2) Integration with Credit bureaus
3) End-to-end process visibility

In addition, some of the emergent technologies that can be relevant in the Credit Reporting Industry are including Advanced Computing, Biometrics& National Identity Systems, Open Data Systems, Distributed Ledger technologies *(*Block chain*)*, Electronic Payment System, and Artificial Intelligence. Mostly the key capabilities of these technologies are to enable better identification, transacting, networking, and sharing as can be found in Figure 2.9.

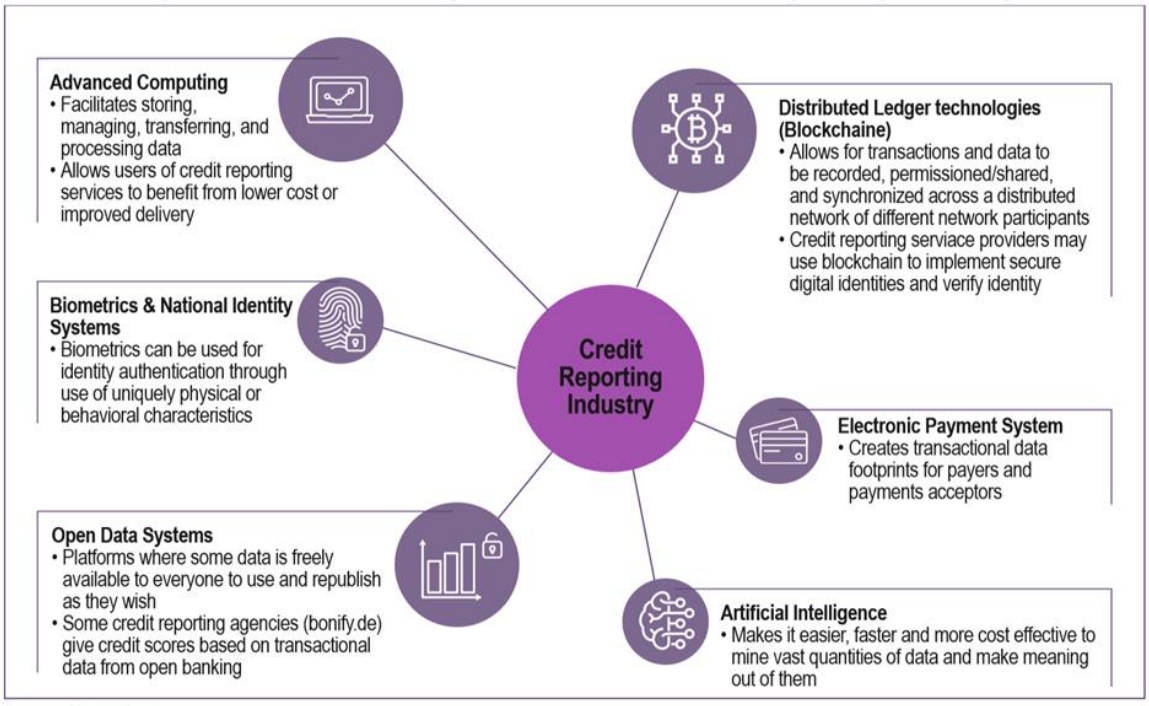

Figure 2.9 Example of emergent technologies of Credit Reporting Industry

(Source: World Bank 2019)

According to the Boston Consulting Group (BCG) 2018, technological advancements will disrupt how consumers research and apply for a loan including the on boarding experience which will be more intuitive, seamless, and convenient. There is an example of digitalized home loan customer journey shown in Figure 2.10 from BCG Analysis, that introduced new digital capabilities that are redefining home loan end to end customer journey.

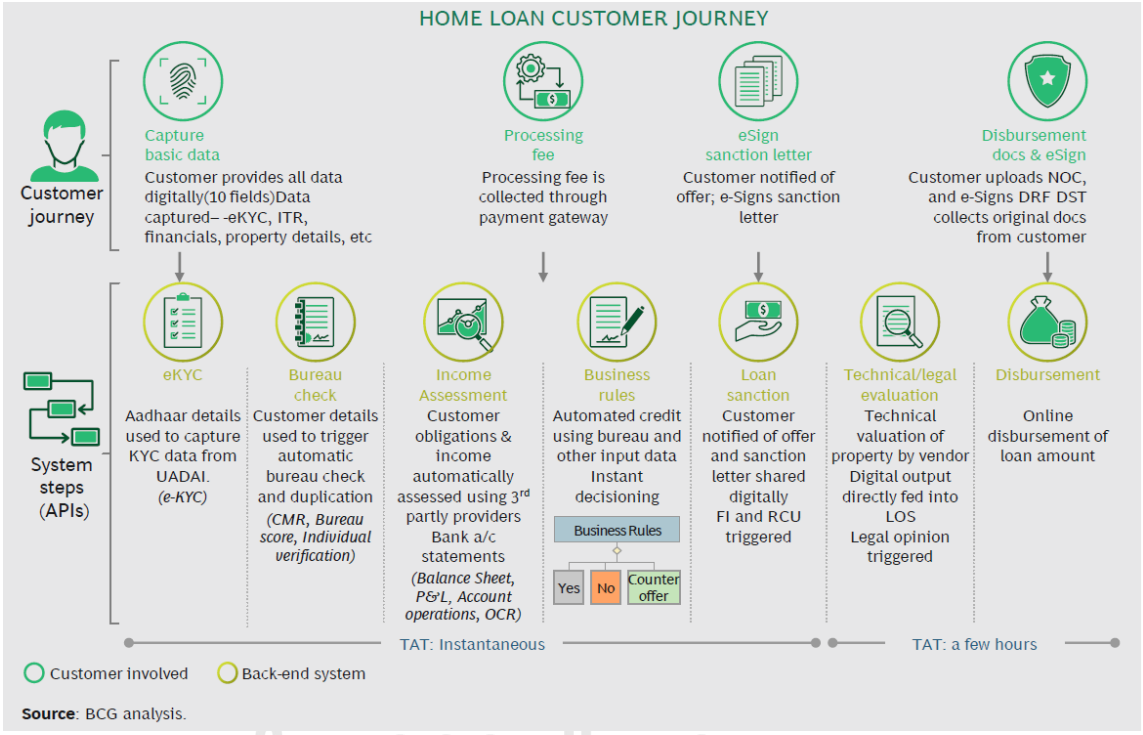

Figure 2.10 Digitalized Home Loan Customer Journey

(Sources: BCG analysis 2018)

Electronic Credit Bureau Check

Credit bureau is classified as one of the credit reporting systems that collect information from creditors and available public sources on a borrower's credit history (World Bank Group, 2019). The data of bureau complies individuals and small firms' credit repayment record, court judgements, and bankruptcies and eventually creates a comprehensive credit report that is sold to creditors such as commercial banks. In Thailand, there is a credit data center known as National Credit Bureau Co. Ltd (NCB) established in 1961. The aim of establishing the credit data center is to exchange the data of clients of commercial banks to reduce the risk of giving a loan and prevent possible damages that may arise to commercial banks.

In the process of getting housing loan, it is surely required to have customer's Credit bureau checked before moving to further approval steps and required consent form of information disclosure from data owner. An overall process of consent for information disclosure via internet in Thailand is provided by Electronic Transactions Development Agency (EDTA), an organization that is responsible of supervising all electronic transactions, ranging from financial transactions and exchange of information to e-commerce and online trading and can be proceeded through six steps as shown in Figure 2.11 and explained as follows.

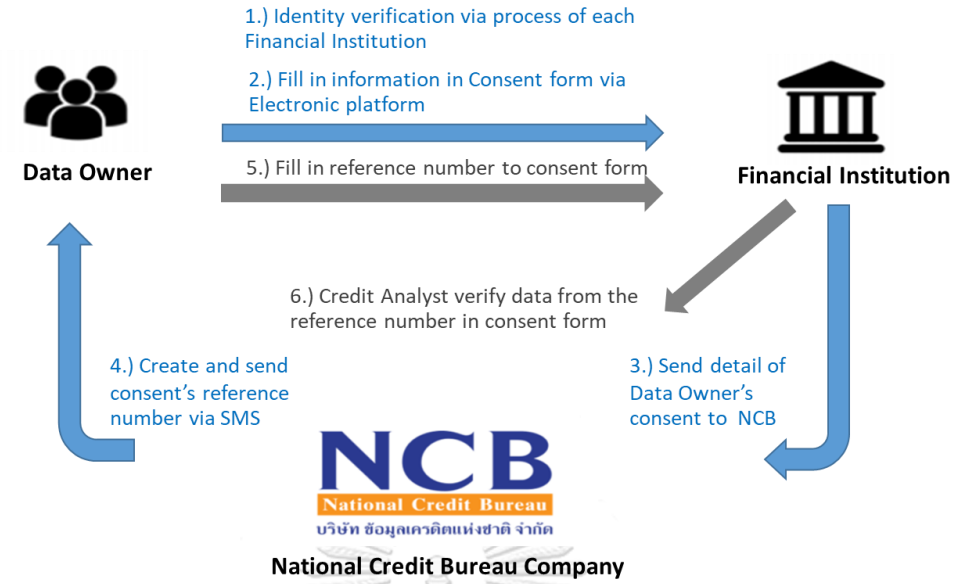

Figure 2.11 Process of consent for information disclosure via internet in Thailand

(Source: adapted from EDTA 2010)

Step 1: Identity Verification:

Before giving any consent, Data Owner is required to have an authentication by log in to creditor's system which can be Mobile Application or Web Application and then using Login Name and Password that been created with that specific creditors to ensure the security and confirm that the consent is being accepted by data owner.

Step 2: Fill in the consent form:

To fill the consent form, it can be proceeded via electronic platform like electronic application (e-App) and paper consent form to follow Credit Data Business Act in 1999.

Step 3: Send detail of Data Owner's consent to NCB:

Each financial institution or creditor need to send the details of Data Owner including:

- Reference Consent ID in the format of [Short Name]-YYMM-XXXXXXXXX for example ABC-1606-16560001
- Identification Card Number
- Name and Surname
- Mobile phone number
- Date of Birth
- Type of Loan that being given the consent
- Date and Time of the given consent
- Short name of the creditors or financial institution
- Date and Time that creditors sent data to CCMS system

Note: CCMS stands for Centralized Consent Management System analyzed and controlled by NCB.

Step 4: Generate and send Reference Number via Short Message Service (SMS):

After receiving the consent, CCMS generates the reference number of consent and send back to data owner via SMS channel.

Step 5: Fill in reference number to consent form:

Data owner input reference number in consent form to creditors or financial institutions for credit analyst to proceed further step.

Step 6: After credit analyst acquired the reference number, the access of information will be enabled and allow credit analyst to verify data.

In Thailand there is an example of electronic Credit bureau check available on mobile application 'Krungthai Next' from the Krungthai Bank with transaction fees of 150 baht. The processing time of Credit bureau check would take around 3 to 7 working days

to get the result and the channel of receiving the result is both currently available on Email and Post. The detail of credit bureau check step by step is shown in Figure 2.12.

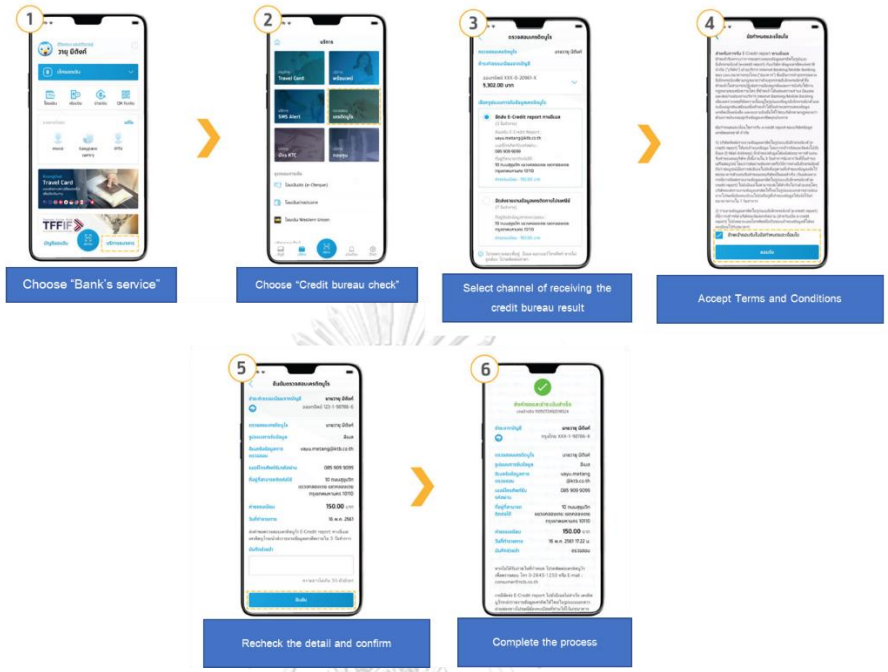

Figure 2.12 Krung Thai credit bureau check process

(Source:https://krungthai.com/th/content/personal/krungthai-next/credit-bureau-status-check-service)

However, by merging the process of electronics Credit bureau check along with an automated credit system could possibly help improving the lead time of end-to-end process of housing loan.

Automated Credit Decision System

Typical credit decision workflow that operates under different channels including Self Service channels, Digital enabled agents, and non-digital in financial institution or banks consist of two main areas including Data Layer where data collection and intelligence extraction can be approached and another area which is highly significant in automated credit decision system known as Decision Management or Decision Engine. In which an overall functional architecture of an automated credit decision system from Infosys, 2019 is illustrated in Figure 2.13.

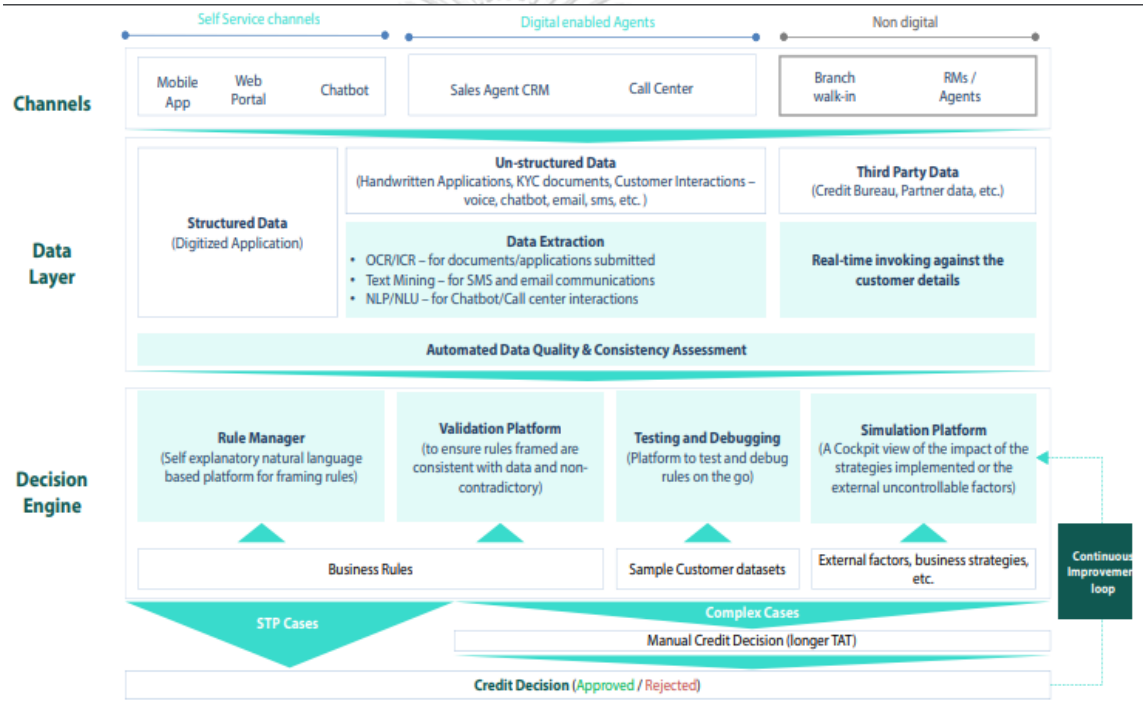

Figure 2.13 Overall functional architecture of an automated credit decision system

(Source: InfoSys 2019)

Furthermore, decision management is an important key to build such a flexible and efficient system which required an import of various sources of data. Its components consist of Rule Manager, Validation platform, Testing and debugging, Simulation platform, and decision repository which could be briefly explained as follows:

1) Rule Manager: A central key component of decision engine which grants users the flexibility of decision making and can be natural language based or decision technology based such as decision trees, scorecards, decision tables, decision flow and rule sets.
2) Validation Platform: This component can ensure the validation between rules framed and consistent with data and non-contradictory.
3) Testing and Debugging: A platform to test and debugs rules on the go.
4) Simulation Platform: A cockpit view of the impact of the strategies implemented or the external uncontrollable factors.

Examples of some financial institutions that applied credit decision management solutions can be founds as Figure 2.14. The major benefits from applying those solutions are improvement of decreasing process time, increasing accuracy of approval steps which can mainly enhance efficiency of the process.

Theme	Partners	Solution	Benefits
Use of alternate data	MicroBank and Entrepreneurial Finance Lab (EFL)	MicroBank partnered with EFL in Spain to assess the credit worthiness of thin-file (with little or no credit history) customers. EFL uses psychometric questionnaires for customers which helps them understand character traits such as attitude, control, entrepreneur potential, social behavior, etc. This data is then fed to risk assessment models to build a credit score	• Approval rate of credit requests increased to 70-80% from 10-20% achieved with traditional models • Ability to extend credit to underserved section of the market leading to greater financial inclusion
Use of AI/ ML and risk analytics platform using big data	Fullerton India and CreditVidya	Fullerton has partnered with CreditVidya to leverage the latter's AI/ML capability to fast-track the loan disbursal process to prospective borrowers. The system ingests a variety of data (demographic, transactional and behavioral) and feeds them to an AI based system and generates a real time Stability Score for customers	• More accurate Credit Assessment than traditional models • Increase in predictability of defaults and CLTV • Can self-develop over time based on performance of customers
Simple and intuitive implementation of decision rules/strategies	Moneyboat and FICO	Moneyboat has partnered with FICO to enhance the credit decision process with the help of a more flexible and sophisticated risk management system, FICO Decision Modeler. It's a platform which ensures that the rules for decisioning can be interactively built, effectively managed, easily modifiable, natural language based, offering more readability and flexibility, and seamlessly implement the business strategies	• A centralized decision-making system • Empowers the credit officers, with no coding skills to easily implement business rules • Test results on the go to proactively understand impact
Automation	Ujjivan and Artoo	Ujjivan, in an effort to extend credit to underserved MSMEs in India, had partnered with Artoo to digitize the lending process. Field agents capture over 800 data points using phones/tablets and send the information directly to Ujjivan's underwriting team for analysis. A loan decision workflow tool developed by Artoo helps in faster decision making. Also, digitized sales information helps the company track agent and portfolio performance	• Loan processing time has decreased by 40% • Number of loans processed by an agent has increased by 50% • SME customer base of Ujjivan has increased by 230% in 3-4 yrs

Figure 2.14 Example of Credit Decision Management solutions that applied in Financial Institutions

(Source: InfoSys 2019)

Example of Digital Lending in Thailand banking

The first example of digital lending that exist in Thailand banking was 'Krungsri iFin' from Bank of Ayudhya, the fifth largest bank in Thailand in terms of loans and deposits. "Krungsri iFIN is a new phenomenon of real digital experience, with a truly full-fledged end-to-end digital process ranging from loan application, document submission, application status check, receiving loan funds, as well as convenient transaction management within the loan account, checking e-statements for all transactions, such as withdrawals, funds transfers and payments through KMA, anywhere, anytime. As a result, the Bank can increase operational efficiency and offer a lower-than-normal interest rate" said by Krungsri Head of Retail Banking and Distribution Group in Krungsri Press Release 2018.

Key features of Krungsri iFIN personal loan are including utilization of online NCB e-Consent service in step of Credit bureau check, online document submission, self-trackable of application status, and notification of loan result within 1-3 business days after completely submitted all required documents to bank. There are only four steps required for customer in processing personal loan using Krungsri iFIN:

1) Fill in application from via KMA (Krungsri mobile banking application).
2) Receive contact call from agent to inform requested loan.
3) Wait for agent to contact back for signing documents.
4) Notice the result and confirm the amount of requested loan, and loan is granted and transfer to account.

Conclusion of review of literature

After literature of relevant concepts including lean principle and digital transformation in banking industry has been reviewed, it can be concluded that to identify and understand the process in detail and to reveal the root causes of problem in process, main lean tools such as Value Stream Mapping and Fishbone diagram can be approached and conducted in research methodology. While simplifying and streamlining and standardization from lean principle can be used as an outline for improvement after all wastes and problems have been explored gathering with concept of digital lending in banking industry.

3. Research Methodology

In this chapter, the methodology of the research is identified to explore the detail of focused process, seek of the root causes of the bottleneck in the housing loan process where wastes or non-value-added activities are hidden regarding to objective in reduction lead time of the process.

To be able to deliver improvement as objective, project improvement team has been set to generate ideas, brainstorming and discussion the problem and solution as a teamwork. In which, the members of the project improvement team are key persons that involve in the housing loan business in the studied bank. The detail of members in team are illustrated in Table 3.1.

Table 3.1 Project improvement team

No.	Functional Title	Educational Background	Working experience
1	Head of housing loan business process	Master's Degree	27 years
2	Senior housing loan business process specialist	Master's Degree	8 years
3	Senior network system execution specialist (Specialist in a role of front-end staff)	Master's degree	38 years
4	Senior housing loan operation management specialist (specialist in a role of back-end staff)	Master's degree	6 years
5	Housing loan business process specialist (Author)	Bachelor's Degree	2 years

According to Sarkar 2007, value stream mapping tool will be used as a key tool to see holistic view of the process and ascertain the hidden opportunities for improvement. Therefore, the methodology of this research will be followed through the step of as Figure 3.1.

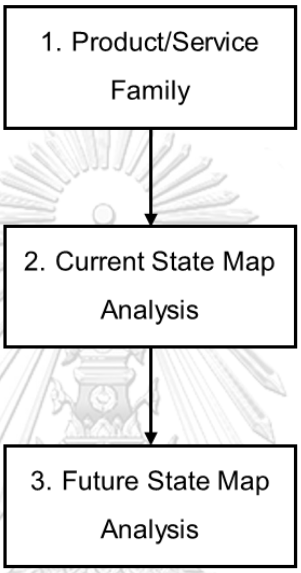

Figure 3.1 Research methodology

(Source: derived by author)

3.1 Product/Service Family

This step is to identify the product family which refer to a group of products that follow the same process steps. In which, the focus product in this research is housing loan which is classified as one type of consumer loans in the studied bank. Figure 3.2 illustrates consumer loans product family that categorized into types of secured loan and unsecured loan.

Secured loan is loan that are backed by an asset such as mortgage or car in which those assets are the collateral for a loan.

Unsecured loan is a loan that is not protected by any collateral such as credit card and personal loan.

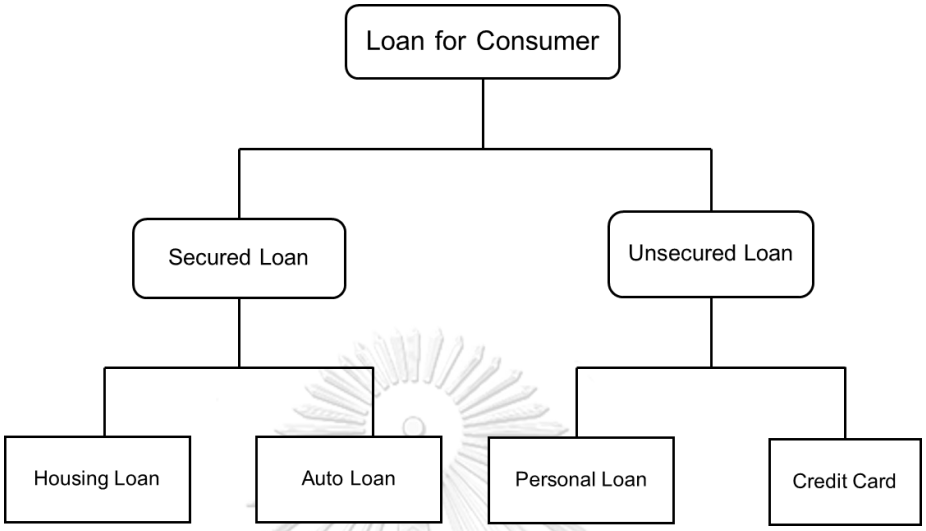

Figure 3.2 Consumer loans product family

(Source: derived by author)

When break down to the detail of housing loan, it can categorize by the purpose of loan as shown in Figure 3.3.

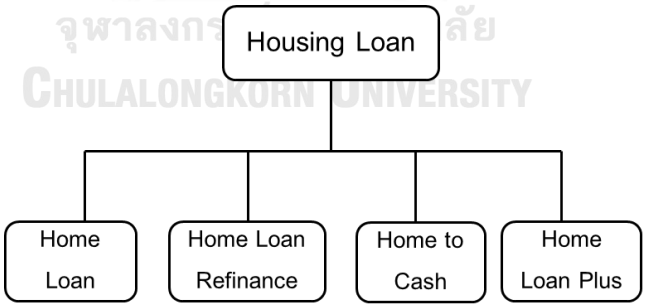

Figure 3.3 Type of Housing Loan product by purpose of loan

(Source: derived by author)

With all types of product, it operates under the same service process in which the generic value stream in housing loan process are operated as shown in Figure 3.4.

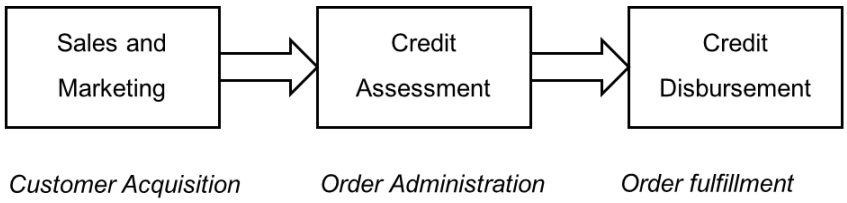

Figure 3.4 Generic value stream in housing loan business

(Source: adapted from Sarkar 2007)

Sales and Marketing is a process of customer acquisition in which in the studied company, the responsible person are front-end staff who operates within the branch and sales agent who work outside branch.

Credit Assessment is a process of order administration starting from data acquisition from customer until the credit is granted, which is a main key process in housing loan business and being focused in this research. The responsible person in this process are including front-end-staff/salesperson, area administrator, back-end staff (underwriter). In which the main processes in credit assessment including pre-screen and approval process in the studied bank will be explored in the current state map analysis (section 3.2).

Credit Disbursement is a process of order fulfilment after the credit decision has been issued. This is a step where customer is getting a loan.

After product and service family has been explored, next step is to analyse the current state of housing loan business process in the focus of credit assessment.

3.2 Current State Map Analysis

For an analysis of current state map, the objective of analysis is to understand the detail of current process that operates to serve customer need. In which lean tool called Value Stream Mapping was used to visualize value-added and non-value-added activities in the process.

Fishbone diagram and Pareto chart were used as in-depth analysis of identification of long lead time root causes and prioritizing on which causes that need to assess for improvement.

3.2.1 Identify customer needs

First, identification of customer needs is reflected through two aspects including external customer referred from Locher 2008, which is borrower and internal customer which are operators in the process.

For internal customer which are operators in both front-end staff and back-end staff, the demand from their aspects are to be able to complete the task within business target that is separated by process stages known as desired cycle time shown in Table 3.2. The desired cycle time of pre-screening stage is 5 days in which the current cycle time of the actual stage was running out of target.

Table 3.2 Desired cycle time of improvement in housing loan business process

Process	Current Cycle Time	Desired Cycle time for Improvement
<u>Pre-screening stage</u> Step 1 Fill in application and consent forms. Step 2 Submit documents to Pre-screen process. Step 3 Credit bureau check. Step 4 Pre-screen check. Step 5 Submit documents to Approval process.	8 days	5 days (Business's target)
<u>Approval stage</u> Step 6 Credit appraisal. Step 7 Credit approval.	3 days	3 days (Customer promise)

When consider with external customer which is a borrower, the desired cycle time is based on customer promise of 3 days after received of document submission from customer as shown in Figure 3.5. Therefore, it is vital for business to ensure that after receiving set of documents, the process of approval must not exceed three days processing time.

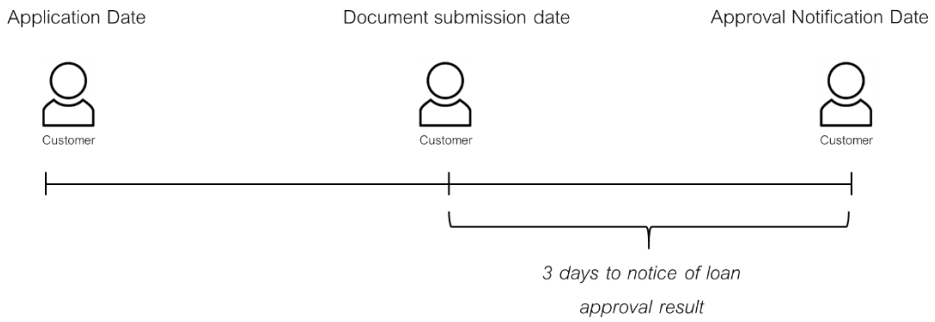

Figure 3.5 Customer's promise period in delivering loan approval result

(Source: derived by author)

To sum up based on identification of customer need, the desired lead time of 8 days are expected from the process improvement in this research.

3.2.2 Identify main processes

The identification of main processes of housing loan business are explained to understand how the current process is being operated and lead to establishment of current state of value stream mapping and being conducted via the method of interview from business operators in each process.

While the scope of process that being focused is credit assessment starting from when customer request a loan until the result of approval is being noticed to customer. In the credit assessment of housing loan business process in the studied bank, there are seven main processes in housing loan business process which divided into two stages including pre-screening and approval as shown in Figure 3.6

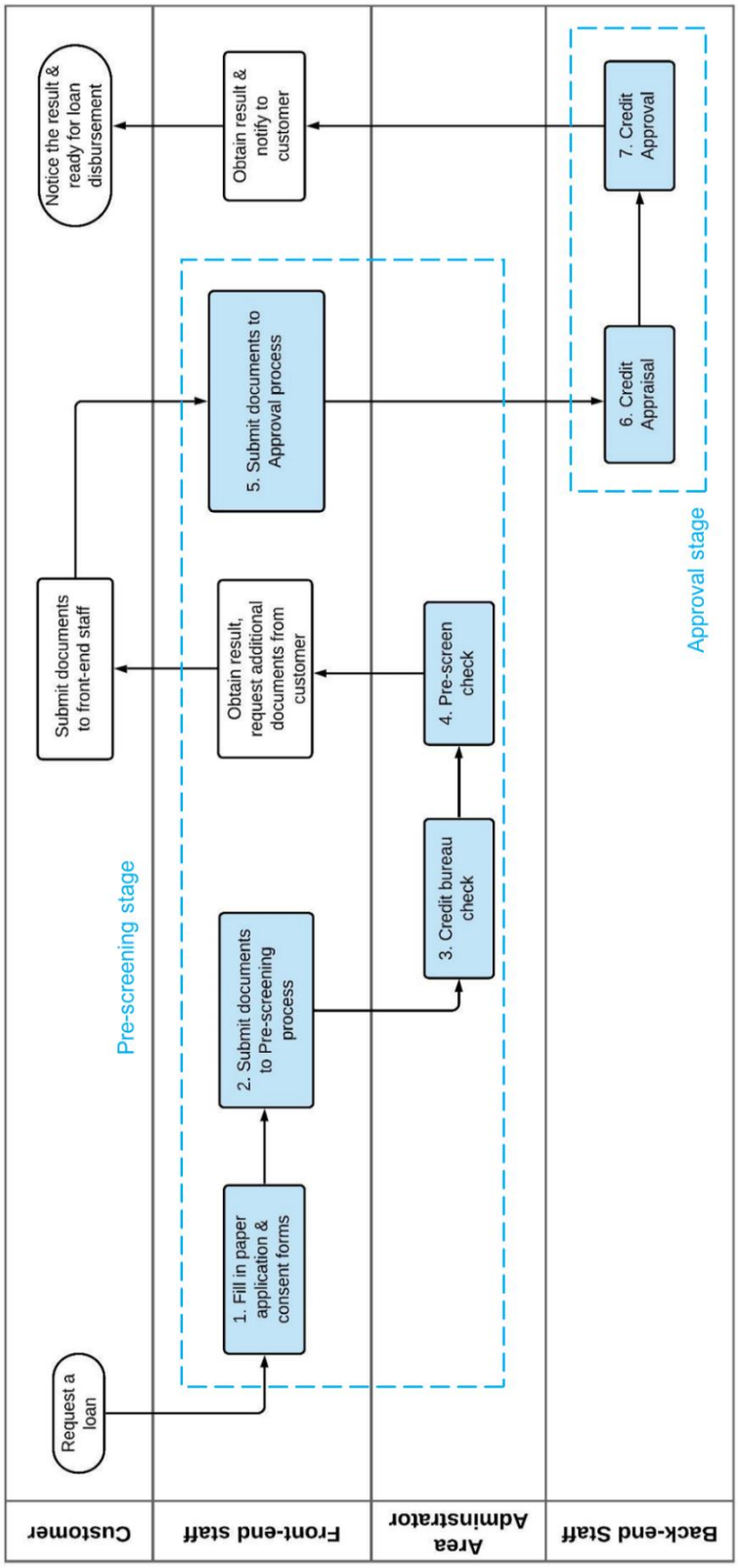

Figure 3.6 Housing loan business process flow

(Source: derived by author)

Pre-screening stage

Step 1 Fill in application and consent forms

This step is known as data acquisition step that front-end staff or salesperson start collecting basic information, detail of occupation and work, detail of requested product from customer to fill in paper application form and consent forms including Credit bureau and credit modelling.

The detail of data that required in paper application are approximately 80 fields based on the character of customer in which required effort from salesperson to fill in by hand-written. While consent forms also required duplicated of customer's data with additional 10 fields including basic information and contact information to fill in for completion of step.

Step 2 Submit documents to Pre-screening process

After customer has signed all application and consent forms, front-end staff/salesperson would submit all documents to area administrator to proceed pre-screening process which include steps of credit bureau check and pre-screen check.

Step 3 Credit bureau check

Credit bureau check is a first station to verify initial customer's eligibility by exchange of customer's credit information with National Credit bureau (NCB), the central data centre.

After received all documents from front-end staff, area administrator starts keying Credit bureau request to KCBS system which is a central system of studied bank that use

for storing customer's credit information with NCB. Approximate waiting time of receiving result after requested is two days. And once a credit result is received, area administrator continues to summarize the credit bureau result into form to submit back to front-end staff. The sub-tasks of credit bureau check step are demonstrated in Figure 3.7.

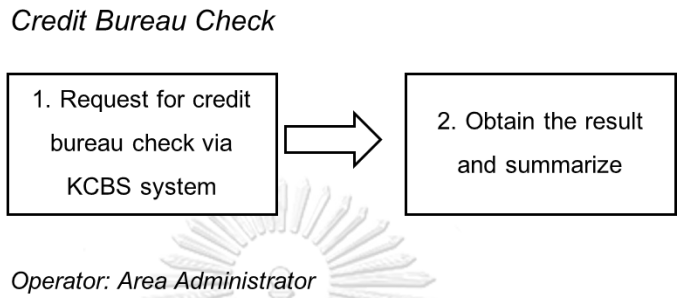

Figure 3.7 Sub-tasks in current step of credit bureau check

(Source: derived by author)

Step 4 Pre-screen check

The second station for eligibility validation is the process of pre-screen check that common policy rules, home loan policy rules, and calculation rules set by the studied bank are being considered such as summary income calculation, debt calculation, credit exposure.

This step also performs by area administrator starting by input customer's data from paper application and Credit bureau result to excel formula template called 'V3' to generate the result of pre-screen. After all result is validated, area administrator continues to submit all documents and result back to front-end staff. The detail of sub-tasks in pre-screen check is shown in Figure 3.8.

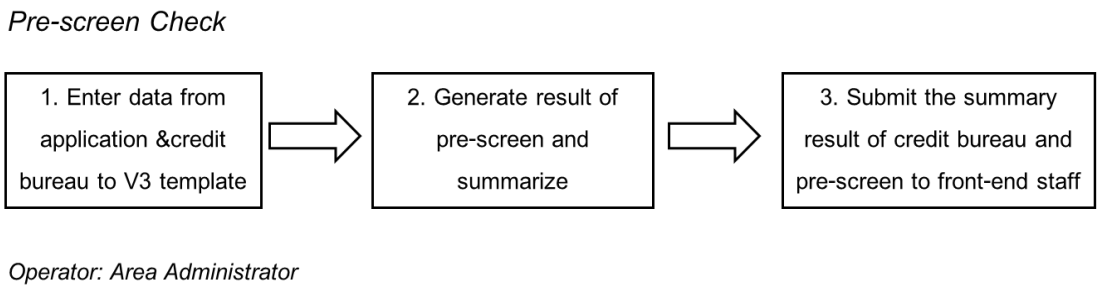

Figure 3.8 Sub-tasks in current step of pre-screen check

(Source: derived by author)

Step 5 Submit documents to approval process

In this step front-end staff obtain all data and documents from area administrator including Credit bureau and pre-screen result and gather all required documents as a set to submit to approval process. List of all documents required are including:

1) Paper application form signed by customer.
2) Credit bureau and credit modelling consent forms signed by customer.
3) Credit bureau and Pre-screen summary result.
4) Additional documents relating to financial status, collateral etc.

After completely collected all set of documents, front-end staff has to re-keying data to 'Transact' which is approval legacy system that store all customer applications and use for tracking the application between front-end staff and back-end staff. And then submit all document to back-end staff via e-mail. Figure 3.9 shows sub-tasks that operate in Step 5.

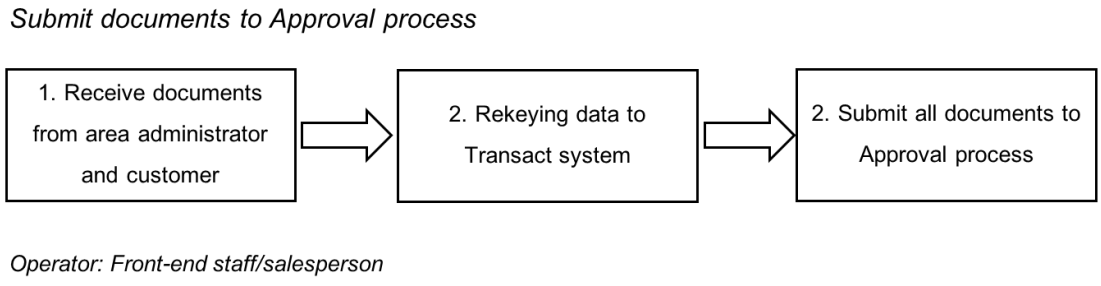

Figure 3.9 Sub-tasks in current step of submit documents to approval process

(Source: derived by author)

To remark, there are waiting time in receiving set of documents from customer which takes around 1-7 days depending from different situations that mainly caused by difficulty in getting specific documents for customer.

Approval Stage

Step 6 Credit Appraisal

As the product housing loan is collateral based, therefore the step of credit appraisal is necessary. In which, the process start by front-end staff has to request for appraisal process using the central system called 'CATs' and then the process continues to appraisal company. The sub-tasks of credit appraisal step are illustrated in Figure 3.10.

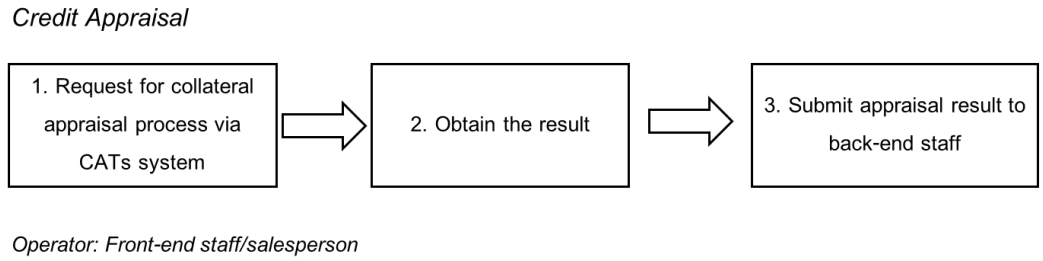

Figure 3.10 Sub-tasks in current step of credit appraisal

(Source: derived by author)

Step 7 Credit Approval

The process continues to back-end staff or underwriter to proceed in the step of credit approval. The roles that involve in this step are including back-end administrator, back-end credit analyst, and back-end credit approval staff. In which, the first step is run by back-end administrator to re-check all information from application and documents before handling to back-end credit analyst.

Then credit analyst continues the process of income validation, appraisal collateral validation, and submit to validate fraud and sanction assessment which takes approximately a day to obtain the result. After tasks of credit analyst has accomplished, then the process goes to the step which is run by credit approval staff to finally validating customer's creditworthiness and give a decision in granting a loan. In which, this is the last step for credit assessment and then a loan disbursement process can continue which is not focused in this research. The detail of sub-tasks in the step of credit approval is shown in Figure 3.11.

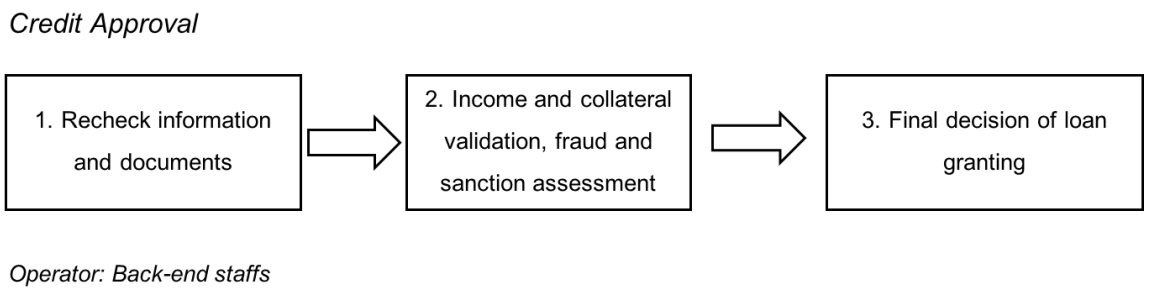

Figure 3.11 Sub-tasks in current step of credit approval

(Source: derived by author)

After the detail of each main processes are explored, Table 3.3 is a summarization of main processes including responsible operators.

Table 3.3 Detail of sub-tasks in each steps of housing loan business process

Processes	Sub-tasks	Operator	No. of operator
Step: 1 Fill in application and consent forms.	-	Front-end staff/Salesperson	1
Step 2: Submit document to pre-screen process.	-	Front-end staff/Salesperson	1
Step 3: Credit bureau check.	3.1 Request for Credit bureau check via KCBS system. 3.2 Obtain the result and summarize.	Area Administrator	1
Step 4: Pre-screen check.	4.1 Enter data from application &Credit bureau to V3 template. 4.2 Generate result of pre-screen and summarize.	Area Administrator	1
Step 5: Submit documents to Approval process.	5.1 Receive documents from area administrator and customer. 5.2 Rekey data to Transact system. 5.3 Submit all documents to Approval process.	Front-end staff/Salesperson	1

Step 6: Credit Appraisal.	6.1 Request for collateral appraisal process via CATs system 6.2 Obtain the result 6.3 Submit appraisal result to back-end staff.	Front-end staff/Salesperson	1
Step 7: Credit Approval.	7.1 Recheck information and documents 7.2 Income and collateral validation, Fraud, and sanction assessment. 7.3 Final decision of loan granting.	Back-end staffs	3

Next step is to explore the time dimensions which will be key process metrics that are essential to establish on Value Stream Mapping as found in the next section 3.2.3.

3.2.3 Select process metrics

After the main processes are identified next step is to select the process metrics to fill in the process boxes on VSM. To be able to identify the suitable metrics, researcher and team has been through the process of interview. In which the participants were operators who usually perform the housing loan transactions including the role of front-end staffs, area administrators, and back-end staffs.

And completion of interview, researcher has gathered all the data and started the group discussion among project improvement team has been proceeded and then came to a final conclusion of the chosen metrics that were Lead Time (L/T), Process Time (P/T), Query Time (Q/T), and Waiting time (W/T) which are the common metrics that being used in value stream mapping.

According to Sarkar 2007, briefly indication of each metric that applied to the housing loan origination process are explained as follows:

-Lead Time (L/T) = Process Time (P/T) + Query Time (Q/T) + Transit time (T/T).

-Process Time (P/T) = the actual time required to complete a task.

-Query Time (Q/T) = the time spent addressing the queries in a process.

-Waiting Time (T/T) = time that the items in the process wait to be worked on such as inventory of materials, physical documents, and information.

Query time is time spending in doing queries of transactions of area administrators and credit appraisal company staff that need to execute before the current task can start which occur in step 3 credit bureau check, step 4 pre-screen check, and step 6 credit appraisal.

While waiting time is time spending in waiting the result from third parties including NCB and appraisal company in step 3 credit bureau check and step 6 credit appraisal and waiting of document submission from customer in step 5 submit documents to approval process. Table 3.4 illustrates observation of additional process metrics including query time and waiting time in housing loan business process.

Table 3.4 Observation of additional process metrics in housing loan business process

Process Steps	Query time	Waiting time
1.Fill in application and consent forms		
2.Submit documents to pre-screen process		
3.Credit bureau check	O	O
4.Pre-screen check	O	
5. Submit documents to Approval process		O
6.Credit appraisal	O	O
7.Credit approval		

After the process metrics are defined, the collection of time dimension in each process metrics are being recorded and summarized in Table 3.5 which is shown in the cycle time in days. The cycle time of each process step were being collected from the method of interview from operators and calculated using an average.

Table 3.5 Process metrics of housing loan business process

Step	Process	Metrics			Cycle Time (Days)
		Q/T	W/T	P/T	
Step 1	Fill in application and consent forms.	0	0	0.04	0.04
Step 2	Submit document to pre-screen process.	0	0	0.04	0.04
Step 3	Credit bureau check.	1	2	0.08	3.08
Step 4	Pre-screen check.	1	0	1	2.00
Step 5	Submit documents to Approval process.	0	3	0.08	3.08
Pre-screening stage		**2**	**5**	**1.24**	**8.2**
Step 6	Credit Appraisal.	0	1	0.08	1.08
Step 7	Credit Approval.	0	0	2	2
Approval stage		**0**	**1**	**2.08**	**3.1**
Total Lead Time (Days)					**11.3**

3.2.4 Value Stream Mapping

After the chosen metrics have collected and summarized in Table 3.5, the tool called Value Stream Mapping has been used to visualize and point out the problems of the current workflow and identify where wastes or non-value added activities are hidden within the current process as shown in Figure 3.12.

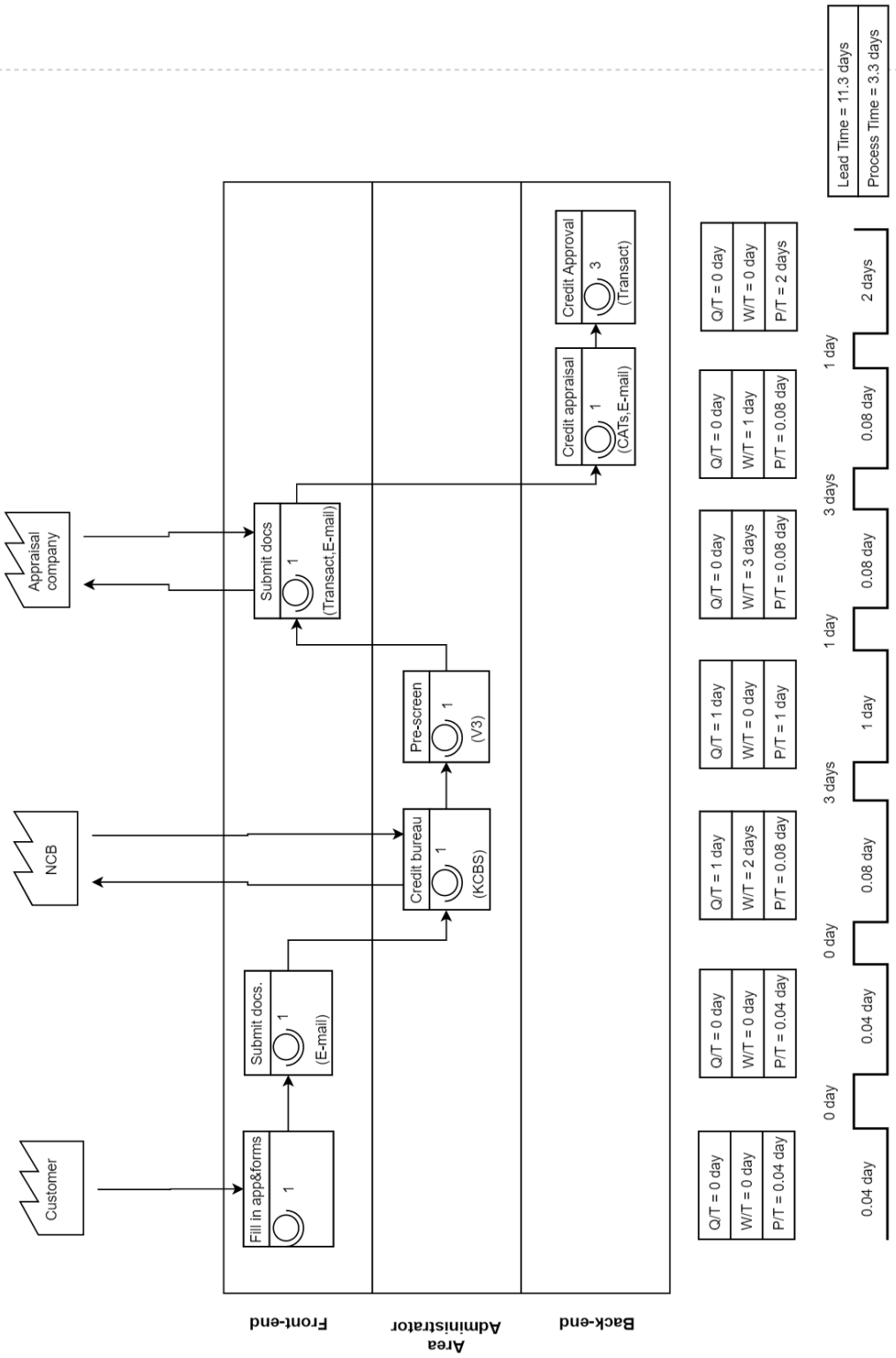

Figure 3.12 Current Value Stream Mapping

To identify current process cycle efficiency based on current value stream mapping in Figure 3.12, the total lead time the current process is 11.3 days where the process time or execution time is 3.3 days making process cycle efficiency which is execution time divided by cycle time is equal to 29% as summarized in Table 3.6.

Table 3.6 Overall current process metrics

Lead Time	11.3	Days
Process Time	3.3	Days
Process Cycle Efficiency	29%	%

While considering at cycle time of pre-screening stage, and approval stage as shown in Table 3.7. Cycle time of Pre-screening stage was taken around 8.2 days while cycle time of approval stage was only 3.1 days.

Table 3.7 Overall current cycle time and lead time

Cycle Time of Pre-screening stage	8.2	Days
Cycle Time of Approval stage	3.1	Days
Lead Time	11.3	Days

As the objective of research is to reduce cycle time of pre-screening stage and improve process efficiency, therefore, identifying waste from observation of specific tasks of current process using appropriate lean tools such as eight wastes analysis, cause and effect analysis, and prioritizing root causes for problem solving using pareto chart in advance are considered necessary which will be conducted in the following sections to eventually find out specific area to improve.

3.2.5 Observation of wastes

The observation of eight wastes in service processes based on Sarkar 2007, has been accomplished to reveal non-value-added activities of housing loan business process. The method of observation was conducted by going through process walk of project improvement team and interview from perspective of actual operators both front-end staff and back-end staff.

1. Overproduction

There was additional comment from back-end staff about receiving extra copies of documents from front-end staff that were unnecessary needed in the step of credit approval (Step 7).

2. Motion

There is no observation of motion of waste as the movement of individual that is unnecessary for completing job in the current process.

3. Inventory

According to the availability of area administrator not fully operate to support only housing loan transactions which assumed at approximately 50% availability to perform housing loan tasks, therefore, it has caused major time spent addressing the queries known as query time in a process as seen in step of credit bureau check (Step 3) and pre-screen check (Step 4) which are one of the key symptoms of process bottleneck.

4. Transportation

There is no observation of transportation waste as the movement of materials in the current process.

5. Waiting

According to observation on VSM and interview of front-end staffs and area administrators, the time spent on waiting are the highest consumption in processing the current process. First is a wait of document submission from customer in step 5 which is unavoidable, dependent, and neither business-value-added nor non-value-added activity and was not considered as waste. The approximate waiting time is in a range of week and taken at average of 3 days spent in the current process.

Another waiting time were from waiting of result from third party like NCB and appraisal company from step of credit bureau check (Step 3) and credit appraisal (Step 6) that takes a day for the result to be notified to operator.

6. Underutilized people

There is no observation of underutilized people waste in the current process.

7. Defects

Possible error that could capture from interview and going through the process was wrong information input from unclear-handwritten application in which could be one of the major reasons of long lead time as the process need to be resubmitted.

8. Overprocessing

Over-processing is observed due to duplication of manual entry of data in step of fill in application (Step 1), enter data to V3 system to validate pre-screen result in Pre-screen check (Step 4), and rekeying data to system before submit to approval process (Step 5). The required input of data in those three steps is found to be similar and repeated process which is considered as non-value-added activities.

To summarize from observation, Table 3.8 illustrates mapping of steps in the process with the observed wastes known as eight wastes analysis.

Table 3.8 Eight wastes analysis

Process	Waste							
	Overproduction	Motion	Inventory	Transportation	Waiting	Underutilized people	Defects	Overprocessing
Pre-screening stage								
1.Fill in application and consent forms							O	O
2.Submit documents to pre-screen process								
3.Credit bureau check			O		O			
4.Pre-screen check			O		O			O
5. Submit documents to Approval process								O
Approval Stage								
6.Credit appraisal					O			
7.Credit approval	O							

After doing analysis of wastes it can reveal that the potential causes of long cycle time are majority of wastes from waiting, over processing, and inventory and the highlight area that need to be focused as priority for improvement.

In which, in the next section, further exploration of long cycle time problem was conducted using cause and effect analysis.

3.2.6 Cause and Effect Analysis

To analyse the main causes of problem, fishbone diagram or cause-effect analysis is a suitable tool to identify the root causes and widely used in the project improvement. To establish the fishbone diagram, brainstorming session is assessed to list out all possible ideas related to the focus problem. After the brainstorming session, fishbone diagram of long cycle time problem has been established with key branches relating to the problem including Process, People, Technology, and Information illustrated in Figure 3.13.

Fishbone diagram shows that main causes of long cycle time problem are varied by several reasons. To summarize based on observation, interview, and discussion among the team, main causes of long cycle time are identified as follows:

1) Inflexibility of process.
2) Long waiting time.
3) Legacy system.
4) Data entry error.
5) Low accessibility of information.
6) Availability of staff.
7) Work experience of staff

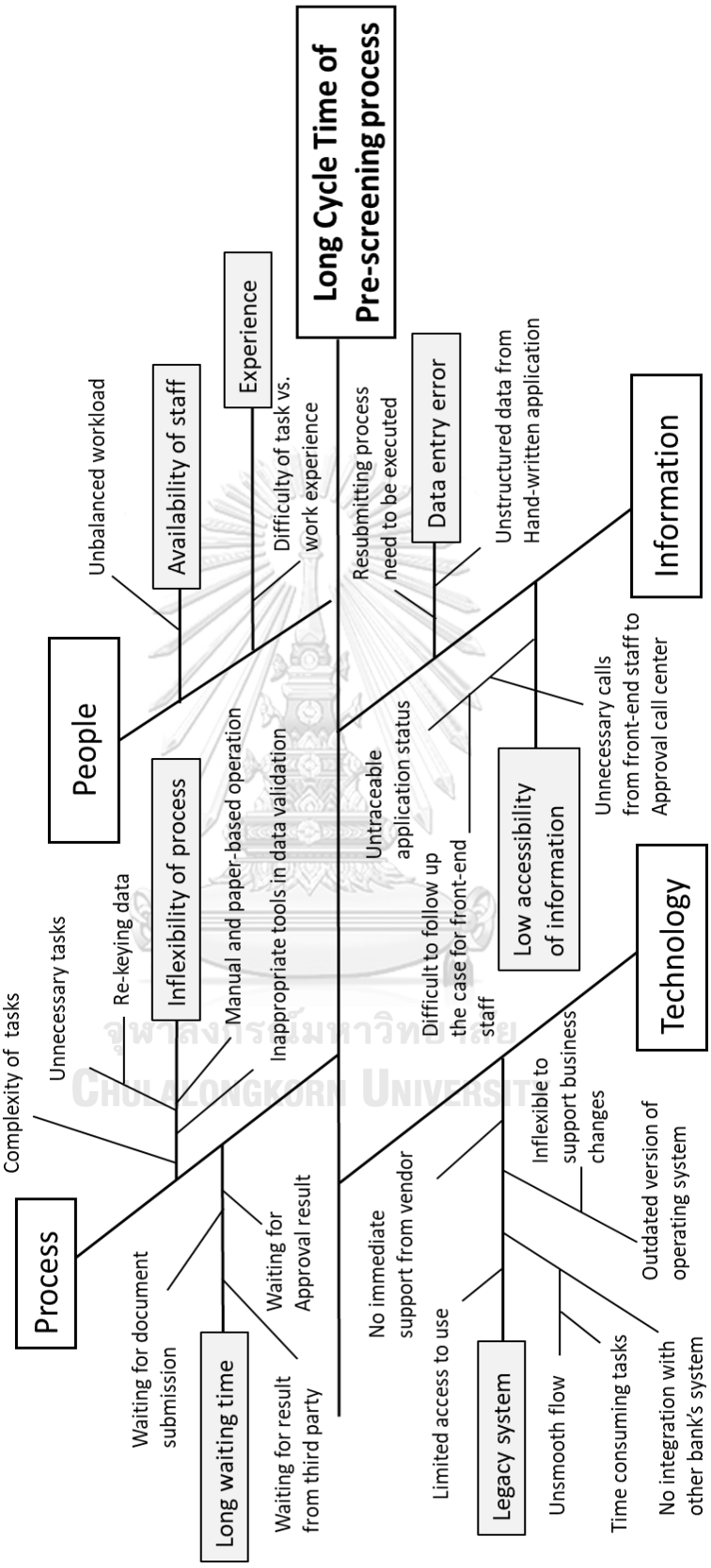

Figure 3.13 Cause and Effect diagram of long lead time problem

According to each main causes contains root causes of the problem, to prioritize on which roost causes need to be primarily focused, pareto chart is approached to identify the importance of causes, the team has been discussed and score the priority of each causes based on degree of seriousness judged by the Head of Housing loan business process in the studied bank that known as housing loan business expertise who has been working in this specific field more than 27 years. In which the priority that scored 5 means the highest importance. The summarization of priorities of long lead time root causes is illustrated in Table 3.9.

The pareto chart of root causes of long cycle time have established and shown in Figure 3.14 after prioritization was conducted while the relationship of root causes affecting with process steps are shown in Table 3.10. The highlight steps that critically contains highest counts of affecting root causes are Step 3 credit bureau check, Step 4 pre-screen check, and Step 5 submit documents to Approval process, in which will be considered as the priorities process for improvement.

Table 3.9 Root causes matrix

No.	Root causes of long cycle time	Priority				
		1	2	3	4	5
Process- Inflexibility of process						
1.	Manual and paper-based operation					O
2.	Inappropriate tools in data validation					O
3.	Unnecessary tasks e.g. re-keying data			O		
Process- Long waiting time						
4.	Waiting of document submission					O
5.	Waiting of result from third parties					O
Technology- Legacy system						
6.	Inflexible system to support business changes					O
7.	Outdated version of operating system				O	
8.	No integration with other bank's system					O
9.	Unsmooth flow				O	
10.	No Immediate support from vendor			O		
11.	Limited access of system		O			
People-Availability of staff						
12.	Unbalanced workload			O		
People- Staff experience						
13.	Difficulty of task vs. work experience	O				
Information- Data entry error						
14.	Resubmitting process need to be executed		O			
15.	Unstructured data from hand-written application		O			
Information- Low accessibility of information						
16.	Untraceable application status		O			

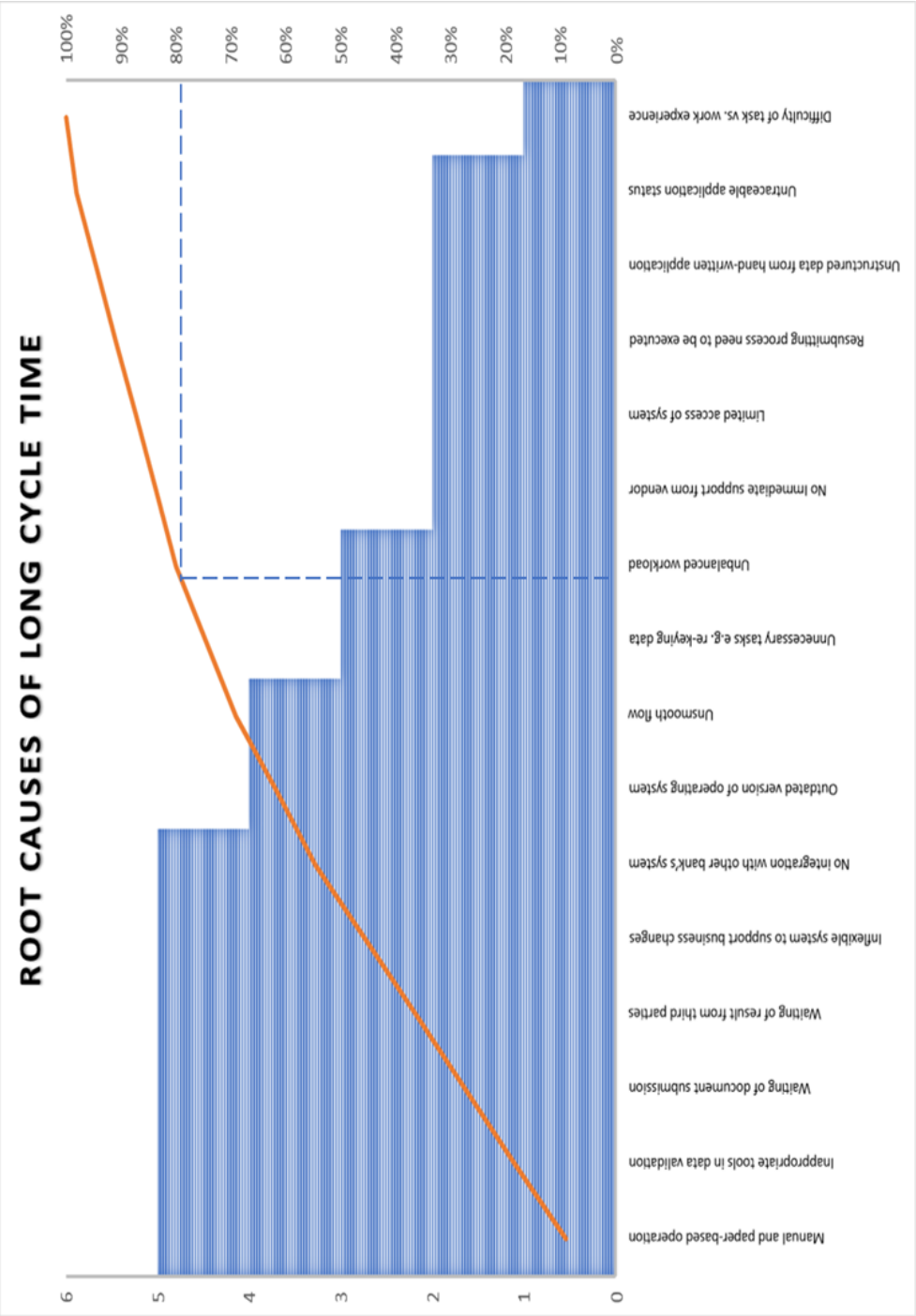

Figure 3.14 Pareto chart of root causes of long cycle time

Table 3.10 Relationship between root causes and process steps

No.	Root causes of long cycle time	Process				
		Step1	Step2	Step3	Step4	Step5
Process- Inflexibility of process						
1	Manual and paper-based operation	O	O	O	O	O
2	Inappropriate tools in data validation				O	
Process- Long waiting time						
3	Waiting of document submission					O
4	Waiting of result from third parties			O	O	
Technology- Legacy system						
5	Inflexible system to support business changes	O	O	O	O	O
6	Outdated version of operating system	O	O	O	O	O
7	No integration with other bank's system	O	O	O	O	O
8	Unsmooth flow	O	O	O	O	O
Process- Inflexibility of process						
9	Unnecessary tasks e.g. re-keying data					O
People-Availability of staff						
10	Unbalanced workload			O	O	

To summarize, the significant root causes of long lead time problem and the focus area of improvement based on priority of importance are illustrated in Table 3.11.

Table 3.11 Significant root causes of long lead time and focused steps for improvement

Significant Root causes of Long cycle time problem
1. **Inflexibility of process** – that mainly caused by manual and paper-based operation, using inappropriate tools in data validation, and composing of unnecessary tasks.
2. **Long Waiting Time-** due to wait of submission of documents and wait of result from third parties' company.
3. **Legacy System –** that are inefficient to support business changes, outdated-version, has no integration with other's bank system causing unsmooth flow in the process.
4. **Availability of staff-** that has unbalanced workload of area administrator causing query time in the process.

3.3 Future State Map Analysis

According to Locher 2008, powerful value stream mapping is the creation of a future state map based on lean concepts which consists of seven guidelines future state questions but in this research some of questions have been chosen for guidelines including:

3.3.1 What does the customer really need?

To recap, respond the demand for internal customers, the desired lead time of each process stage is being set as the target for improvement of cycle time based on desired business target and customer promise which is demonstrated in Table 3.12. The target cycle time of 5 days is aimed for improvement of process in pre-screening stage which contribute in reducing the desired lead time after improvement to 8 days.

Table 3.12 Desired cycle time and lead time for improvement

Process	Current Cycle Time	Desired Cycle time for Improvement
Pre-screening stage Step 1 Fill in application and consent forms. Step 2 Submit documents to Pre-screen process. Step 3 Credit bureau check. Step 4 Pre-screen check. Step 5 Submit documents to Approval process.	8 days	5 days (Business's target)
Approval stage Step 6 Credit appraisal. Step 7 Credit approval.	3 days	3 days (Customer promise)
Desired Lead Time for improvement		8 days

3.3.2 What process improvements will be necessary?

According to the identification of root causes of problem and non-value-added activities are revealed, listing out of possible solutions to improve can be considered.

The common significant solution that effectively solve all key root causes of problem in terms of efficiency, accuracy, and cost is to transform the process to be digitized and automation through the concept of digital transformation. In which in the studied bank has been currently working on transformation of business process under the improvement project called Formula Lending Project (FLP). All members of project improvement team in this research were also involved in FLP project in a role of business process improvement that involved in every stages of the project starting from stage of business requirement until the project is launched to go-live phase or production phase in which will be explained in section 3.4.2. Project team.

Key concept from digital lending was approached in the FLP project in including transformation of paper to electronic application with enhancement of key technologies including Artificial Intelligence and Machine Learning. The new system called 'Formula Lending System' or FLS which being developed under FLP project is web-based application developed by the studied company and their subsidiary business technology company. FLS was aimed to replace Transact system which was a legacy system that being operated for more than 10 years under support from vendor. It is a single integrated system that designed to be more applicable, friendly use, and combined all decision engines that can help user to proceed the tasks faster with less complexity. It was not designed for only branch staff but for all parties related such as approval staff which is another main role in the process of housing loan business.

Desired improvement of reduction of cycle tme are expected from main key capabilities of the new system including electronic credit bureau check, automated credit decision for pre-screen check that introduced the transformation of process which will be explained as follows:

Electronic Credit bureau check process

When moving to digital platform, the process of re-keying data from paper application to system is automatically eliminated as customer or staff can directly fill in the data on electronic application using FLS. This is highly efficient in terms of saving time of both customer and staff. The basic screens in application will contain all fields required paper application plus, some of fields will be automatically filled if the customer is existing customer in which partial information are collected already such as basic information including name, surname, identity card number, contact number etc.

The process of electronic Credit bureau check in the studied commercial bank are described as follows:

Step 1 Front-end staff/Salesperson log in to FLS application via Tablet.

Step 2 Key in customer's detail including Identity card number and mobile phone number that registered to Mobile Banking application.

Start of e-Consent process via customer's mobile banking application.

Step 3 Notification of e-Consent will pop up on customer's mobile banking application.

Step 4 Customer Log in to application.

Step 5 Detail of Credit bureau and credit model e-Consent are provided for customer to accept.

Step 6 If the customer accepted all the consent, there will be related documents of consent sent to the customer via e-mail.

And then the process of e-Consent will end in the part of customer and move on to front-end staff role to check the result of Credit bureau result which is real-time processing from FLS system. By approach of electronic Credit bureau check, it also contributes in making the overall journey of pre-screening stage to be harmonized as the step of pre-screen check can be proceeded right after completion of electronic consent.

Automated credit decision in pre-screen check

According to approval result of in housing loan process is to verify qualification of the customer not only ability to pay debt but also include rule checking that followed by the bank's policy that need to be considered before making approval such as policy related to verification of sanction list, financial history, credit policy. Before the decision can be proceeded, the layer of data need to be input before validating the result as can be found in credit decision model of pre-screen process in Figure 3.15.

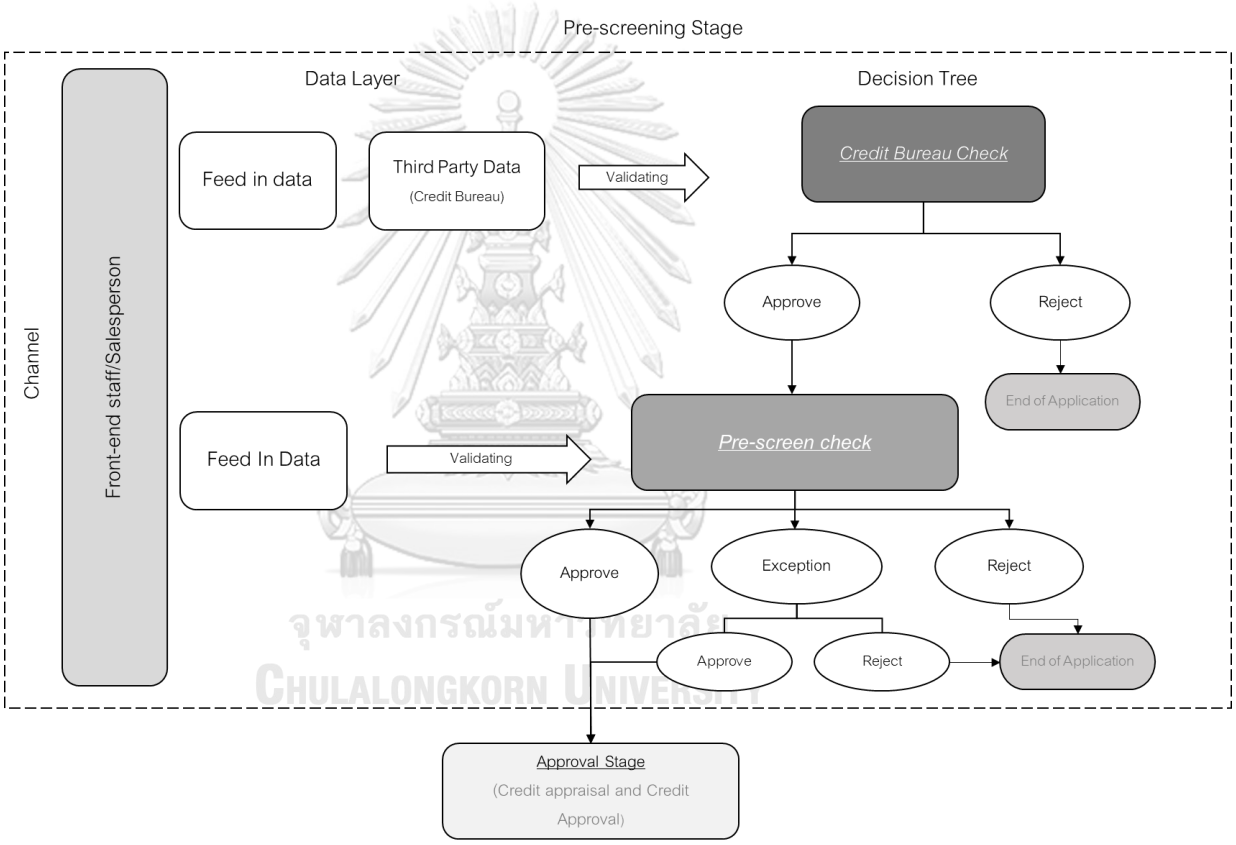

Figure 3.15 Credit decision model of FLS system

(Source: derived by author)

Data Layer

Before the decision can be made, the data layer that includes feed in of customer's data for credit bureau check and pre-screen check validation must be fulfilled. Therefore, it is essential for staff to fill required data to obtain credit decision. The detail of

data that required to fulfil in pre-screen process of the studied bank can be described though Table 3.13.

Table 3.13 Data required to run pre-screen decision for pre-screening process

Process	Data required to run the decision
Credit bureau Check	1. Identity Card Number. 2. Mobile Phone Number that registered to Mobile Banking Application.
	Customer Accept the consent via mobile banking application and then Credit bureau result can be checked via FLS. (Real-time approval)
Pre-screen check	*If Credit bureau result is passed,* 1. Detail from identity document. 2. Basic detail for verifying ability to pay debt. *(e.g. Purpose of requesting Loan, Purchasing price of collateral, Loan limit, Terms, Income per month)* 3. Customer detail. *(e.g. Address, Work address, Contact detail, Marital Status)* 4. Detail of Income. *(e.g. Income, Occupation, Work detail)* 5. Detail of requested product *(e.g. Type of Loan, Loan Limit, Term, Collateral Detail)* 6. Pricing Package

After all data required have been input, then the decision engine can run the Pre-screen result of the application. Next section will describe the detail of housing loan business rule is being validated and the output after decision engine has proceeded in the FLS application process.

Business Rule to Decision Engine

From the modification from FLS, it enhances the process of running pre-screen result to be automatic by approaching the credit decision engine that consists of rule manager, validation platform that allows the branch staff to run pre-screen result within few minutes rather than relying on manual intervention from the legacy system. In which, the detail that will be explained is reflected from business's point of view.

Credit Decision Engine referred from InfoSys,2019 compose of key components including Rule Manager, Validation Platform, and Testing and Debugging in which can be adapted for FLS Credit decision engine in terms of business perspective.

Rule Manager and Validation Platform:

These two components are set by housing loan business rules of the studied commercial bank that mainly consists of three main categories including common policy rule, home loan policy rule, and calculation that being used in the process of pre-screening. In each main category, there will be minimum acceptance criteria for decision to be made depending on the criticality level of rules. In the FLS system, each main category of rules will divide into subcategories and separated into groups for each time of running policy on FLS system. The example of rules that will be managed when running the pre-screen result using FLS are briefly described as the following Table 3.14.

Table 3.14 Example of pre-screen rules in credit decision engine of FLS system

Step	Rule Categories	Rule Sub-categories
Pre-screen check	1. Common Policy	Sanction & Fraud List (e.g. Sanction List, Suspect List, Fraud List)
		Credit Policy (e.g. Age, Nationality, Unsupported Company)
		Financial History (e.g. Credit Card Block Code, NCB Worse Performance flag)
	2. Home Loan Policy	Sanction & Fraud List (e.g. Fraud Company, Bankruptcy Company)
		Pricing (e.g. Verify Pricing)
		Product & Program (e.g. LTP/LTV, Loan Amount Limit)
		Related Income (e.g. Minimum Income)
		Other Rules (e.g. Number of House, Years of work, Ownership of collateral)
		Analytic (Decision making with Application, Customer and Transactional Score)
	3. Calculation	Calculation (e.g. Summary Income Calculation, Debt Calculation, Credit Exposure, Loan Calculation)

After rules of decision engine in business aspect are described, next step is to illustrate how the rules are being managed and validated in the FLS application. The screen of pre-screen summary result in Figure 3.16 is an output after decision engine has been processing and validating the rules to make credit decision of Housing Loan application based on business rules set in the studied commercial bank.

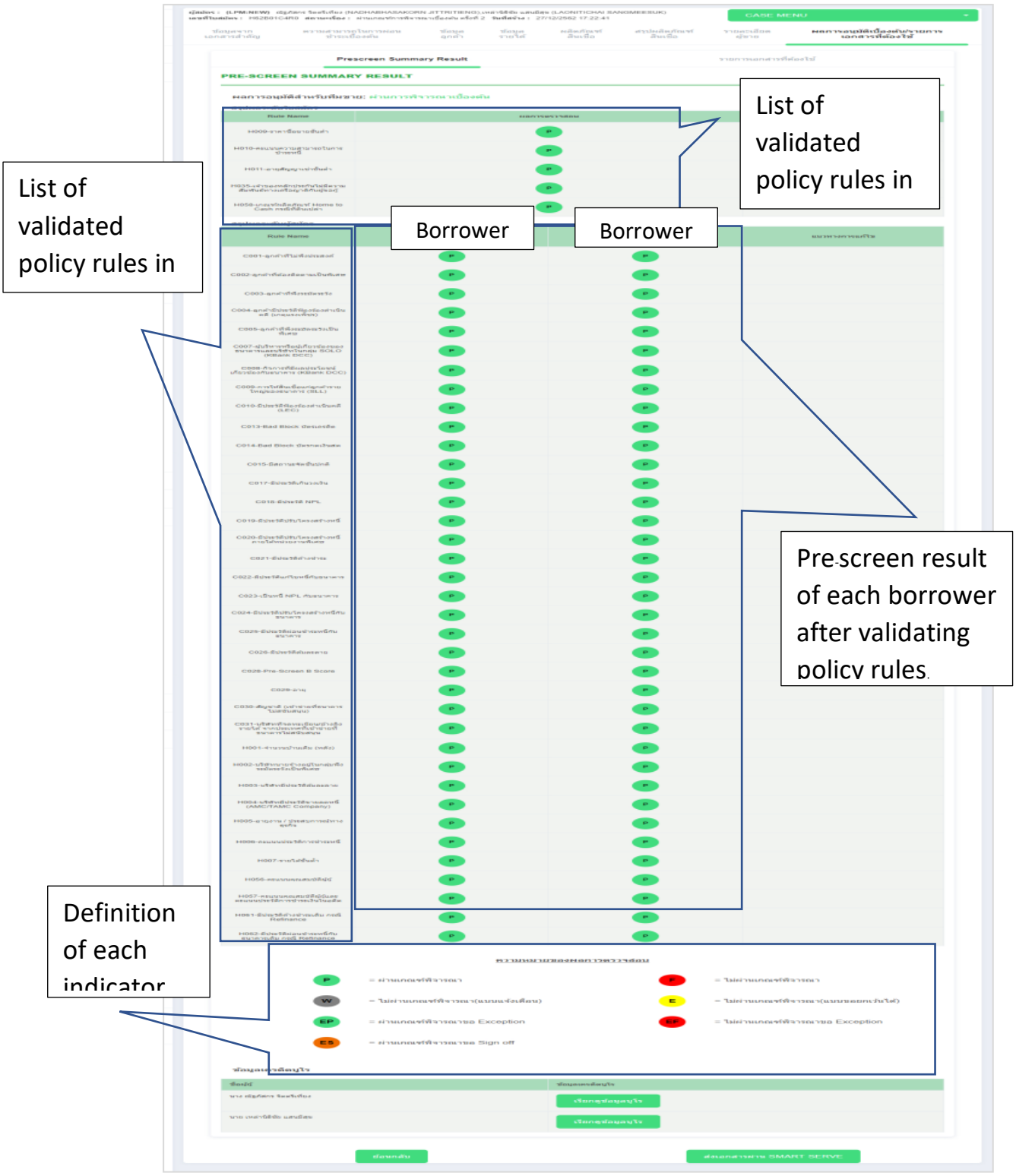

Figure 3.16 Screen of pre-screen summary result of FLS system

The pre-screen summary result will evaluate the decision made after validating all required rules that have been set in decision engine. In which the result can be varied depending on customer's eligibility. The definition of each result indicator that shown in pre-screen summary result are briefly explained as the followings and shown in Figure 3.17.

Result Indicators:

1) *Passed:* meaning that the application is approved at Pre-screen process.
2) *Warning:* meaning that the application is still passed but need further consideration from approval staff in some rules.
3) *Failed:* meaning that the application is rejected at Pre-screen process and it is end of the application.
4) *Exception:* meaning that the application is rejected but still can make an exception and need approval from manager level or higher.
5) *Exception Passed:* meaning that the exception is approved. Further step can proceed
6) *Exception Sign Off*: meaning that the exception is approved but still need consideration from approval staff to make final decision.

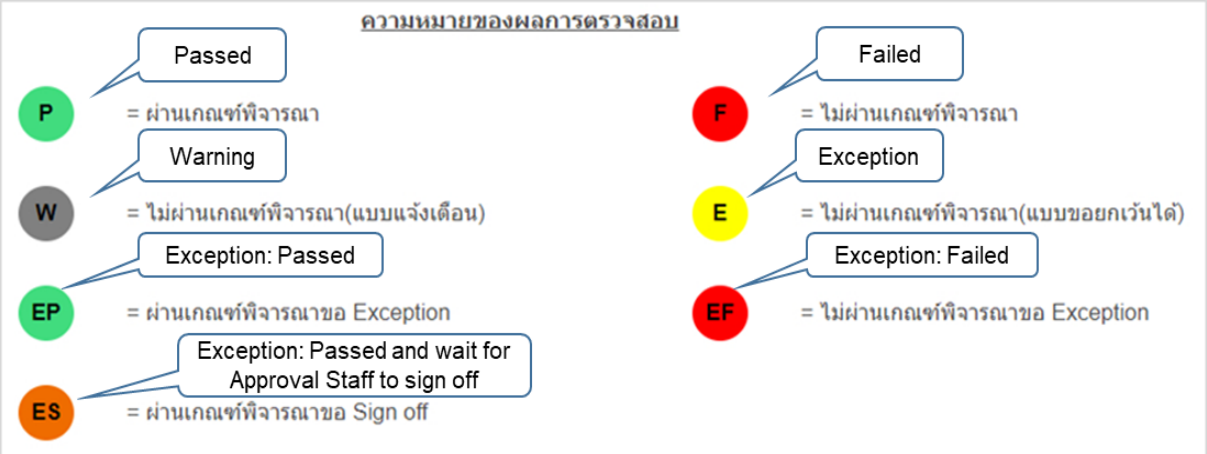

Figure 3.17 Definition of result indicators in pre-screen summary result screen of FLS system

Testing and Debugging:

After all the credit decision has been developed to serve housing loan business rules and before the system can be launched to production environment. It is necessary to test the functionality and usability of the system whether it serve business rules and operation or not to prevent any severe failures which are mostly conducted using the process of User Acceptance Testing which is key activity in project implementation and will be explained in section 3.4.3.

Conclusion of solution for Improvement

By gathering the solution from FLS system implementation under FLP project which mainly were from the concept of digital transformation in lending process with lean solutions including standardization, simplifying, and streamlining, the problem of long cycle time in pre-screening stage was aimed to be resolved. All possible solutions are listed and summarized in Table 3.15.

Table 3.15 Possible solutions to solve long cycle time problem

No.	Root causes of long cycle time	Lean Solutions	Possible solution	Responsible Team
Process- Inflexibility of process		**Standardization &Simplify and Streamline**	**Implementation of new system under Formula Lending Project (FLP)**	**FLP Project Team**
1	Manual and paper-based operation	-Eliminating a process step -Simplifying tools		
2	Inappropriate tools in data validation			
Process- Long waiting time		**Standardization &Simplify and Streamline**		
3	Waiting of document submission	Standardized documentation.		
4	Waiting of result from third parties	Streamline process by interfacing data with third-party to provide real-time processing.		
Technology- Legacy system		**Standardization &Simplify and Streamline**		
5	Inflexible system to support business changes	-Simplifying and upgrading tools. -Replacement of new developing system. -Order of process steps -Order of tasks within each process step.		
6	Outdated version of operating system			
7	No integration with other bank's system			
8	Unsmooth flow			
Process- Inflexibility of process		**Standardization &Simplify and Streamline**		
9	Unnecessary tasks e.g. re-keying data	Eliminating unnecessary tasks.		
People-Availability of staff		**Standardization &Simplify and Streamline**		
10	Unbalanced workload	Rearranging tasks to proper responsible operator.		

Next, the detail of changes of process after system implementation will be explored.

Detail of changes in future housing loan business process

According to digital transformation concept, the key processes are change based on approach of automation from technology of Artificial Intelligent and Machine Learning which will totally changing the whole end-to-end housing loan business process. The detail of changes in process steps will be explained by the steps based on new developing FLS system that will become as a new tool for operating housing loan process and aim to alleviate the bottleneck of the traditional process. The future process flow of housing loan business process is illustrated in Figure 3.18.

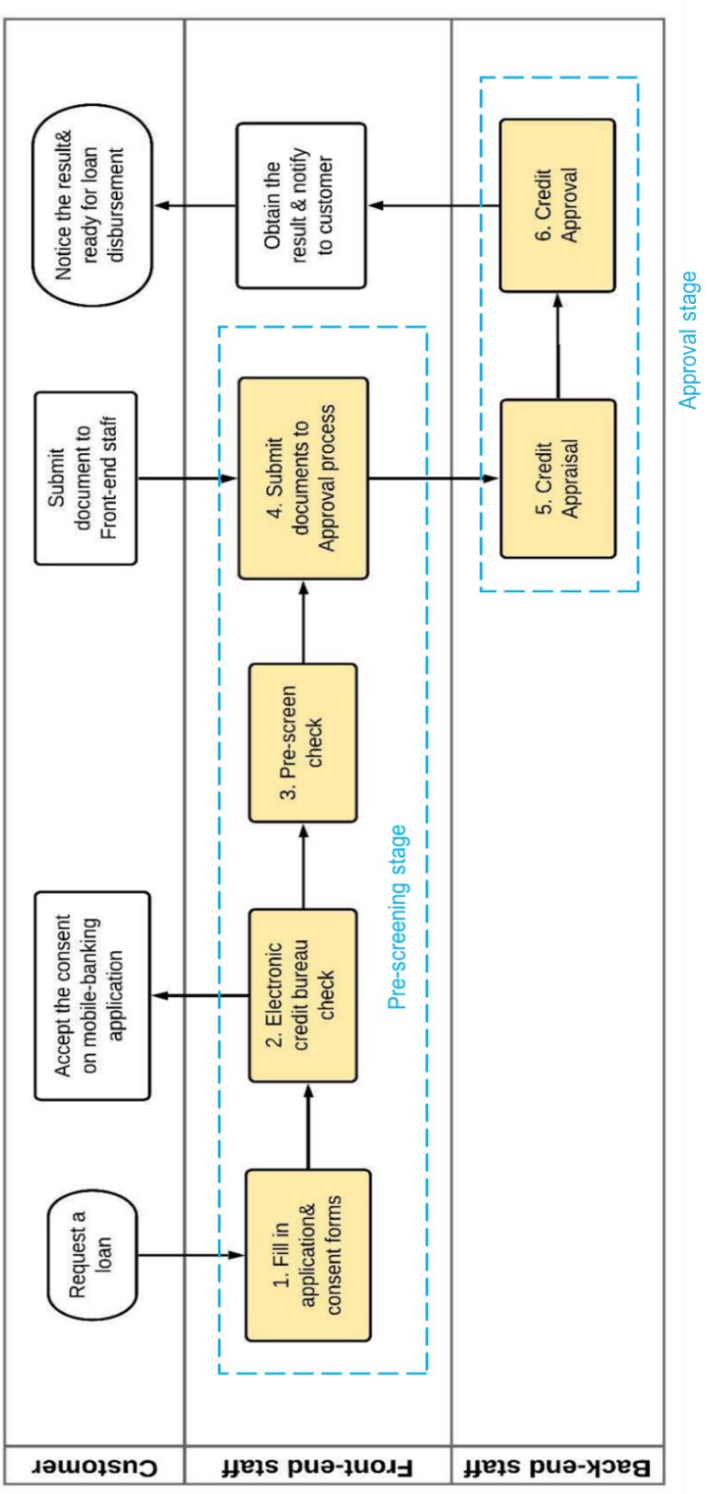

Figure 3.18 Future process flow of housing loan business process

Pre-screening stage

Step 1: Fill in application and consent forms

The step of fill in application and consent forms will be changed to electronic platform known as e-application which operated using FLS system via tablet or computer. The responsible role is still front-end staff or salesperson. Starting the process by log in to the system and fill in customer's basic information including registered mobile phone number and identity card number and then the process continues to electronic Credit bureau check automatically. The detail of sub-tasks is provided in Figure 3.19.

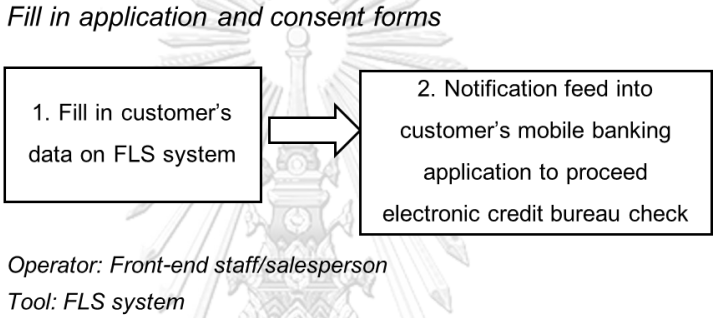

Figure 3.19 Sub-tasks in future step of fill in application and consent forms

Source: derived by author)

Step 2 Submit documents to pre-screen check

This step will be eliminated after system implementation.

Step 3 Credit bureau check

This step will be involved with customer as after the front-end staff filled the data to FLS system, there will be notification to customer's mobile banking application to let the customer proceed electronic consents including credit bureau check and credit modelling consents. If the customer accepts the consent via mobile banking application, it would automatically be syncing the data to NCB, third party company to request for credit bureau result. In which the result can be checked right after the request by front-end staff via FLS system.

To remark, the responsible operator in this step is changed to front-end staff as the process is changed to be continuous and can proceed instantly. Therefore, the role of area administrator is no longer required in this step which resulting in reduction of waiting time for credit bureau result and query time from addressing the queries before picking up tasks of area administrator. The detail of sub-tasks in this step is shown in Figure 3.20.

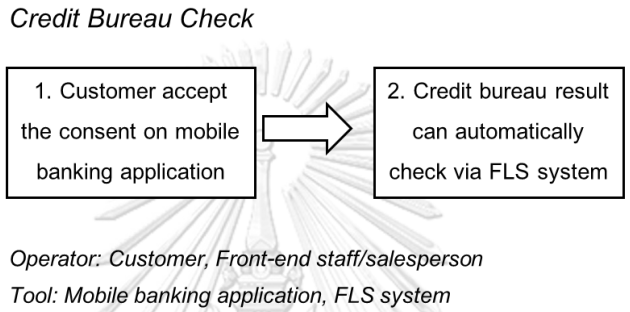

Figure 3.20 Sub-tasks in future step of credit bureau check

(Source: derived by author)

Step 4 Pre-screen check

If the credit bureau result is passed, front-end staff continues to the process of pre-screen check via FLS system. In which additional customer's data including detail of work, detail of requested products, detail of income is required to run the result based on common policy rules of bank before submitting to Approval process. The pre-screen result proceeded via FLS can be noticed within few minutes as it run automatically in which enhancing the process time to be shorter and reducing waiting time and query time when compared to the traditional process. Similarly, to step 3, the role of administrator is considered unnecessary and can be replaced and operated by front-end staff. The detail of sub-tasks is shown in Figure 3.21.

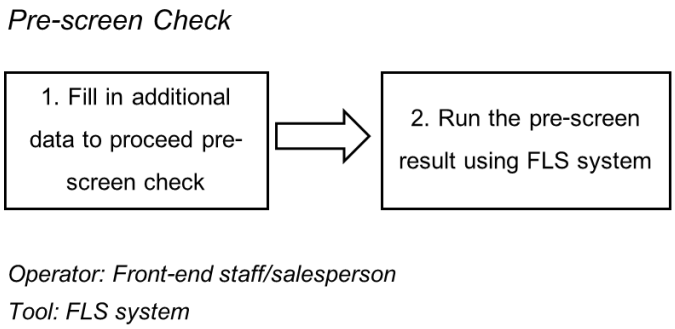

Figure 3.21 Sub-tasks in future step of pre-screen check

(Source: derived by author)

Step 5 Submit documents to Approval process

After Credit bureau and pre-screen result is noticed, before the process can continue, complete submission of documents from customer is required. In which the waiting time is dependent and still unavoidable. To assess for improvement, review list of required documents by making it to be standardized can be considered.

However, despite the waiting time of document submission, with enhancement of FLS system, unnecessary task like re-keying data from paper application to system is being eliminated as an approach of e-Application. Therefore, the process time of process would reduce from elimination of unnecessary task. The detail of sub-tasks is shown in Figure 3.22.

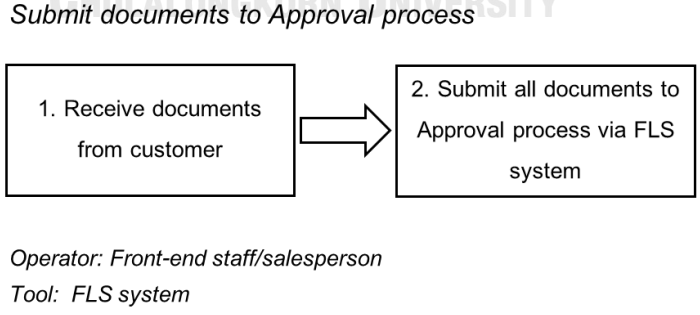

Figure 3.22 Sub-tasks in future step of submit documents to approval process

(Source: derived by author)

Approval stage

Step 6 Credit Appraisal

There is no significant change in the step credit appraisal except reducing of process time that contributed from aligning with FLS system. To start the step, front-end staff also need to request for collateral appraisal via CATs system and wait for the result from appraisal company which basically no change is assessed here. After front-end staff received the result, request number from CATs system need to input to FLS system to automatically pull in data from CATs system to record in FLS system.

From automatically linking appraisal data with FLS, this can enhance the process to be more efficient and seamless as all the data is recoded in the single integrated system. The detail of sub-tasks is shown in Figure 3.23.

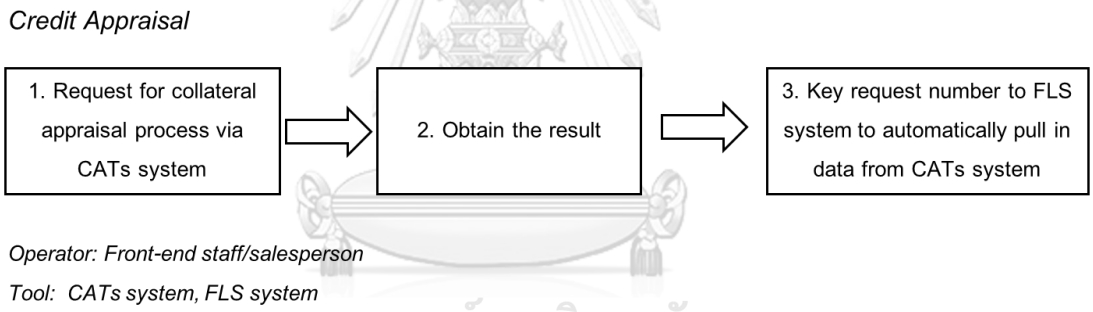

Figure 3.23 Sub-tasks in future step of credit appraisal
(Source: derived by author)

Step 7 Credit Approval

The last step of approval stage, all the data including Credit bureau, pre-screen check, collateral appraisal data has gathered to back-end staff to proceed the final credit assessment. Entire step in the credit approval process will be operated using FLS system.

In which according to each sub-task in the approval stage including income validation, fraud and sanction assessment normally taken operating hours nearly a day due to limited times of running of fraud result from responsible department in the studied bank which still need further improvement. Therefore, when compare between traditional

process and improved process, the process time is remained the same. The detail of sub-tasks is shown in Figure 3.24.

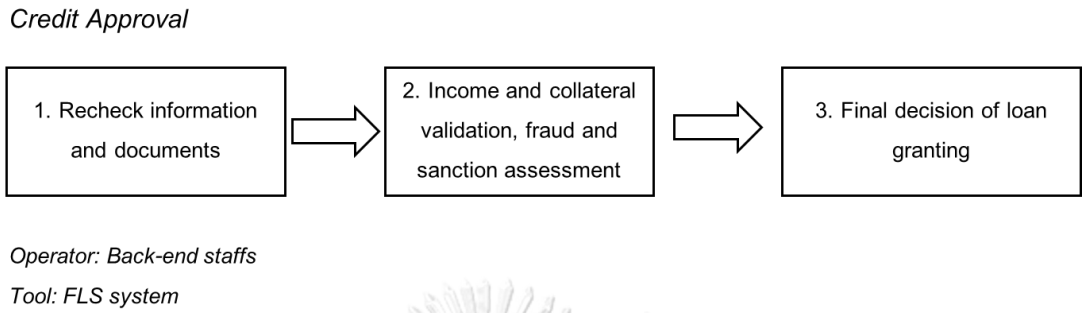

Figure 3.24 Sub-tasks in future step of credit approval

(Source: derived by author)

The summarized Table 3.16. demonstrates the comparison of traditional process and the future process in which there will be elimination of step 2 and role of area administrator occurred in future process.

Table 3.16 Summarized table of changes between current process and future process

Process	Current Process	Operator	New Process	Operator
Step1 Fill in paper and consent forms	1.1 Fill in paper application and consent forms. 1.2 Customer sign all forms.	Front-end staff	1.1. Fill in electronics application via FLS system.	Customer& Front-end staff
Step 2 Submit documents to Pre-screen process	2.1 Scan documents and submit to area administrator for Credit bureau check.	Front-end staff	This step is eliminated.	-
Step 3 Credit bureau Check	3.1 Request for Credit bureau check via KCBS system 3.2 Obtain result and summarize the result	Area Administrator	3.1 Customer receive notification of electronic consent and accept the consents via mobile banking application. 3.2 Real-time Credit bureau result can be checked via FLS system.	Customer& Front-end staff
Step 4 Pre-screen check	4.1 Enter data from application &Credit bureau to V3 template. 4.2 Generate result of pre-screen and summarize. 4.3 Submit the summary result of Credit bureau and pre-screen to front-end staff.	Area Administrator	4.1 Fill in additional data to run pre-screen check. 4.2 Pre-screen result is generated automatically.	Front-end staff

Step 5 Submit document to Approval process	5.1 Receive documents from area administrator and customer. 5.2 Re-key data to Transact system. 5.3 Submit all documents to Approval process.	Front-end staff	5.1 Receive documents from customer. 5.2 Submit all documents to Approval process.	Front-end staff
Step 6 Credit Appraisal	6.1 Request for collateral appraisal process via CATs system. 6.2 Obtain the result and submit appraisal result to back-end staff	Front-end staff	6.1 Request for collateral appraisal process via CATs system. 6.2 Key number of CATs request to FLS system and the appraisal result is automatically sync to FLS system.	Front-end staff
Step 7 Credit Approval	7.1 Recheck information and documents. 7.2 Income and collateral validation, fraud, and sanction assessment. 7.3 Final decision of loan granting.	Back-end staffs	7.1 Recheck information and documents. 7.2 Income and collateral validation, fraud, and sanction assessment. 7.3 Final decision of loan granting. (Steps are remained the same only change of system)	Back-end staffs

3.3.3 Future State Map

After all detail of changes in process has been explained, future process time dimensions including query time (Q/T), waiting time (W/T), and process time (P/T) are collected based on the performance that currently implementing, in which can be summarized in Table 3.17. The estimated cycle time of future pre-screening process is 6 days while the waiting time is reduced to 3 days and process time is 0.14 days. Moreover, Figure 3.25 shows the future state mapping of process after implementation.

Table 3.17 Future process metrics of housing loan business process

Step	Process	Metrics			Cycle Time (Days)
		Q/T	W/T	P/T	
Step 1	Fill in application and consent forms.	0	0	0.02	0.02
Step 2	Credit bureau check.	0	0	0.02	0.02
Step 3	Pre-screen check.	0	0	0.04	0.04
Step 4	Submit documents to Approval process.	0	3	0.06	3.06
Pre-screening stage		**0**	**3**	**0.14**	**3.14**
Step 5	Credit Appraisal.	0	1	0.08	1.08
Step 6	Credit Approval.	0	0	2	2
Approval stage		**0**	**1**	**2.08**	**3.08**

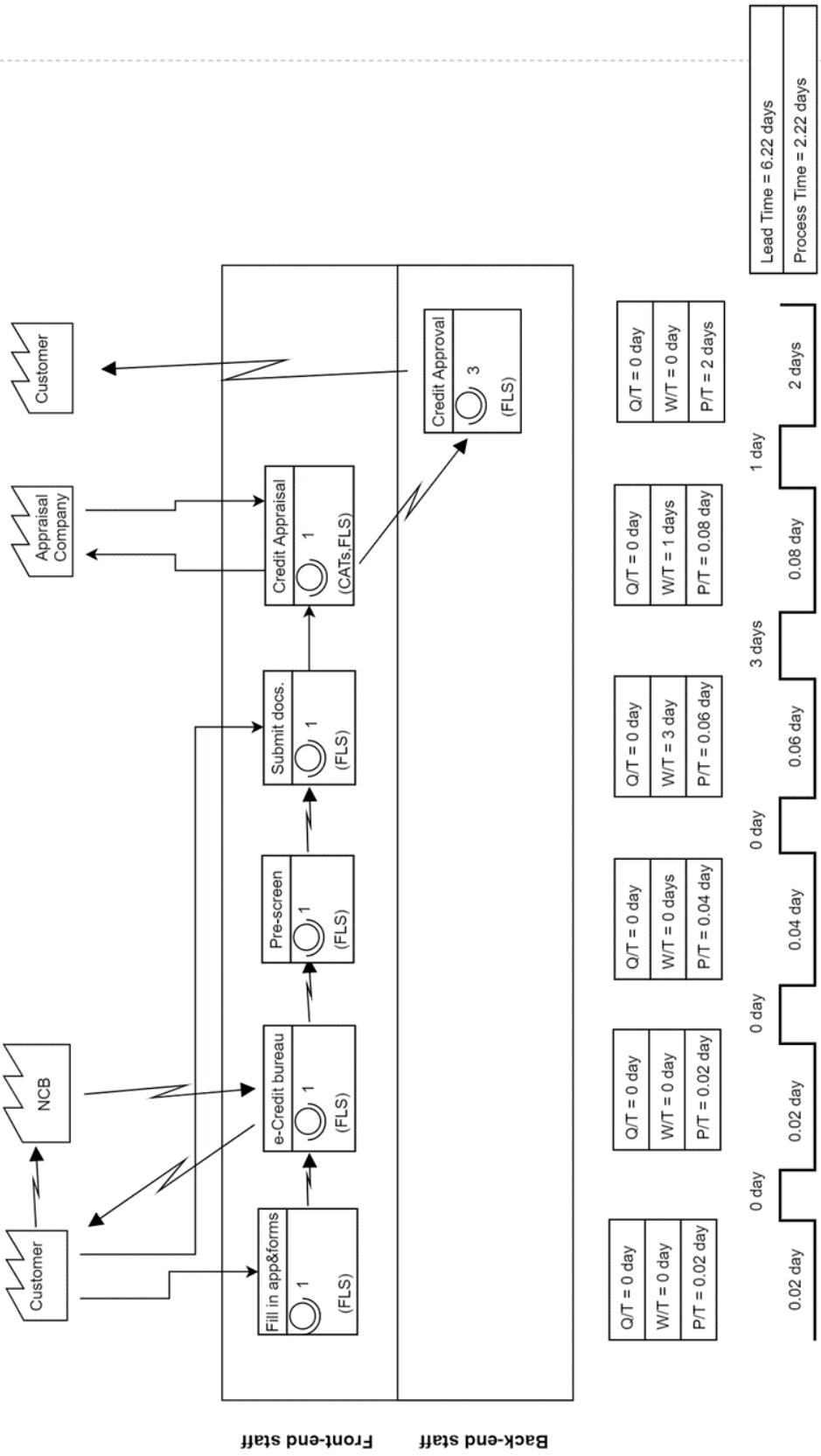

Figure 3.25 Future Value Stream Mapping

From the future state mapping in Figure 3.25, the total lead time the future process is reduced to 6.2 days where the process time or execution time is 2.2 days making process cycle efficiency which is execution time divided by cycle time is equal to 35% as summarized in Table 3.18.

Table 3.18 Overall future process performance

Lead Time	6.2	Days
Process Time	2.2	Days
Process Cycle Efficiency	35%	%

While considering at cycle time of pre-screening stage, and approval stage as shown in Table 3.19. Cycle time of Pre-screening stage was reduced to 3.1 days while cycle time of approval stage was remained the same.

Table 3.19 Overall future cycle time and lead time

Cycle Time of Pre-screening stage	3.1	Days
Cycle Time of Approval stage	3.1	Days
Lead Time	6.2	Days

3.4 Detail of Project Implementation

3.4.1 Design Principles of Formula Lending System (FLS)

Firstly, key design principles of FLS system are mainly applied from five mechanisms for information systems in processed-based organization (Grover and Markus 2008) which are composed of:

1) Provide real-time training and knowledge about both immediate tasks and the process.
2) Provide and Maintain a transactive memory of who knows what in the group.
3) Provide real-time monitoring of performance and decision-making support.
4) Provide a virtual workspace to allow people to see each other's work.
5) Simplify coordination of work.

Based on the analysis in each principle among project improvement team, only four key principles have been selected as the most suitable description in design of FLS system which can be explained as follows:

Design Principle 1: Provide real-time training and knowledge about both immediate tasks and the process.

FLS is designed to be integrated and aimed to be a single platform that used to perform the end-to-end process of housing loan business. Therefore, the accessibility of system is available for all roles that operate the process including front-end staff and back-end staff. Despite the knowledge and experience of operators, FLS is understandable and easy to operate as it provides a complete process view that going step by step either front-end staff or back-end staff can track and understand the detail of application without performing it at the beginning.

Design Principle 2: Provide real-time monitoring of performance and decision-making support.

According to FLS is a web-based application platform, it can be tracked and view in real-time. In terms of monitoring performance, FLS can track the service level agreement (SLA) which is a formal contract between internal user and the end user of the service set by the studied bank to track employee's performance in performing each process. This can enhance the employee to perform the responsible task within the target service level agreement.

While in terms of decision-making support, as the housing loan business process contains the steps of decision-making including pre-screen check and credit approval process. With an approach of automated credit decision making, it can enhance the process by to run pre-screen or approval result within just few minutes and contributes in making the process to be standardized with no individual discretion or judgement from underwriter or back-end staff.

Design Principle 3: Provide a virtual workspace to allow people to see each other's work

Benefit of virtual workspace is beneficial for operator in terms of tracking an application status and following up employee's case in which contributing the problem of visibility in accessing information for operators. FLS can be a virtual workspace system that allow involving operators to visualize all detail of application process that are traceable and manageable.

Design principle 4: Simplify coordination of work

According to the previous process has a problem in complexity and unnecessity of tasks causing from non-seamless flow in gathering all data and information together along the journey which resulting in Inflexibility of process. To simplify coordination of work, the design process of FLS need to be user-friendly system for operator in terms of both functionality and usability. Perceive ease of use and perceive usefulness can be considered as key factors during system design and implementation.

3.4.2 Project team

The detail of FLP project team is illustrated in Figure 3.26. There are two departments in the project including IT department and Business Department. Brief detail of responsibilities in those business functions are explained as follows:

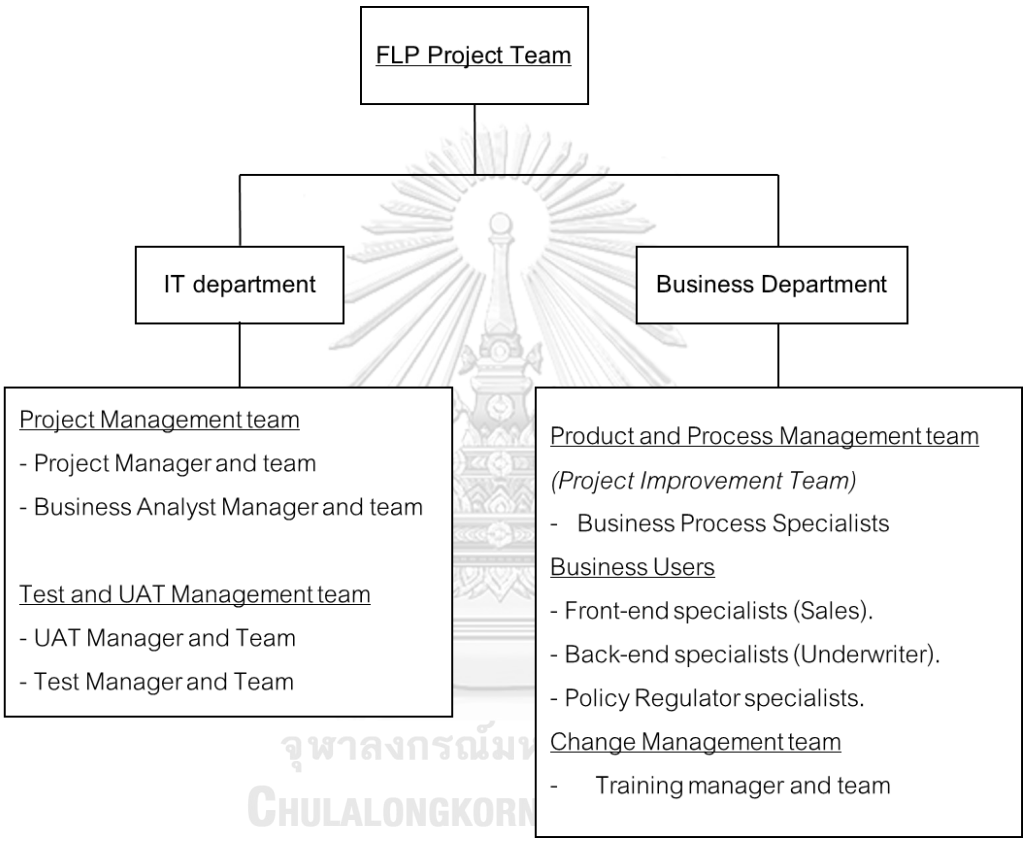

Figure 3.26 FLP Project team

(Source: derived by author)

IT department

There are two main functions from the involvement of IT department including Project management team and UAT and Test Management team. UAT stands for User Acceptance Testing which is a formal testing that used to ensure functionality and usability of software or system before entering to production phase.

At the initial stage of project, Project management team were playing as a key role due to responsibilities in overseeing the gathering and analysis of the requirements. While the role of business analysts was responsible in analysing the business and technical requirements from business process specialists in product and process management team in which key members in the project improvement team in this research were also involved.

UAT and Test management team played key important part in the stage of project execution as the objective in delivering working solution to meet the project requirements in various aspects including on-time delivery, performance, reliability, and security.

Business Department

Business department that involves in FLP project are Product and process management team, Business users, and Change management team. Product and process management team is the key role in central coordinators among all functions in the project both IT and business users as responsibility in deliver and manage the process of housing loan business to achieve the project requirements.

Business users consists of business divisions that mainly operate the housing loan business including back-end specialists from division of Enterprise Risk Management in unit of housing loan approval, credit underwriting, and credit policy and process development. Housing loan approval unit and credit are responsible mainly in the step 7 credit approval while credit policy and process development is responsible in organizing all tasks that related to credit policy and regulations which mainly related to all policy in both pre-screening and approval stage process.

While the division of Distribution Network is responsible in the unit of network operation quality assurance which includes front-end specialists. All business users were mainly involved in every stages of project and played as one of important parts of the project.

Lastly, change management team from division of distribution network in unit of network operation quality assurance was set as responsible team in arranging training session and plan after the project entered to implementation phase during business process transition.

3.4.3 Detail of Implementation activities

Implementation activities in FLP project has divided into three phases of project implementation based on Watt 2003 including requirement phase, project execution, and handover phase. In which brief detail of key activities in each phase are described as follows:

Requirement Phase:

There were two main activities including technology requirements and business requirements in which the work during this phase were mainly included key businesspersons and IT persons to gather all detail of requirements. While business analysts in the project management team were responsible in translating business requirements into technical specification and involve assisting in writing test cases and test script. Gathering with business process specialists from product and process management team that were responsible in listing down business requirements in all aspects including process, product, policy, pricing. In which the detail in each aspect also required in-dept knowledge from specialists in each business divisions. Therefore, at the requirement phase, all key participants from each specific division in both IT and business were required to deliver the most successful requirement of project implementation.

Project Execution phase:

At this phase of project execution, it consists of sub-activities starting from solution research phase, design phase, build phase, pilot phase, and implementation phase in which there were additional key person involved from UAT and Test Management team as after business and technical requirements have been determined and solution research phase is conducted to finally reveal high-level design. Then the phase of design and build could start.

During the design phase, test cases which consists of specific sequences of steps and related conditions used to test the expected behaviour of functional components are generated in which briefly detail of test condition and test cases in the studied project are explained as follows:

Test Condition

The detail of condition will be based on the business requirements. In which there are many types of test cases needed to be tested such as Workflow, Pricing, Notification, Contract Documentation etc. But two main types that will be explained are 'Workflow' and 'Pricing' that some of the main key example conditions are shown in Table 3.20 and 3.21, respectively.

Table 3.20 Example of workflow test conditions for UAT in FLP project

Flow	Sales Channel	Approval Decision	Product	Loan Purpose	Product Program
Salary/Freelance	Branch Staff	Approve	Home Loan	Buy	Thai Borrower with Foreigner Spouse Program
Entrepreneur	Sales Agent	Reject	Home Decor Loan	Refinance	Court Program
			Home for Cash	House Remodeling	Leasehold Program
			Home for Cash OD	Buy Vacant Land	
			Home Loan for Multi-Purpose	Multipurpose	
			Home Loan for Life Assurance		
			Home Loan for Fire Insurance		
			Home OD		

Table 3.21 Example of pricing test conditions for UAT in FLP project

Occupation	Product	Loan Purpose	Salary/Month	Type of Collateral	Grade of Collateral
Salary/Freelance	Home Loan	Buy	<=100,000 THB	House	A star
Entrepreneur	Home Decor Loan	Refinance	>100,000 <200,000 THB	Townhouse	A1
Special Occupation	Home for Cash	House Remodeling	>200,000 THB	Commercial Building	A2
Justice/Lawyer	Home for Cash OD	Buy Vacant Land		Condominium	A3
	Home Loan for Multi-Purpose	Multipurpose		Vacant Land	Z (Non-grade)

Test Cases

Test conditions of workflow and pricing shown in the Table 3.20 and 3.21 are the main factors that would be designed into the set of test cases that varied from business scenarios and requirements. Some of example of workflow test cases have been brought and described in Table 3.22 and 3.23.

Table 3.22 Example of workflow test case scenario 1

Example of Workflow Test Case Scenario#1: **Flow:** Entrepreneur **Product:** Home Loan, Home Loan OD, Home Loan for Fire Insurance **Purpose of Loan:** Remodeling **Product Program:** Generic Program **Sales Channel:** Branch Staff **Approval Decision:** Approve at all decision points
End-to-End Objective Statement: *Existing customer (single borrower) apply paper Application with Branch Staff, Borrower is more than 22 years-old entrepreneur with sales/month 80,000 baht, %Margin = 60%, Margin/month = 48,000 baht and the marital status is single.* *The detail of requesting loan is Home Loan, Home Loan OD, and Home Loan for life insurance with Loan Limit of 4,203,000 baht (Home Loan Limit=2,000,000 baht, Home Loan OD = 2,000,000 baht, Home Loan for Fire Insurance =3,000 baht), Loan term 20 years.* *Type of collateral is Townhouse with A1 grade of collateral (z).* *Decision Point at Pre-screen, Credit Approval:* • *Approve* *Then, the final decision of application would approve at all decision points.*

Table 3.23 Example of workflow test case scenario 2

Example of Workflow Test Case Scenario#2: **Flow:** Salary **Product:** Home Loan **Purpose of Loan:** Buy **Product Program:** Thai Borrower with Foreigner Spouse Program **Sales Channel:** Sales Agent **Approval Decision:** Reject at Pre-screen check
End-to-End Objective Statement: *Existing customer (single borrower) apply e- Application with Sales Agent, Borrower is more than 22 years-old freelance with salary/month 25,000 baht and married with English foreigner spouse who is guarantor (Referred Income) and working as engineer with salary/month 50,000 baht.* *The detail of requesting loan is Home Loan and Home Loan for Fire Insurance in the purpose of buying with purchasing price of 2,800,000 baht, Loan Limit 2,003,000 baht (Home Loan Limit=2,000,000 baht, Home Loan for Fire Insurance =3,000 baht), Loan term 30 years.* *Type of collateral is Condominium with A2 Grade of collateral.* *Decision Point at Credit bureau check:* • *Borrower is rejected with 'Exception' by the rule of Bad Block Credit Card.* *Decision Point at Pre-screen check:* • *Borrower is rejected with 'Exception' by the rule of Bad Block Credit Card.* • *Guarantor is rejected with 'Fail' by the rule of Bad Block Credit Card, Fake Card detected.* *Then the final decision is the application would reject at Pre-screen check.*

Basically, test cases specify the preconditions, inputs, expected output and post conditions for a test of whether a test condition is true (Hambling and Goethem 2013). Therefore, for each test cases to generate the outcomes as expected, there must be inputs of data related to each scenario to ensure that the application is being worked correctly in which type of data are the deta that required in Table 3.12 that previously mentioned in section 3.3.2.

User Acceptance Testing (UAT)

While during build and pilot phase, the activity of User Acceptance Testing or UAT have been approached. The detail of UAT activities that being conducted during build and pilot phase are explained as follows:

The Formula Lending System (FLS) for housing loan product has separated into two phases of implementation based on type of customer in which first phase is supported for Salary Earner customer type and second phase could support in both Salary Earner and Entrepreneur types. The reason why it had to separate into two phases is due to difficulties of income validation process for Entrepreneur type that required more steps and addition screens when compared to Salary Earner type.

The detail of implementation is indicated by implemented channels including Direct Sales Agent (DSA) and Branch as shown in Figure 3.27. For DSA channel, 100% of implementation of all 5 teams has achieved since January 2020 while channel of branch is currently at 20% of implementation and aimed to achieve 100% in November 2020 if conducted via classroom training. But as the current situation of COVID-19, the plan can be fluctuated and postponed if it needs to be conducted via online training.

Therefore, the case study of UAT in the FLP project can be used as an example to see how UAT could deliver expected benefits to the studied commercial bank.

Detail of Implementation	Year 2019 (Feb-Dec)	Year 2020										
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
% Implemented on DSA Channel	40% (2/5 Team)	100% (All team)										
%Implemented on Branch Channel	3% (23/887 Branches)	20% (177/887 Branches)					Estimated to achieve 100%					

Figure 3.27 Detail of implementation phase

Another key activity in implementation phase was training session, as a whole process of housing loan business has been completely transformed. Therefore, it is essential in every project implementation to consider in change management to avoid resistance of change that could be from people as the perceive of usefulness and ease of use were difficult to achieve. During training session, there has been involvement of trainers from change management team to handle in terms of providing materials including manual of system use and practical workshop that allow user to test on protocol of FLS system before enter to production environment.

In which the status of FLP project is currently at implementation phase and continues training session and aim to complete the training to all branches in Thailand in November 2020.

Handover phase

The last of project implementation is handover phase which collates the output of all previous phases into a set of support resources for operational and support staff including training of support staff and the creation of final project documentation. In which at the current stage of FLP project has not reached the handover phase yet.

To summarize the detail of activities in FLP project implementation, Table 3.24 summarizes the detail of required activities including responsible person for specific activity. While Figure 3.28 shows timeline of FLP project implementation that currently reaching project execution stage at implementation phase.

Table 3.24 Detail of key activities in project implementation phase

Project Implementation phase	Key Activities	Responsible Team
1. Requirement Phase	1.1 Technology requirements	-Project Management team -Product and Process Management team -Business Users
	1.2 Business requirements	
2. Project Execution	2.1 Solution research phase	-Project Management team -Product and Process Management team -Business Users -UAT and Test Management team
	2.2 Design phase	
	2.3 Build phase	
	2.4 Pilot phase	
	2.5 Implementation phase	-Project Management team -Product and Process Management team -Business Users -UAT and Test Management team -Change Management team
3. Handover phase	3.1 Handover session	-Project Management team -Product and Process Management team -Business Users

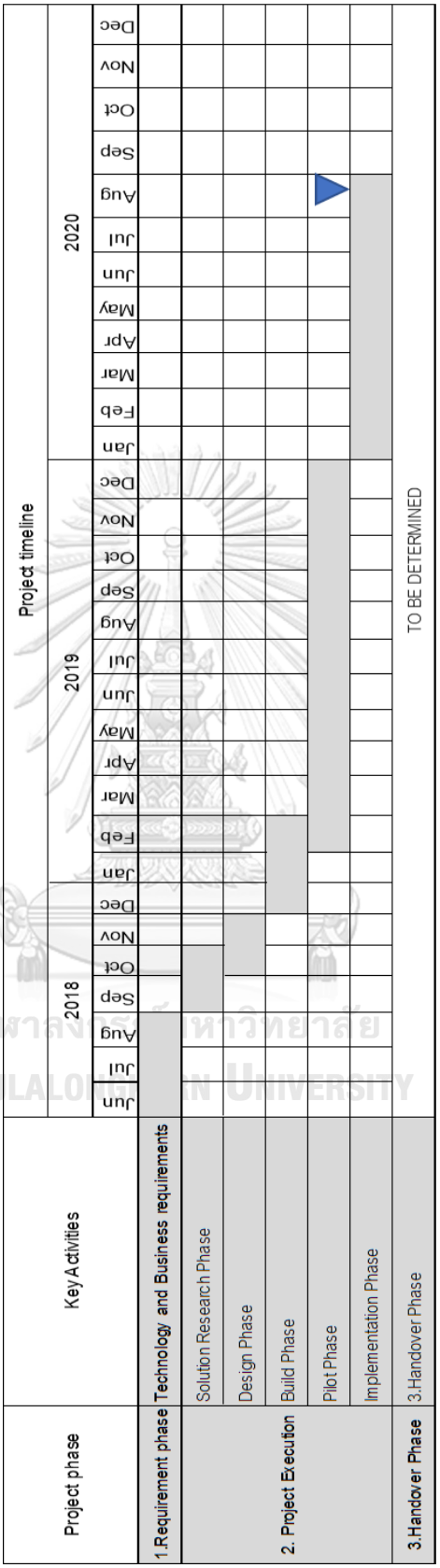

Figure 3.28 Project Implementation Timeline

3.4.4 Interview of FLP project participants

The method of interview is chosen to reflect overall feedback from system implementation and suggestions from expertise's point of view including management level and business process specialists that mainly involved in the system implementation. The detail of questions, participants, and method will be explained in the followings.

Interview questions

The design of interview question will divide into main three topics including basic information of the participants, questions reflected through feedback after involved in the project, and future recommendation/suggestion.

1) What is your current role in the studied commercial bank?
2) How long have you been working in the studied commercial bank?
3) What part of your involvement in the Formula Lending Project?
4) How long have you involved in the project?
5) What is your opinion through success of FLS in delivering housing loan business benefits?
6) What is your opinion through success of FLS in delivering better housing loan customer experience?
7) What aspects of the FLP project and associated process could be improved upon?
8) To suggest for future development, which part of the project that you find the most difficult to access and need a serious concern?

Interview participants

The participants included in this interview consist of users from Formula Lending System implementation who has been testing the User Acceptance Test (UAT) phases starting from February 2019 to present. User's Role are composed of Branch Staff (Front-end staff) and Approval Staff (Back-end staff) which are the main roles that operate in the

process of Housing loan application. While the roles of business process specialist and business analyst are also interviewed to reflect in perspective from development team who involved in the project at the beginning starting from giving business requirement stage.

In addition, there will be an interview of Management level person who is directly responsible for the project of Housing Loan Formula Lending System which is known as Head of Housing Loan Business Process Division from the studied commercial bank. An overall of system implementation including benefits, key capabilities, feedbacks, and expectations of the project will be concluded and shared through management level's perspective.

Steps of Interview

Before the process of interview can be started, the ethical approval form will be submitted and after getting approved, the steps of interview are described as the followings.

Step 1: Invite participants and describe a brief detail of interview by phone calls.

Step 2: If the participant accepts an invitation, the Participation Information Leaflet (PIL) and questions will be given to participants to have clear understandings of interview.

Step3: Consent form of interview will be given to participants to sign for agreement.

Step 4: Starting an interview

After the interview session has ended, the discussion of the result from interview will be addressed which can be found in the result section.

4. Results

4.1 Result of implementation

According to the implementation of new developing system known FLS that has been currently implementing in the studied bank, the collection of data including cycle time, lead time, and process cycle efficiency are being collected to respond through research objectives in reduction of lead time of housing loan business process by focusing on reduction of cycle time in pre-screening stage.

Table 4.1 illustrates the comparison of result between before and after improvement of cycle time in pre-screening stage of housing loan business process. The result shows the reduction of 62.3% of cycle time after implementation of new system due to the elimination of query time and waiting time that causes from availability of area administrator tasks that could not support the demand as desired in which resolved by re-arranging tasks to proper operator after streamlining the process in system implementation. In addition, with the improved cycle time of 3 days, it also contributes achievement of desired cycle time based on business target of 5 days which is considered as satisfactory.

Another enhancement was also from an approach of simplify and streamlining the process by elimination of step 2 submit documents to pre-screen process and interfacing data with third party company, NCB to provide real-time processing. In which enhancing the process to be continuous and seamless.

Table 4.1 Improvement of cycle time in pre-screening stage

Step	Process	Cycle Time (Days)	
		Before	After
Step 1	Fill in application and consent forms.	0.04	0.02
Step 2	Submit documents to Pre-screening process	0.04	-
Step 3	Credit bureau check.	3.08	0.02
Step 3	Pre-screen check.	2.08	0.04
Step 4	Submit documents to Approval process.	3.08	3.06
Pre-screening stage cycle time (Days)		**8.32**	**3.14**
Improvement rate (%)		**62.3%**	

In addition, overall metrics that could be considered are lead time, process time, and process cycle efficiency that contributes from reduction of cycle time in pre-screening stage which illustrated in Table 4.2.

Table 4.2 Improvement of overall metrics in housing loan business process

Metrics	Before	After
Lead Time (Days)	11.3	6.2
Process Time (Days)	3.3	2.2
Process Cycle Efficiency (%)	29%	35%

4.2 Interview result

According to the objective of interview is to share the feedback of FLS after involving during system implementation from different point of views of the key persons including Head of Housing loan business management, Housing loan Business process specialist, Business Analyst, Network System Execution Specialist, and Operation Management specialist. The detail of interview will be reflected through the key elements as follows.

1) How FLS successfully deliver housing loan business benefits
2) How FLS successfully deliver better housing loan customer experience
3) How FLS development could still be improved upon
4) Suggestion for future IT implementation

Next, the detail of participants and the summarized of interview in each key element will be explored and the consent form for interview of each participant can be found in the Appendix A.

Basic Information of participants

Participant No.1 Head of Housing Loan Business Process: responsible in delivering housing loan business process as required.

Table 4.3 Participant No.1 Basic information

Corporate Title:	Vice President
Functional Title:	Head of Housing Loan Business Process
Working years of Experience:	27 years
Working years of involvement in FLP project:	2 years

Participant No.2 Business Process Specialist: responsible in giving business requirements of the project.

Table 4.4 Participant No.2 basic information

Corporate Title:	Unit Manager
Functional Title:	Senior Housing Loan Business Process Specialist
Working years of Experience:	8 years
Working years of involvement in FLP project:	2 years

Participant No.3 Business Analyst: responsible in translating business requirements into technical specifications.

Table 4.5 Participant No.3 basic information

Corporate Title:	Unit Manager
Functional Title:	Advanced Software Engineer
Working years of Experience:	2 years
Working years of involvement in FLP project:	2 years

Participant No.4 Network System Execution Specialist: responsible in testing during UAT as a role of branch staff, preparing the material for training.

Table 4.6 Participant No.4 basic information

Corporate Title:	Unit Manager
Functional Title:	Senior Network System Execution Specialist
Working years of Experience:	38 years
Working years of involvement in FLP project:	2 years

Participant No.5 Operation Management Specialist: responsible in testing during UAT and operate at production stage as a role of Approval staff.

Table 4.7 Participant No.5 basic information

Corporate Title:	Unit Manager
Functional Title:	Senior Housing Loan Operation Management Specialist
Working years of Experience:	1 year
Working years of involvement in FLP project:	1 year

Opinion through the success in delivering business benefits of FLS

According to an interview of participants, majority of them have mentioned that FLS is a sales tool that can screen quality of application at pre-screen process before submitting to the process of approval as the enhancement in Credit bureau check step that allow salesperson to proceed the pre-screen step by themselves and the process of e-Consent that can notify the result within short period of time compared to the previous process that still required area administrator to proceed which was a time-consuming task and can be concluded as useful tool for operators in each different role. Moreover, FLS also give suggestions or comments to salesperson in the case of rejected application whether what action need to do next to retain smooth and seamless process. While the process of override and exception is becoming more flexible by the enhancement of automation and linkage between core system in the bank. While the process of UAT is considered as significantly relevant to ensure the system readiness in terms of usability and functionality.

Another point is the process of document storage that became easier to access as turned into online platform compared to the previous process that used to collect the document from customer and stored as physical papers, with this transformation, it has contributed in prevention of loss of important document and flexible for branch staff to proceed to further tasks as it is always available on the FLS application.

Lastly, as the perspective from approval staff, by running the approval result through the decision engine and automation, it contributes in making the process to be standardized with no individual discretion as reduce of error from judgment and also can fasten the processing time with more accuracy and quality.

Opinion through the success in delivering better customer experience of FLS

In delivering better customer experience, participants have mentioned that by noticing faster pre-screen result, it helps customer to decide and increase a chance that customer would possibly choose and confirm a loan with bank. And with the feature in offering all available pricing campaigns that matched with customer characteristics, this is beneficial for customer to get better suitable and valuable pricing campaign when comparing to the previous process that basically salesperson would look through the manual and find the best matches campaign which is still risky in terms of human error that could occur from doing such a manual task.

Opinion on what could be improved

As the duration on business requirement stage was limited and short, this has caused in resulting inadequate requirements that could support actual business when it was launched and tested. And due to frequent changes of business such as change in policy regarded to situation of Covid-19 or Bank of Thailand Requirements, the flexibility of the system is still not being met and there were many gaps between previous and FLS process in which proceeding via the previous system is actually more flexible.
However, there are some negative aspects that basically need time and experience to solve for example in the case of resistant to change from the aspect of users like branch staff and sales agent that at the beginning of production launch. This can be dealt with time and convince of management level in each division.

Moreover, additional comment about moving to digital platform like approach of e-Application to customer might not be the rightest choice, as there are some thoughts that applying via tablet is still inconvenient as requirement of skill in using technology that may not be proper in every range of age of customer. Therefore, attempt concern in service design thinking is required to deliver the best-suit for all type of customer.

Suggestion and Recommendation for future implementation

The process of giving business requirement is considered to be the most relevant and need to be assessed critically as it could affect to the downstream process for example, if the requirement is not all covered or not being translated correctly, then in test design, the test cases or business scenarios would not also be covered and that could lead to the problem when operating in the production environment.

In addition, IT resource planning is also important as during the test or even when operating in the production, there would definitely be incidents occurred that need IT resources to asses in fixing those problems, but with the limitation number of resource, to resolve those incidents must be based on the priority and severity of problem and cause an inflexibility of the process and negative prospects as user need to wait for the problem to be resolved.

For future recommendation, as the continuous development through the concept of digital lending, if the process of applying for loan can move to the platform of self-service where customer can proceed the request of housing loan by themselves via online platform without no attempt of going to branches or elsewhere.

5. Conclusion and Recommendations

5.1 Conclusion

This research has applied the lean principle including appropriated tools to improve in reduction of cycle time of pre-screening stage of housing loan business process that suspected to be the bottleneck of the current process. In which, by comparing to the customer demand in terms of internal aspect that are operator in housing loan process. The current cycle time of pre-screening process was significantly long and beyond the business target. While consider the current lead time of housing loan business process compared to competitors, current lead time in the studied bank was still not competitive as resulting of long lead time. Therefore, to respond through customer demand in both internal and external aspect and being competitive among competitors in banking business, improvement of cycle time needs to be assessed.

At the initial stage of this research, the current map analysis of current process using the tool known as Value Stream Mapping (VSM) was conducted to understand on how the current process was operated and able to identify wastes or non-valued added activities. After the VSM was mapped, it showed that there were non-valued-added activities occurred in the process causing high waiting time and query time in which resulting of total lead time of 11.3 days which contributed from long cycle time in pre-screening stage around 8 days. While the process time was only 3.3 days making process cycle efficiency was at 29%. To continue in understanding the cause of problem in long cycle time, observation of wastes in the process was conducted by the project improvement team including key roles in housing loan business process which are Head of housing loan business division and business process specialists to list out possible wastes in each process step and eventually generate the fishbone diagram of long cycle time problem. From analysis of fishbone diagram, it revealed the potential root causes of long cycle time problem which mainly caused from Inflexibility of process, long waiting time, legacy system, and availability of staff. Inflexibility of process was mainly caused by

manual and paper-based operation which is considered as time-consuming. Long waiting time are caused by waiting time of document submission from customer and result from third-party and approval result. While legacy system that being operated are currently outdated and had no integration with other system. Lastly, the availability of staff especially in a role of area administrator were considered inadequate due to unbalance workload. As it is impossible to solve all the root causes, pareto analysis was approached to prioritize in what to focus for improvement. The significant root causes were related to the main three steps in pre-screening process including step 3 Credit bureau check, step 4 pre-screen check, and step 5 Submit documents to Approval process which considered as the bottlenecks in pre-screening stage.

Then the stage moved to future state map analysis to find out the possible solutions to solve long cycle time problem. Possible solution that could be addressed were from lean tools of standardization and simplify and streamlining process which being implemented through new system implementation in Formula Lending Project. The new system was developed to streamline and eliminate unnecessary steps in which the result of implementation showed that there was necessity of area administrator in proceeding the task as the process was becoming continuous and seamless to operate by front-end staff. Another key approach was from digitization of process by transforming to electronic application that including real-time processing in Credit bureau check and pre-screen check. The result from implementation showed approximately 62.3% in reduction of cycle time in pre-screening stage which also contributed in shorter lead time of overall housing loan business process and improvement in process cycle efficiency from 29% to 35%.

5.2 Recommendations

As the focus process for improvement was pre-screening stage, then next step that could be considered for further improvement can be credit appraisal process in terms of interfacing data with appraisal company to also provide real-time process which will eventually reducing of cycle time and contribute in making more efficiency to the process.

Another recommendation for future prospect in improvement of housing loan business process, consideration in transforming the process to be self-service journey for customer using relevant technology or concept from digital transformation in banking can be relevant according to changes in customer behaviours that tend to move to digital platform in which available channels that should be prioritized is mobile banking application to become one stop digital channel solution in proceed financial transaction in banking business.

Lastly, reflection from the interview of key roles in system implementation in the studied project could be guideline for future study in the scope of project implementation whether in banking business or other service industry to critically consider in the stage of giving business requirements and involvement of key expertise in specific division of business which are significant success factors in delivery business benefits as expected.

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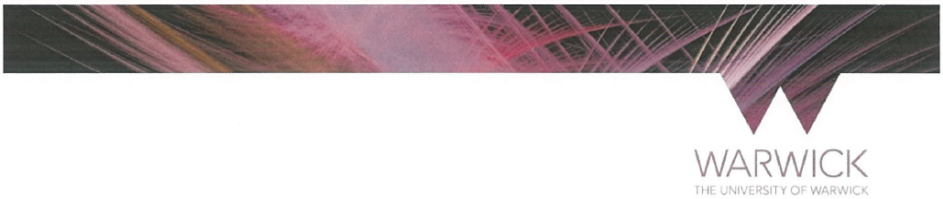
Appendix

A: Consent forms for Interview

Participant No.1 Head of Housing Loan Business Process:



Consent Form for Interview

Project Title: *Process Improvement of Housing Loan product in Thailand Commercial bank*

Researcher: *Araya Santitrakulvech*

☒I confirm that I have read and understood the provided Participant Information Leaflet (PIL) for the above project, and that I have had the opportunity to ask any questions about the research that I may have.

☒I have been given a copy of the PIL which I may keep for my records.

☒I agree to take part in the above study and am willing to have my involvement in the interview noted.

☒I have additionally agreed to have the interview electronically recorded.

☒I understand that my information will be held and processed to be used anonymously for internal publication for an MSc project, to be submitted for assessment for an MSc degree. I also understand that such anonymous data may be used for future research, including that for publication.

☒I understand that my participation is voluntary and that I am free to withdraw at any time up to the submission of the dissertation without giving any reason and without being penalised or disadvantaged in any way.

Name of participant KAMONRAT KOOSAWAD Date 1-July-20

Signature .....

Participant No.2 Business Process Specialist:

Consent Form for Interview

Project Title: *Process Improvement of Housing Loan product in Thailand Commercial bank*

Researcher: *Araya Santitrakulvech*

☒I confirm that I have read and understood the provided Participant Information Leaflet (PIL) for the above project, and that I have had the opportunity to ask any questions about the research that I may have.

☒I have been given a copy of the PIL which I may keep for my records.

☒I agree to take part in the above study and am willing to have my involvement in the interview noted.

☒I have additionally agreed to have the interview electronically recorded.

☒I understand that my information will be held and processed to be used anonymously for internal publication for an MSc project, to be submitted for assessment for an MSc degree. I also understand that such anonymous data may be used for future research, including that for publication.

☒I understand that my participation is voluntary and that I am free to withdraw at any time up to the submission of the dissertation without giving any reason and without being penalised or disadvantaged in any way.

Name of participant ..... Date 25-Jun-20

Signature .....

Participant No.3 Business Analyst:

Consent Form for Interview

Project Title: *Process Improvement of Housing Loan product in Thailand Commercial bank*

Researcher: *Araya Santitrakulvech*

☒ I confirm that I have read and understood the provided Participant Information Leaflet (PIL) for the above project, and that I have had the opportunity to ask any questions about the research that I may have.

☒ I have been given a copy of the PIL which I may keep for my records.

☒ I agree to take part in the above study and am willing to have my involvement in the interview noted.

☒ I have additionally agreed to have the interview electronically recorded.

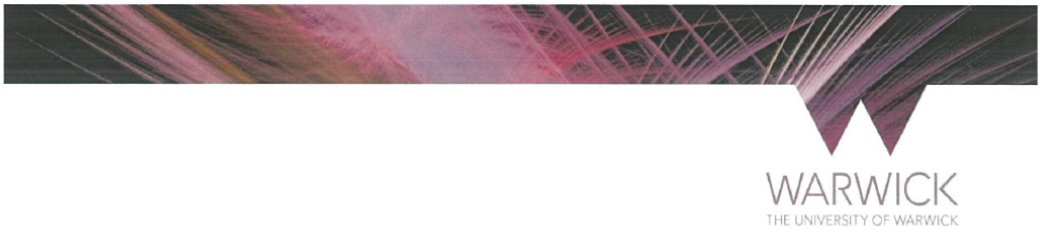
☒ I understand that my information will be held and processed to be used anonymously for internal publication for an MSc project, to be submitted for assessment for an MSc degree. I also understand that such anonymous data may be used for future research, including that for publication.

☒ I understand that my participation is voluntary and that I am free to withdraw at any time up to the submission of the dissertation without giving any reason and without being penalised or disadvantaged in any way.

Name of participant Keeratikan Akavawitta yawong Date 1-July-20

Signature

Participant No.4 Network System Execution Specialist:



Consent Form for Interview

Project Title: *Process Improvement of Housing Loan product in Thailand Commercial bank*

Researcher: *Araya Santitrakulvech*

☒I confirm that I have read and understood the provided Participant Information Leaflet (PIL) for the above project, and that I have had the opportunity to ask any questions about the research that I may have.

☒I have been given a copy of the PIL which I may keep for my records.

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☒I understand that my participation is voluntary and that I am free to withdraw at any time up to the submission of the dissertation without giving any reason and without being penalised or disadvantaged in any way.

Name of participant ONJEERIA BONGKOTJINDA Date 25-Jun-20

Signature .....