# REDUCING CUSTOMER WAITING TIME OF COMMERCIAL BANKING INDUSTRY (A CASE STUDY)

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Feng Gao

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____________________________
Dr. Hans Chapman
Director of Thesis

Master's Committee: ____________________________, Chair
Dr. Ahmad Zargari

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Dr. Nilesh N. Joshi

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Dr. Hans Chapman

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Date

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Feng Gao
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Originating from Motorola and Toyota, Six Sigma and Lean Production have been widely applied in manufacturing industry since the 1990s and then extended to the financial, medical, government and other services industries across the world. Six Sigma and Lean Production techniques helped companies to effectively improve product and service quality and meanwhile enhance the productivity. At the beginning of the 21st century, the idea of combining the Six Sigma and Lean Production was proposed. It means to increase productivity by improving quality, and to improve quality by increasing productivity, which results in cost reduction to the greatest extent and improvement of customer satisfaction. That is what is called Lean Six Sigma. Nowadays, Lean Six Sigma has been widely used in large international commercial banks such as Bank of America, Citi Bank, HSBC and JP Morgan Chase, etc.

With fast economic growth, China's banking industry is facing increasingly fierce competition, with competitors not only from more and more foreign banks, but also from many non-bank financial institutions. Besides, China's banking sector will be gradually opened to private capital that has been yearning for this market for a long time. At present, China's local commercial banks are speeding up the transformation with one of the focuses laid on improving service quality and efficiency, which will help to reduce operating cost, improve customer satisfaction, and finally enhance the overall competitiveness.

Starting with the Lean Six Sigma theory, this paper links domestic and foreign researches as well as practices with commercial bank's business character and operation environment. With a case assumption study for a project which reduces customer waiting time of one of a top four nationalized commercial bank in China, this paper is to explore how the Lean Six Sigma – an approach oriented by customer needs, process and data analysis, can be applied in commercial banks and help them to improve service quality and productivity, and ultimately improve shareholder return.

Accepted by: ______________________________, Chair
Dr. Ahmad Zargari

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Dr. Nilesh N. Joshi

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Dr. Hans Chapman

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# Chapter 1 Introduction

## 1.0 Background

With China's World Trade Organization (WTO) entry, an increasing number of Chinese enterprises are transformed from original management mode "with Chinses Characteristics" to internationalization management mode. The Chinese Banking industry is no exception.
There are many kinds of banks existing in China, including: four nationalized banks, stock holding commercial banks, city commercial banks and rural commercial banks. As more and more foreign banks keep the number rising trend entering into Chinese market, of course they have a huge impact on Chinese local banking industry. Therefore, the Chinese banking industry needs to make adjustments on the implementation for improving efficiency and performance. Before 2013, few Chinese commercial banks have taken Lean Six Sigma method for enhancing service quality, and only China Construction Bank and China Merchant Bank have begun to adopt Lean Six Sigma. Obviously, China Construction Bank won more customers and market shares, achieving a new high profit level after implementing Lean Six Sigma in its processes.

## 1.1 Objectives

Financial industries pay close attention to service process and customer experience, and put a high value on service efficiency. On the one hand, it is hard to provide a consistently high service quality to customers because of the various difference of work individuals in service process. On the other hand, frequent resignations of service personnel also brings obstacles to service efficiency and customer experience. Those reasons made heavy pressure to banking service process. However, those reasons provide broad improvement space for enhancing service process and customer experience.

Both domestic and international practices have demonstrated that banking business operations have strong regularity, in other words, banking business operations with high repeatability. Lean Six Sigma is based on paying a close attention on processes and customers, focusing on how to improve key business processes, removing unevaluable links, decreasing mistake rates, reducing service period, and improving customers satisfaction. Learning how to recognize Lean Six Sigma and finding the ways to apply the method into the realistic issues are the most important and necessary actions that should be taken at this moment.

This thesis intends to apply the Lean Six Sigma Method to Chinese commercial banks through the following objectives:

1. Identify the customers' acceptable waiting time to help the staff of Chinese commercial banks learn more about customers.
2. Investigate the root causes customer of long customer waiting time.
3. Analyzing the Queue Theory in case studies, assisting the bank to confirm the number of service windows for the suitable number of customers, then avoiding the waste of labor and martial resources, which gives a better sense of how Chinese commercial banks should apply Lean Six Sigma to practical issues.

### 1.2 Statement of the Research

For a long time, Chinese commercial banks were subjected to a nonmarket economy system, playing monetary fund managers and business operators roles. At the beginning of the 1990's, Chinese commercial banks realized how important the service was to the bank industry. With the deepening Chinese market reform, the business model of Chinese commercial banks changed by centering on the product to meet the need of customers. An increasing number of

Chinese commercial banks realized that customers are essential to business resources, a source of wealth to commercial bank, and needed to be carefully maintained and nurtured.

Since 2007, line up issues in bank has raised widespread concerns in public opinion and the level of service of the domestic banking industry has been questioned. In fact, the line up issue in banks is an old issue, especially in a number of large nationalized banks, but has never been raised to such a high degree. Faced with the complaints of long-time customers, the new line up issue became the main reforming issue in the Chinese banking industry. The waiting time of customers in banks became one of the most important factors affecting customer satisfaction, even evaluating the banking service quality and market competitiveness of the banks, so the service processes of commercial bank branches were in urgent need of improvement.

Overall, the poor quality and low level of banking service is still an urgent outstanding problem in Chinese bank branches, reflected in the following aspects:

1. A large gap exists when compared with world's advanced commercial banks;
2. Overall, Chinese banks' service quality still do not meet customer expectations;
3. There is a big difference in the service quality of nationalized banks and stock-holding banks;
4. Customers have higher expectations for nationalized banks than stock-holding banks.

### 1.3 Research Rationale

Since 2007, line up issues in bank has raised widespread concern in public opinion and the level of service of the domestic banking industry has been questioned. In fact, the lineup issues in banks is an old issue, especially in a number of large nationalized banks, but has never been raised to such a high degree. On one side, customers complain the service waiting time too long and they have to wait in order, however the VIP customers have the priority; on the other side, the bank tellers always have an intense pressure from customers and they complain that the customers do not understand them. Consequently, customers' waiting time becomes an essential factor which impacts assessing quality and market competitiveness for a bank. In a nutshell, Chinese commercial banks need to optimize their service processes.

Financial industry focuses on service processes and customer's experiences, and pay special attention to service efficiency. Regardless of the fact that technology has developed at such a rapid rate, machines and computers cannot completely replace human in providing service to customers. On one hand, due to the employees' individual difference in habit, appearance and other aspects, it is difficult to ensure consistent customer experiences. On the other hand, frequent resignations of service personnel create tremendous difficulties on service value, efficiency and customers' experiences. These reasons have brought huge pressures on current financial enterprises to improve service quality. However, these issues cannot be directly resolved because of their limited labor and other resources. They need more time and resources to address these problems.

Lean Six Sigma summed up the successful experience of TQM (Total Quality Management) and other Lean systems in the past 20 years as new management theories and methods to improve customer satisfaction and business performance. The quality and productivity improvement principles embodied in a set of results to improve management and competitiveness model, and from a strategic height they were fully implemented in all aspects of business management. Thus, it is not just a Six Sigma quality management method, it is a management philosophy to enhance the core competitiveness of enterprises' strategic choice; it is a way to combine the advanced management methods to improve customer satisfaction and business performance.

Lean Six Sigma is a digital management method. Meanwhile, the financial industry transits thousands of real time data and "talk with the data", which has created favorable conditions for applying Lean Six Sigma into them.

With the development of economic globalization, especially after China's accession to the WTO, banking industries in China have been pushed to the world's common platform competitions by market economics. Therefor the Chinese banking industries are forced to find an effective method that can compete with other advanced banks around the world as soon as possible. Lean Six Sigma itself is a competitive strategy and approach. Through the usage of scientific, effective, and quantitative methods to analyze and improve the key factor of business process, it reduces defects and cost, shortens the operation cycle, and enhances customer satisfaction. Its fundamental purpose is to improve the enterprise's core competitiveness in the world's market competition and to improve companies' market shares to achieve maximum profits.

Through combining Lean Six Sigma management theory researching and case studies analyzing, the author aims to provide some practical suggestions and strategies to Chinese commercial banking in order to reduce customer service waiting time.

**1.4 Limitation**

There are 3 limitations on this research paper:

1. Lean Six Sigma is not omnipotent. Although Lean Six Sigma as a strong management philosophy, successfully applying Six Sigma is not equal to the success of enterprise operation. Lean Six Sigma has its inherent limitations which applies statistic tools and other various set of graphs to discover and explore mistakes or disadvantages in process implementation. Lean Six Sigma is to improve the performance of the existing producing or

service process. However Six Sigma does not work well on improving and enhancing enterprise operating results. For instance, in the past decade, the reason of IBM's success was not because of adopting DMAIC into a higher level but realizing enterprise transformation.

2. Lean Six Sigma is not suitable for every type project. Lean Six Sigma is more suitable for the processes which have strong volume, frequent repeat times, low and control ability.
3. The last limitation for this research paper is that the sample data were limited. Because the time and distance are limited, the author did not have enough time to follow the entire Chinese banking service process for a long time. In this paper, the author only selected a small amount of people for the survey about customer waiting time and gathered the sample data for analysis.

### 1.5 Assumption

The bank in this study currently has not applied Lean Six Sigma methods into its system. This paper assumes that a standard Lean Six Sigma approach would be expected for an organization that seeks to reduce customer waste and waiting times.

### 1.6 Definition of Terms

**Six Sigma**: Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects (driving toward six standard deviations between the mean and the nearest specification limit) in any process – from manufacturing to transactional and from product to service. (What is Six Sigma? 2015)

**TQM**: Total Quality Management is the continuous process of reducing or eliminating errors in manufacturing, streamlining supply chain management, improving the customer experience and ensuring that employees are up-to-speed with their training. Total quality management aims to hold all parties involved in the production process as accountable for the overall quality of the final product or service. (What is Six Sigma? 2015)

**ISO:** International Organization for Standardization, a voluntary, non-treaty federation of standards setting bodies of some 130 countries. ISO covers standardization in all fields including computers and data communications, but excluding electrical and electronic engineering (governed by the International Electro technical Commission or IEC) and telecommunications (governed by International Telecommunications Union's Telecommunications Standards Sector or ITU-TSS). (What is Six Sigma? 2015)

**DMAIC**: DMAIC referred to define, measure, analysis, improve, and control. It is an approach to problem solving defined by Motorola as part of the Six Sigma management philosophy. DMAIC is a tool for improving an existing process. (What is Six Sigma? 2015)

**CTQ**: Critical to Quality is a process characteristic or component that has a direct effect on whether the overall process or product is perceived by customer to be of acceptable quality. CTQ is essential for meaningful and measurable business process improvement. (What is Six Sigma? 2015)

**DFSS:** Design for Six Sigma is used to design or re-design a product or service from the ground up. The expected process Sigma level for a DFSS product or service is at least 4.5 (no more than approximately 1 defect per thousand opportunities), but can be 6 Sigma or higher depending the product. Producing such a low defect level from product or service launch means that customer expectations and needs (CTQs) must be completely understood before a design can be completed and implemented. (What is Six Sigma? 2015)

**VOC:** Voice of the customer is a process used to capture the requirements/feedback from the customer (internal or external) to provide the customers with the best in class service/product quality. (What is Six Sigma? 2015)

**DPMO**: Defects per million opportunities (DPMO) is the number of defects in a sample divided by the total number of defect opportunities multiplied by 1 million. DPMO is a measure of process performance. (What is Six Sigma? 2015)

**CTR:** Cycle Time Reduction is the strategy of lowering the time it takes to perform a process in order to improve productivity. (What is Six Sigma? 2015)

**CFPM:** Cross Functional Process Mapping sometimes referred to as a deployment flowchart, is a business process mapping tool used to articulate the steps and stakeholders of a given process. CFPM consists of a sequence of activity steps and also the interaction between individuals or groups. (What is Six Sigma? 2015)

# Chapter 2 Review of Literatures

## 2.1 A brief historical review

Six Sigma implement method was created by Motorola Company, development in General Electric, and beginning transition from manufacturing to service industry since GE. Six Sigma is in the ascendant throughout the world in all walks of life.

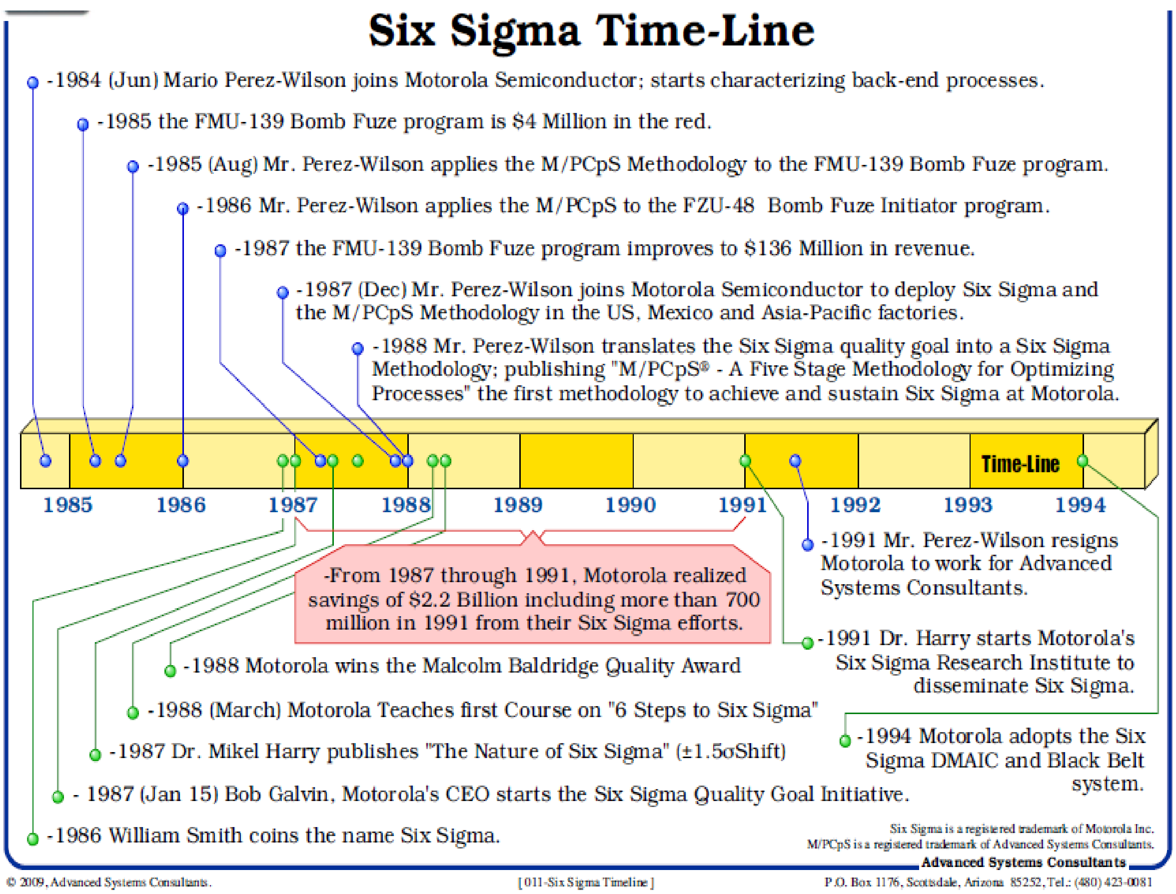



Figure 1: Six Sigma Time-Line by *www.mpcps.com/Six-Sigma-Time-Line2016*

In the 1980's, the Japanese products with high quality and low costs were sweeping the world. In the United States, manufacturers continuously suffered blows, and Motorola also suffered heavy losses.

Motorola also felt surprise that a TV factory, which was Motorola's subsidiary, was acquired by a certain Japanese company and with a total new mode of governance and management, the products quality had a great change that the defect of the television was only approximate 1/20 of the Motorola management period, and Motorola had to admit their own quality in a recession, and management fall behind a lot to Japan. In 1981, top management members with Chairman Bob Galvin at the helm, Motorola engineers in Motorola decided to set out their own quality strategy for improving products 'quality to satisfied customers. Six Sigma is the greatest creative idea appeared in Motorola revolution.

After Motorola implemented Six Sigma in detail in producing process since 1986, the products and service quality improved 10 times until 1989, 100 times to 1991, and reached from 4 sigma level to Six Sigma level in 1992. In 1995, the president and CEO Jack Welch in General Electric Company started to spread applying Six Sigma management, and Six Sigma management brought the benefits that had been more than cost of investment in 1997. Since then, hundreds of companies around the world have adopted Six Sigma as a way of improving quality and doing business. Six Sigma is more than just a quality system like TQM (Total Quality Management) or ISO. The author Geoff Tennant describes in his book Six Sigma: "Six Sigma is many things, and it would perhaps be easier to list all the things that Six Sigma quality is not. Six Sigma can be seen as: a vision; a philosophy; a symbol; a metric; a goal; a methodology".

Six Sigma management stared in electronic industry, transition from manufacturing area to service area started with General Electric's financial department. President Jack Welch applying Six Sigma management in manufacturing department and achieving desired effect, therefore he implementing it on financial department and also achieving a good result. This action proved that Six Sigma management able create huge benefit in service industry. The case which General Electric Company pursued Six Sigma management in financial department had led to a growth in service industry, particular financial service, insurance industry, and health care industry. Today, many financial institutions worldwide have introduced into Six Sigma management, including Bank of America, Citibank, Wells Fargo, HSBC, and JPMorgan Chase, etc.

Citibank is the earliest American bank applying Six Sigma management philosophy to improve its nonmanufacturing environment in 1997. Citibank hired Motorola University Consulting and Training Services for extensive Six Sigma training. The goal was to improve Citibank operations globally defect reduction and process timeline improvement while increasing customer loyalty and satisfaction. Citibank fund Cycle Time Reduction (CTR) and Cross Functional Process Mapping (CFPM) to be extremely useful in financial areas. CFPM involves developing "maps" of process flows by describing the functions involved in each step of a particular process. CFPM helps Citibank not only to map the steps for correct the defects, also involves eliminating wasteful steps, which are defined as any activities that don't contribute to the goal of meeting customers' needs. Through CTR and CFPM, many groups belong Citibank achieved amazing results, including: private bank of Citibank reduced internal call back rate by 80%, external call back rate by 85%, and reducing credit processing time by 50%. Global financial equipment, provides global finance lease service to customers, this group was not only reducing cycle time of customer orders to product delivery, but also credit decision making cycle time shorten by 67%, that is to say shorten from three days to one day.

Actually, no matter in manufacturing industry or service industry, the basis of applying Six Sigma methodology as management philosophy are same, they are focusing on process and customers, concerned about how to improve critical business flows and improve customer satisfaction. Six Sigma management mothed has been changed from strategy tools to strategy thinking. When an enterprise use Six Sigma to improve its operation and performance, the top managers should establish a set of management strategies basis on development purpose, from top to down to training and implementation. This is the reason that Six Sigma is called management philosophy.

**2.2 Six Sigma**

Six Sigma can be referred as philosophy of quality and efficiency of management, namely in working process of the fine management as the goal, measure working process quantitatively, and require defect rate in control three over one million of a point within four. Therefore, there are two meaning of Six Sigma: one refers Six Sigma statistical explanation; another is from a management point of understanding.

From a statistical of view, use Greek symbol σ to present Sigma for describing quality level. σ represents standard deviation that the dispersion degree of data in statistical area. Any quality of certain working process or technical process can be presented in Sigma. Sigma level means how many defects appear in manufacturing process. If the Sigma level is high, that means defect rate is low; and the lower Sigma level indicating appears more defects and low quality level.

Table 1: Sigma Conversion Table by *www.free-six-sigma.com2016*

| Sigma Level | DPMO | % Defective | % Yield |
|---|---|---|---|
| 1 | 691,462 | 69% | 31% |
| 2 | 308,538 | 31% | 69% |
| 3 | 66,807 | 6.7% | 93.3% |
| 4 | 6,210 | .62% | 99.38% |
| 5 | 233 | .023% | 99.977% |
| 6 | 3.4 | .00034 | 99.99966% |

From the Table 1 Sigma Conversion Table, DPMO indicate defects per million opportunities. It means that 691462 defects per million opportunities in 1 sigma level, and the percentage of yield is 30.85%; in 6 sigma level, there are only 3.4 defects opportunities per million, the percentage of good is 99.99966%. Obviously, there exist huge different between 1 sigma to 6 sigma. For example, in bank assume that a counter withdrawals within 2 minutes after the operation is qualified. A certain bank branch there were 300 withdrawals in a day, if 83 withdrawals were more than two minutes, from the perspective of quality management, which it is defective. Therefore the passing rate of the day of the outlets is 72.3%, about 2.1 sigma level. If the operating time passing rate of withdrawals to achieve Six Sigma, it means more than every half two years appearing a withdrawal time's timeout phenomenon.

1. Six Sigma is a management mode. Six Sigma focus on customers 'needs, depends on data and fact, aims at taking active on improving process, emphasizes prevention management, cooperates with different department, and keeps improving and pursue quality and efficiency.

Quality and value of products is determined by the customers, enterprises must be think like from a customer's perspective to analyze, rather than top managers believe their own experience what the customer wants. For example, bank credit card business, often accompanied by a number of value-added services, but these are value-added services if customers need, if the client does, the bank but will provide more value-added services and increase operating costs. How to understand what customers need? This need to collect Voice of the Customer (VOC, Voice of Customer), refining the key quality characteristics from the voice of the customer (CTQ, Critical to Quality), in order to assess existing products or services to meet the level of business for the CTQ will be included CTQ improved process flow among the final meet customer needs.

2. Everything depends on data and facts. Management Practice has proved that the facts and data-based management can be more effectively detect and analyze problems and solve problems, and Six Sigma management is a kind of data-driven based management, emphasizing the data used to speak, according to the decision-making data. A process to improve all the information needed, are included in the data. Six Sigma pay attention and use data throughout the management has always been that the definition of the project from the beginning, data collection and analysis of key variables, and possible solutions to quantify evaluation, further optimization to quantify the results of monitoring and control, the only way to be able to issue It was found more effective analysis and resolution. Thus, Six Sigma is more willing to believe that data rather than experience it through the use of a range of methods and tools, so that we believe that all the results are the measure can improve and be effectively controlled, all outputs are required to quantify, products will have to measure quality indicators and quality of service should follow certain rules to quantify.

3. Process Management. One simple and the strongest philosophy of Six Sigma is: any output of certain process caused by the input process.

Y is output, and X is the process input variables: $Y= f (X_1 + X_2 + X_3 \ldots)$

In Six Sigma, Y is CTQ, and X are the key variables which able impact on CTQ. Six Sigma more emphasizes “good input cause good output”.

4. Reducing variation, and constantly strive for excellence in quality to provide first-class products to customer. Reduce the variation is the core concept of Six Sigma. In order to eliminate fluctuations, quality engineers need to use to define - measure - analyze - improve - control (DMAIC) control methods and tools to solve them. When a company increase original Sigma level three to four Sigm, which has been described achieved a stage victory and success. However, the ultimate goal of a company is Six Sigma level, which prompted the company to once again embarked on a starting point four Sigma level, so the cycle repeated, persistent, from Six Sigma goals that getting closer. From this perspective, Six Sigma is a gradual process cycle to near-perfect quality product or service and high customer satisfaction as the goal, which is to the traditional quality management inject new vitality, but also rely on the quality achieved efficiency gains become reality. Thus, Six Sigma is a management philosophy which continuous improvement and breakthroughs, the pursuit of excellence.

### 2.3 Lean Six Sigma

Lean is a systematic method for the elimination of waste with a manufacturing system. Sometimes lean is called lean management or lean production. Lean is generally derived from the Toyota Production System as developed by Taiichi Ohno, Shigeo Shingo and others over a forty year period (Ronald M. Becker). It began with efforts to reduce die change time on the stamping press which then allowed for a reduction of in-process inventory and this became just-in-time inventory management. Lean consists of proven tools and techniques that focus on minimizing wasteful activity and adding value to the end product to meet customer needs. Lean principles help to examine business processes and focus on minimizing unnecessary costs, reducing waste and improving inefficient procedures.

Lean is a process improvement methodology, use to deliver product and service better, faster and at a lower cost. Womack and Jones (1996) defined it as:

A way to specify value, line up value creating actions in the best sequence, conduct those activities without interruption whenever someone requests them and perform them more and more effectively. In short, lean thinking is lean because it provides a way to do more and more with less and less, including less human effort, less human equipment, less time, less space, while coming closer and closer to providing customer with exactly what they want. (Womack and Jones, 1996)

Six Sigma was defined by Snee (1999) as: a business strategy that seeks to identify and eliminate causes of errors or defects or failure in business process by focusing on outputs that are critical to customers.

Both Lean and Six Sigma have been used for many years, they were not integrated until the late 1990s and early 2000s (George, 2002). Today, Lean Six Sigma is recognized as: a business strategy and methodology that increases process performance resulting in enhanced customer satisfaction and improved bottom line results. (Snee, 2010)

Lean Six Sigma is a methodology that relies on a collaborative team effort to improve performance by systematically removing waste, combining lean manufacturing and Six Sigma to eliminate waste, such as: time, inventory, motion waiting, over production, over processing, defects, and skills.

Lean Six Sigma utilizes the DMAIC phase similar to that of Six Sigma. Lean Six Sigma project comprise aspects of Lean’s waste elimination and the Six Sigma focus on reducing defects, based on critical to quality characteristics.


Figure 2: Lean Six Sigma DMAIC Tools by www.datemplate.com2009

### 2.3.1 Core Concepts of Lean Thinking

Core concepts of Lean Six Sigma summary: realize and eliminate waste, increase production and service efficiency, shorten production or service cycle. The details are as follows:

**Recognize the value and the waste from the customer's point of view**. All customers that have value added activities are called "value-added activities" (Value-added). From the customer's perspective, if a client knows the detailed cost of a job, the customer is willing to purchase this product or service, this product or service is value-added. If the client does not want to purchase this product or service, this product or service is non-value-added. Non-value-added includes 7 types:

Over processing: It is where people use inappropriate techniques, oversize equipment, processes performance that are not required by the customer, etc. All of these things consume customer's time and money. One of the biggest examples of over-processing in most companies is that of the "mega machine" that can do an operation faster than any other, but every process flow has to be routed through it. This causes scheduling complications, delays and so on. In lean; "small is beautiful". Appropriately using fewer machines in the flow without breaking the flow to route through a highly expensive machine that the accountants insist to keep operating.

Transportation: It is the movement of materials from one location to another, this is a waste as it adds zero value to the product. Transport adds no value to the product, as a business pays employees to move material from one location to another, a process that only costs customers' money. The waste of transport can introduce tremendous costs for any business.

Motion: Unnecessary motions are those movements of machines which are not as small or as easy as possible to achieve.

Inventory: Inventory costs Company's money, every piece of product tied up in raw material. The progressing or finished products have costs until they are actually sold. In addition to the pure cost of the inventory, it adds many other costs; thus, inventory brings many other wastes. Inventory has to be stored since the raw products need space, packaging and being transported around. It might be damaged during transportation and it may become obsolete. The waste of the Inventory hides many of the other wastes in the systems.

Waiting Time: If people tend to spend an enormous amount of time solely waiting for something in working (or personal live), this is an obvious waste. The waste of waiting disrupts flow, which is one of the main principles of Lean Manufacturing. Thus it is one of the most serious of the seven wastes of lean manufacturing.

Defect: The most significant waste in the seven wastes. Although it is not always the easiest way to detect the products before they reach the customers. Quality errors that cause defects invariably cost industries far more than expected. Every defective item requires rework or replacement, thus it wastes resources and materials and it creates paperwork, which results in customers lost. The waste of defects should be prevented where possible. It is better to prevent than to detect them. Implementation of Pokayoke systems and automation can help to prevent defects from occurring.

Overproduction: The most serious waste in the seven wastes; the waste of overproduction is processing the products too much or too early. This is usual because of the oversize batches, long lead times, poor supplier relations, etc. Overproduction leads to high levels of inventory which results in many of the problems within the organization. It aims to what is required by the customer, the philosophy of Just in Time (JIT). However, many companies work on the principle of Just in Case.

**Increase process efficiency**. Use Process Cycle Efficiency (PCE) to evaluate how to apply Lean Six Sigma for increasing service efficiency and shorten service cycle:

PCE = Value added time / Total process time

PCE determines that in a process of how much time was spent on value-added activities, and how much time was spent on waste. In general, when PEC less than 10%, it means that there are many non-value-added activities during process. Usually in the service industry, the PCE is only

5%, which means that 95% of the work was non-value-added. Of course, those non-value-added activities caused service work delay, and cost highly.

## 2.4 Lean and Six Sigma

Six Sigma is strong tool to improve quality, and Lean thinking can increase service efficiency. Therefore, combine Lean thinking and Six Sigma to improve quality and efficiency in the same time to achieve the lowest cost.

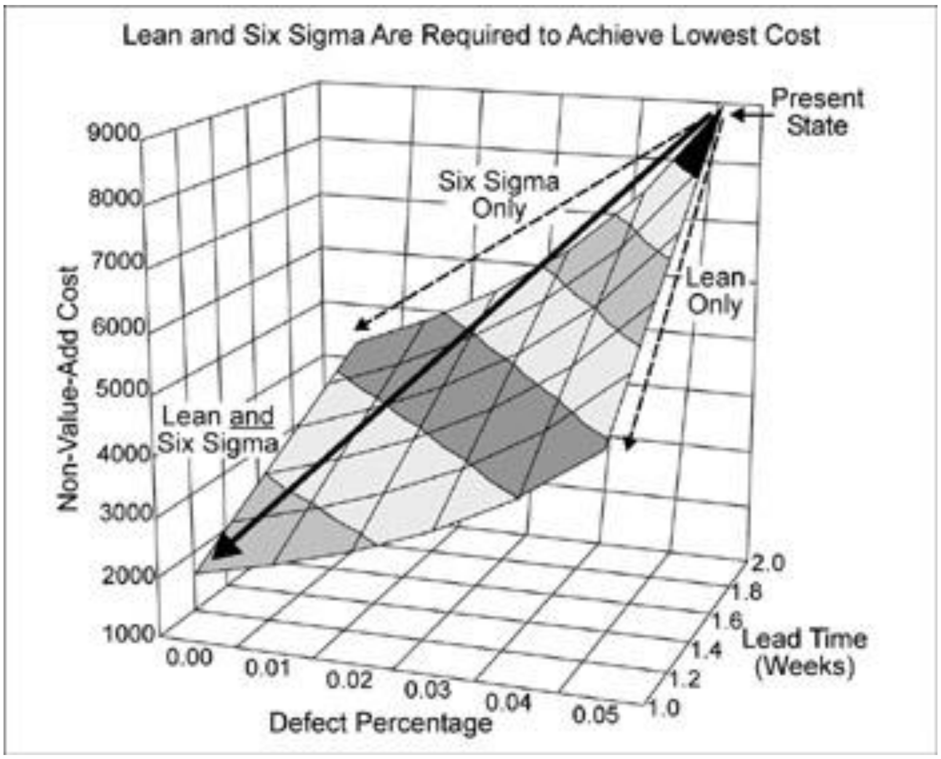



Figure 3: Lean and Six Sigma are required to achieve lowest cost

*Michael L. George, Lean Six Sigma for Service. (MCGRAW-HILL, 2003) P9.*

From figure 3, only Lean + Six Sigma = Lowest Cost. This figure shows the output from these calculations. The horizontal axis depicts the defect rate (the target of Six Sigma); the axis that goes into the page shows cycle time (the target of Lean). The value of greatest interest on this chart is the vertical axis, representing costs that add no value to the product or service. The ideal state is in the lower left front corner—where costs are lowest. Reducing defects alone or reducing lead time alone bring some gains, but process can achieve the lowest cost only if managers simultaneously improve both quality and speed.

## 2.5 Lean Six Sigma in Banking Service Industry

Lean Six Sigma has been widely adopted widely not only in manufacturing, but also in service industries, and its success in many famous companies, for instance GE and Motorola. The service industry has its own special characteristics, which differentiate it from manufacturing and make it harder to apply Lean Six Sigma tools, which can be summarized in the following main areas: intangibility, perishability, variability. (Kotler 1997, Regan 1963, Zenithal, Parasur and Berry 1985)

**Intangibility**: Services and customers cannot be measured easily and objectively, like manufacturing products. An objective measurement is a critical aspect of Six Sigma, which requires data driven decisions to eliminate defects and reduce variation. The lack of objective metrics is usually addressed in service organization through the use of proxy metrics.

**Inseparability**: Delivery and consumption of service is simultaneous. This adds complexity to service processes, unknown to manufacturing. Having customers waiting in line or on the phone involves some emotional management, not present in a manufacturing process.

**Variability**: Each service is a unique event dependent on so many changing conditions which cannot be reproduced exactly. As a result of this, the variability in service processes is much higher than in manufacturing processes, leading to very different customer experiences.

It has been harder for service organizations, such as financial companies, banking industry to apply Lean Six Sigma to their own reality. However, there are also great opportunities in the service organizations (George 2003):

Empirical data have shown the cost of service are inflated by 30-80% of waste Service functions have little or no history of using data to make decisions. It is often difficult to retrieve data and many key decision makers may not be as "numerically literate" as some of their manufacturing counterparts.

Approximately 30-50% of the cost in a service organization is caused by costs related to slow speed, or carrying out work again to satisfy customer needs.

In the last few years, successful application in service organizations has come to fruition. Banks and insurance companies are primarily service industries. The application of the Lean Six Sigma is therefore ideal for efficient process organization. In addition however, many processes within the financial sector are similar to production processes. These transactional processes are well suited the application of Lean Six Sigma tools.

**2.6 Banking Queue Service System**

Queuing theory had its beginning in research work of a Danish engineer named A. K Erlang (Lee A.M 1996). In 1909, Erlang experimented with fluctuating demand in telephone traffic. Eight years later, he published a report addressing the delays in automatic dialing equipment. At the end of World War II, Erlang's early work was extended to more gener problems and to business applications of waiting lines.

There are three parts of a queuing system: (1) the arrivals or inputs to the system (sometimes referred to as the calling population), (2) the queue or the waiting line itself, and (3) the service facility. These three components have certain characteristics that must be examined before mathematical queuing models can be developed.

1. Arrivals Characteristics. The input source that generates arrivals or customers for the service system has three major characteristics. It is important to consider the size of the calling

population, the pattern of arrivals at the queuing system, and the behavior of the arrivals.

Size of the calling population: Population sizes are considered to be either unlimited (essentially infinite) or limited (finite). When the number of customers or arrivals on hand at any given moment is just a small portion of potential arrivals, the calling population is considered unlimited. For practical purposes, customers arriving at bank is the example of unlimited population.

Behavior of the arrivals: Most queuing models assume that an arriving customer is a patient customer. Patient customers are people or machines that wait in the queue until they are served and do not switch between lines. Unfortunately, life and quantitative analysis are complicated by the fact that people have been known to balk or renege. Balking refers to customers who refuse to join the waiting line because it is too long to suit their needs or interests. Reneging customers are those who enter the queue but then become impatient and leave without completing their transaction.

2. Waiting line Characteristics: The waiting line itself is the second component of a queuing system. The length of a line can be either limited or unlimited. A queue is limited when it cannot, by law of physical restrictions, increase to an infinite length. Analytic queuing models are treated in this chapter under an assumption of unlimited queue length. A queue is unlimited when its size is unrestricted. A second waiting line characteristic deals with queue discipline. This refers to the rule by which customers in the line are to receive service. Most systems use a queue discipline known as the first come first service (FCFS).

3. Service Facility Characteristics: The third part of any queuing system is the service facility. It is important to examine two basic properties: (1) the configuration of the service system and (2) the pattern of service times. Service systems are usually classified in terms of their

number of channels, or number of servers, and number of phases, or number of service stops, that must be made. A single-channel system, with one server, is typified by the drive-in bank that has only one open teller, or by the type of drive-through fast-food restaurant that has become so popular in the United States. If, on the other hand, the bank had several tellers on duty and each customer waited in one common line for the first available teller, we would have a multichannel system at work. Many banks today are multichannel service systems, as are most large barber shops and many airline ticket counters.

Service patterns are like arrival patterns in that they can be either constant or random. If service time is constant, it takes the same amount of time to take care of each customer. This is the case in a machine-performed service operation such as an automatic car wash. More often, service times are randomly distributed. In many cases it can be assumed that random service times are described by the negative exponential probability distribution. The exponential distribution is important to the process of building mathematical queuing models because many of the models' theoretical underpinnings are based on the assumption of Poisson arrivals and exponential services.

Queuing models is often used basic three symbol called Kendall notation:

Arrival distribution/ Service time distribution / Number of service channels open, where specific letters are used to represent probability distribution:

M = Poisson distribution for number of occurrences

D = constant (deterministic) rate

G = general distribution with mean and variance known

Figure 4 shows one of the four basic queuing system configurations which is most use in banking industry queuing system. Thus, a single channel model with poison arrivals and exponential service times would be represented by: M/M/1. The multiple channel with poison arrivals and exponential service times would be: M/M/C. C distinct service channels in the queuing system.

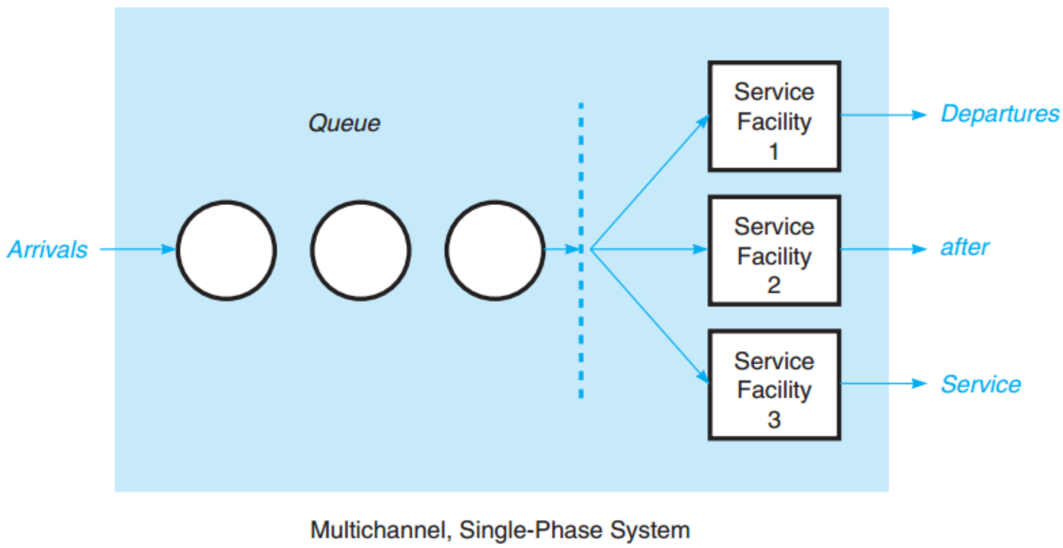



Figure 4: One of Four Basic Queuing System Configurations: Multichannel, Single-Phase System by *Derbala, Ali. "Priority Queuing in an Operating System", (2005):P229*

Service windows of banking belong to traditional queue system which consists of one or more servers that provide service to arriving customers.

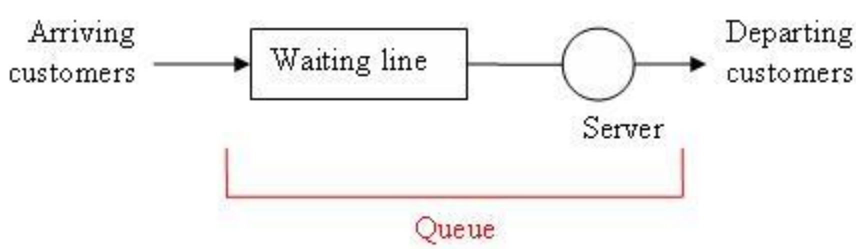



Figure 5: Simplest Queue System by Computer_Systems_Engineering/ Queueing_system_models

Figure 5 shows the characteristics of queuing system. For banking, process of arriving customers determine an input process that the number of customer arrive to bank in unite time.

Poisson distribution is the most common distribution in queuing system, and the customer arriving in a random fashion. In additional, arriving customer do not impact by other person. Queue represents a certain number of customers waiting for service. The capacity of a queue is either limited or unlimited. Bank is an example of unlimited queue length. (K. Sanjay, Bose, 2002)

Normally, banking queue system obeys FCFS role which is refereed to first come first served. Today, majority Chinese commercial bank applying queuing machines in service process, this is “single line to multiple service windows”. According researching by Yan， R.N. and Lotz， S. (2006), if customer waiting time exceed 10 minutes, customer began impatience; if waiting time over 20 minutes, customers were bored with waiting; and if waiting time exceed 40 minutes, customer usually felt angry and left. The human behavior scientists found that waiting 10 more minutes will lost 20% to 30% customers. According to 23,000 survey report by Chinese Financing Center 2011, 10 minutes waiting time are the suitable time to customers. Unfortunately, only a few Chinese commercial banks meet this requirement.

# Chapter 3 Methodology

## Research Methodology

In this research, author decides to implement DMAIC methodology into practice. Some research methods are applied to verify DMAIC, for instance literature review, interviews, questionnaire design, survey, and data analysis.

Author used to work in certain community branch of Bank of China, therefore author enable to get the first hand information from the bank. Because of the author is studying in American, so that the questionnaire survey through e-mail sending to employees which are still working in Bank of China, they sent back to author when completed survey. The data analyses in this thesis paper focus on how to reduce customer waiting time and improve customer satisfaction. Using Minitab software to help at analyzing data and unfold graphs.

1). Identify the customers' acceptable waiting time to help the staff of Chinese commercial banks learn more about customers.

2). Investigate the root causes customer of long customer waiting time.

3). Analyzing the Queue Theory in case studies, assisting the bank to confirm the number of service windows for the suitable number of customers, then avoiding the waste of labor and martial resources, which gives a better sense of how Chinese commercial banks should apply Lean Six Sigma to practical issues.

# Chapter 4 DMAIC Methodology and Finding

## 4.1 Definition

This is the beginning step of Lean Six Sigma project. It describes project background, main problem, improvement target, project range etc.

### 4.1.1 General Descriptions of Research Target

The target bank to be researched on is BOC (Bank of China) Lotus branch, which is located in Guigang City, Guangxi Province, China. The reason to choose this bank as research target because it is a traditional representative of community bank branch which is facing business transition. Address in detail of BOC Lotus branch in the first floor of Guigang City international hotel which is the biggest hotel of Guigang City. The location of BOC Lotus branch is very important, because is next to a busy crossroad. This crossroad is linked to two large residential area, and the local city government building is only 500 meters from here. Obviously, BOC Lotus branch not only undertake surrounding citizens individual financial business, but also undertake some public financial work of government, such as payroll service to official.

Table 2: Define session of DMAIC

| | |
|---|---|
| Project Background | Customer manager, bank tells and clients complaining that the waiting time of customer come to bank for financial service are too long. |
| Problem Describe | Part of general customers' waiting time exceed acceptable time. |

| | |
|---|---|
| Target | 1. Reducing customer's waiting time.<br>2. Make sure to control waiting time in customer acceptable range. |
| Range | Normal work day 8 hours |
| Benefit | Meet customer need to help boots loyalty. |

### 4.2 Measurement

Create 120 questionnaires send to customers who came to Bank of China Lotus Road branch in 24th February, and 104 answers were valid.

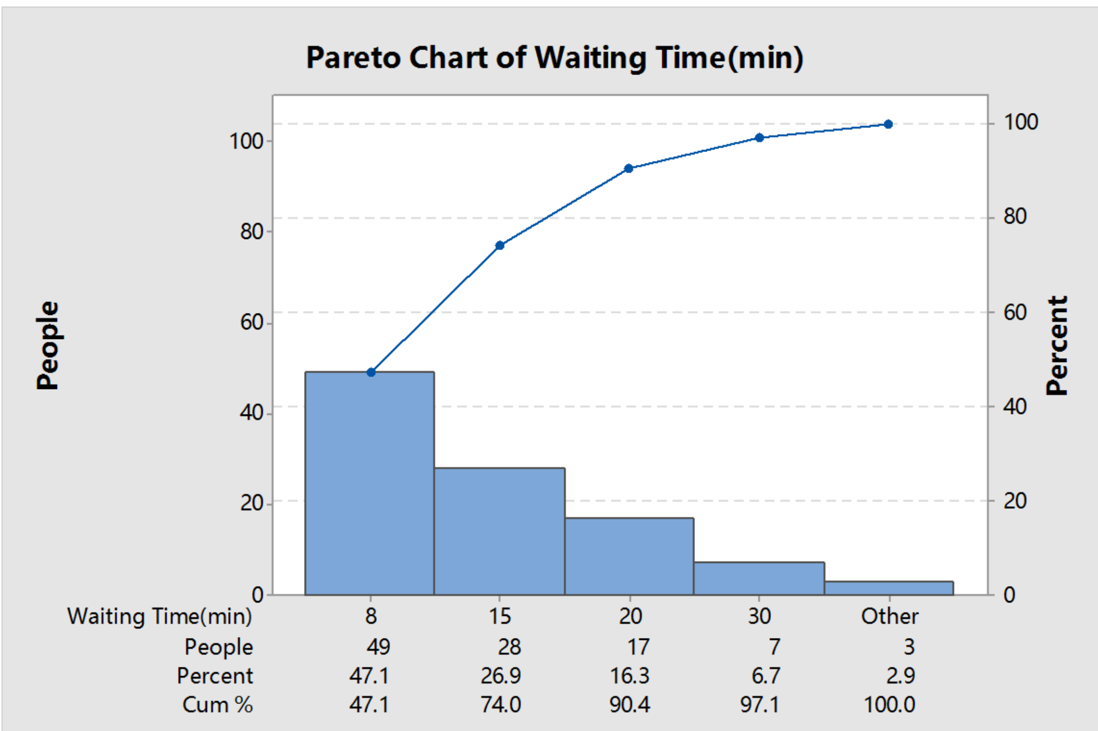
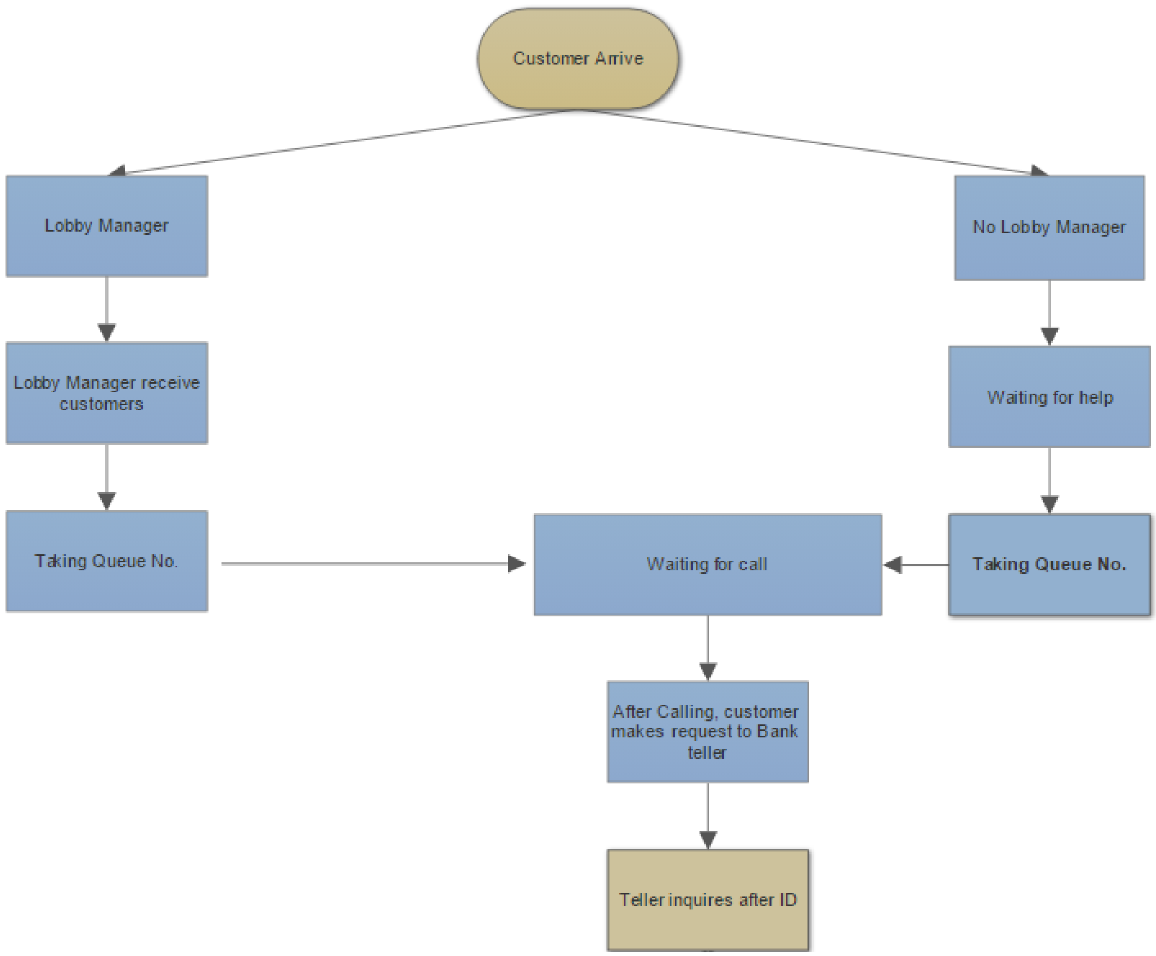



Figure 6: Pareto Chare of Waiting Time in Minitab 17. *Data from Questionnaire "Waiting Banking Service Time for the tolerance 2016".*

From the Figure 6, 47.1% customer can endure waiting time in 8 minutes, 26.9% customers can endure waiting time in 15 minutes, 16.3% customers able endure waiting time in

20 minutes, and only 6.7 % and 2.9 % customer can endure waiting time in 30 minutes even over 40 minutes. Therefore, service waiting time in 8 minutes is the best time for this bank's customers.



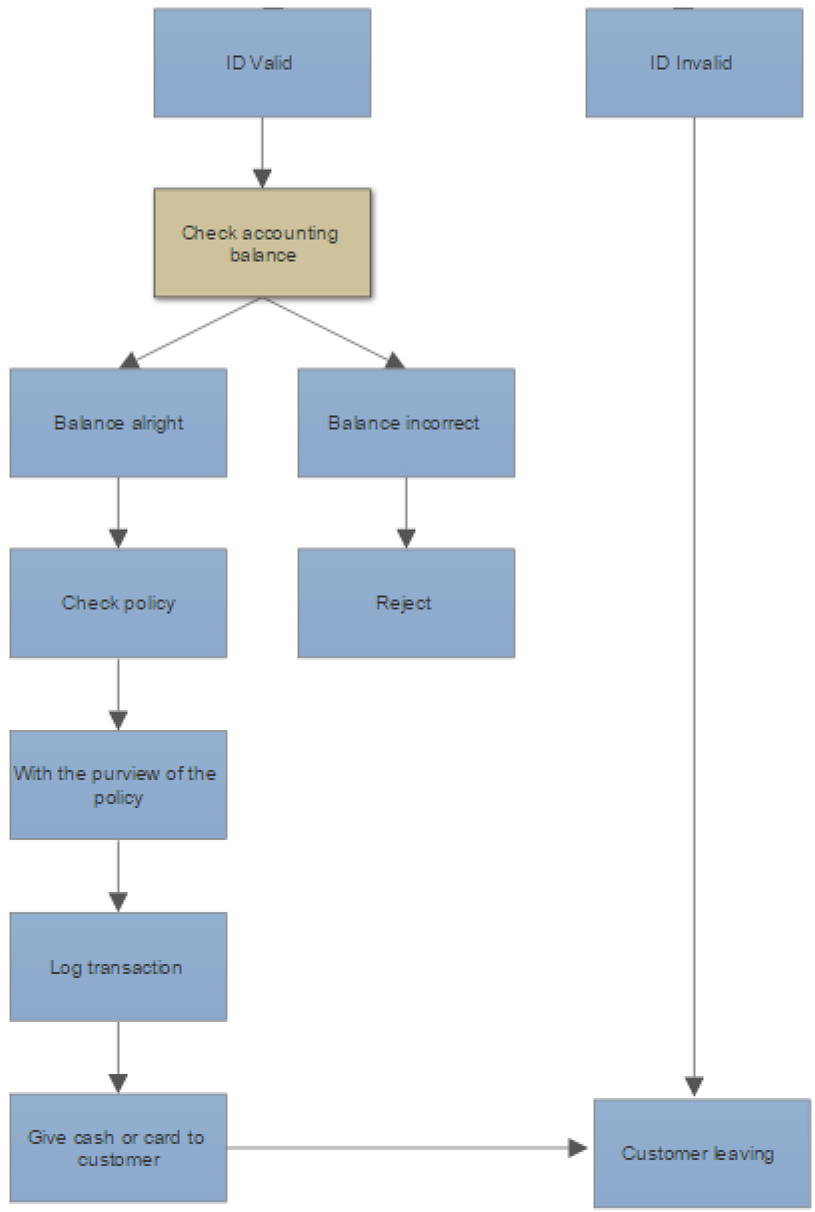



Figure 7: Flow Chart of General financial business process

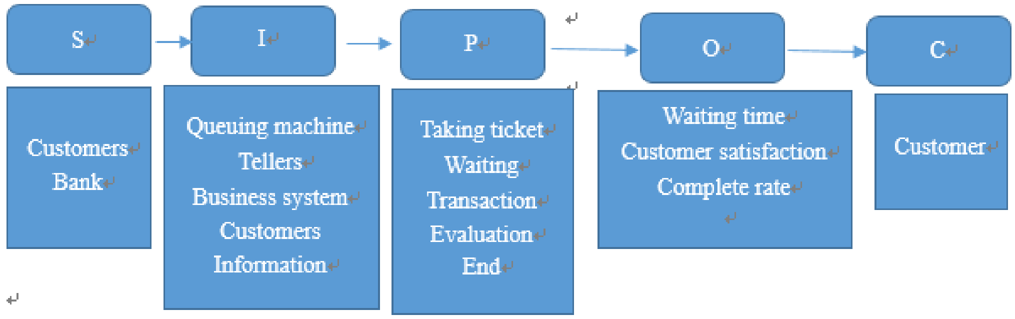



Figure 8: Supply Input Process Output Customer (SIPOC) Chart

Point out the steps from flow chart, discovering serval problems need to improve.

1) Cannot guarantee the Lobby manager in the post in work time.

Recommendation for improvement: Strengthening the training to lobby manager, establish a sense of time in post.

2) No complete fill form guideline in fill single desk.

Recommendation for improvement: As soon as possible create and print enough number fill form guideline textbook providing to customer for reducing fill forms time and lighten lobby manager's work.

3) No notification to inform customers in different financial service require different personal documents in detail.

Recommendation for improvement: Listing different financial service detail and documents clearly on the wall for customer preparing in advance.

4) Part of the bank tellers unskilled

Recommendation for improvement: Strengthen business skills training to tellers.

5) ATM machines are so few in number

Recommendation for improvement: Increase number of ATM for lighten tellers work. In order to make the customer who withdraw small number cash feel more convenient and faster.

**4.3 Analysis**

One of the most important question of service industry is how to manage the queue. Characteristic of customer arriving is arriving randomly, and they also require receive service immediately. However when certain customer coming, there was no service windows available, the customer had to wait in the queue. Customer arrival time rate greater than service time, which leads to the queue. Applying queue theory to help banking industry relieving service pressure.

There are some symbols and notations in Queue theory:

n = total number of customers in the system, both waiting and in service

$\lambda$=Average of customer arriving per unit of time

$\mu$=Average number of customers being serviced per unit of time

$L_s$ = Average number of customers in the system both waiting in the service = $\lambda/(\mu- \lambda)$

$L_Q$ = Average number of customers waiting in the queue = L - $\lambda/\mu$

$W_S$ = Average customer waiting time in the system both waiting and in service = L/ $\lambda$

$W_Q$ = Average customer waiting time in the queue = $L_q/ \lambda$

$p_0$ = Probability 0 customers in the system = $1-\lambda/\mu$

$P_n$ = Probability that there are n customers in the system = $(\lambda/\mu)^n p_0$

$\rho$ = Average number of busy servers (utilization rate) or Average number customers being served = $\lambda/\mu$

Table 3: Waiting Time Data

| **n(9:00-10:00am)** | **$T_i$** | **$s_i$** | **$t_i$** | **$w_i$** |
|---|---|---|---|---|
| 1 | 0 | 1 | 3 | 5 |
| 2 | 3 | 4 | 1 | 6 |
| 3 | 5 | 4 | 2 | 3 |
| 4 | 7 | 6 | 3 | 2 |
| 5 | 10 | 2 | 2 | 3 |
| 6 | 14 | 5 | 4 | 5 |
| 7 | 18 | 3 | 5 | 6 |
| 8 | 22 | 1 | 8 | 0 |
| 9 | 27 | 6 | 3 | 5 |
| 10 | 29 | 3 | 4 | 4 |
| 11 | 33 | 8 | 3 | 7 |
| 12 | 36 | 2 | 3 | 8 |
| 13 | 36 | 3 | 2 | 9 |
| 14 | 38 | 4 | 4 | 9 |
| 15 | 42 | 1 | 6 | 10 |
| 16 | 44 | 4 | 2 | 7 |
| 17 | 47 | 7 | 3 | 6 |
| 18 | 50 | 3 | 7 | 5 |
| 19 | 57 | 1 | 5 | 3 |
| 20 | 60 | 2 | 2 | 3 |

C=2 Number of channels open

n: Number of customers

Ti: Customer arrive time (min)

$s_i$: Customer receive service time (min)

$t_i$: Customer arrive interval time (min)

$w_i$: Customer waiting time in queue (min)

Entire data from whole normal work day 8 hours totally. After calculation, the result as following:

$\lambda$= 0.475 person / min

$\mu$= 0.25 arrive person/ service min

There are 4 service window in the branch, but Lotus bank branch usually opens 2 personal service windows providing private financial service to individual customers. Assume C = 1, 2, 3, 4.

When C = 1, ρ =λ /μ = 0.475/0.25 = 1.9 > 1, the system is not balance.

When C = 2, ρ =λ /2μ = 0.475/2* 0.25 =o.95 < 1, the system is balance.

1. Probability of Service windows free:

$$P_0 = \left[\sum_{k=0}^{1} \frac{1}{k!}\left(\frac{0.475}{0.25}\right)^k + \frac{1}{2!}\left(\frac{0.475}{0.25}\right)^2 \frac{2*0.25}{2*0.25-0.475}\right]^{-1} = \left[1+1.9+36.1\right]^{-1} = 0.0256$$

2. Average number of customers waiting in the queue:

$$L_q = \frac{(C\rho)^C}{C!(1-\rho)^2}\rho P_0 = \frac{(2*0.95)^2}{2!(1-0.95)^2}*0.95*0.0256 = 17.559 \approx 17$$

3. Total number of customers: Ls =$L_q$ +$C_p$ =17.559+2*0.95 =19.459 =19 person

4. Waiting time in queuing:

$W_Q = \frac{Lq}{\lambda} = \frac{17.559}{0.475}$ = 36.9663 min

5. Average staying time

$T_s = \frac{Ls}{\lambda} = \frac{19.459}{0.475}$ = 40.9663 min

Obviously, if the Lotus branch keep opening only two service windows, average approximate 17 people waiting in queue line, waiting time amount 37 minutes, and the queue problem is serious.

When C = 3, $\rho = \frac{\lambda}{3\mu}$ = 0.6333< 1

Po=0.1278

$L_q$= 0.6618 person

$L_s$=2.5618 person

$T_{q=}$1.3933 min

$T_s$=5.3933 min

When C = 4, $\rho = \frac{\lambda}{4\mu}$ = 0.0.4750< 1

Po=0.1453

$L_q$= 0.136 person

$L_s$=2.036 person

$T_{q=}$0.2863 min

$T_s$=4.2863 min

Depends on previous calculation, the Lotus branch keep open three or four service channels will meet the requirement. Consider about economic and budget problem, 3 service channels opening are more appreciate for Lotus branch.

### 4.4 Improvement

For different time period, the number of bank service windows can be adjusted. No long rigid setting only two service channel, but according to the number of customers arriving to make a decision. There are two improve ideas:

**Announced customer arrives law**

Customers understand the bank's customer-through rule, traffic can choose a smaller time period to conduct business. Banks can use a variety of ways to reach the customers and the media published the law. For example, by operating the electronic screen in the hall.

**Display wait time estimates**

On the banks Queuing electronic screen displays wait time estimates. The waiting time can effectively help customers estimate value judgment. After customers arrive, you can use the waiting time to deal with other matters, shorten customer perception of time. If the customer left in the bank waiting, the expected wait time pages do not have a strong boredom.

### 4.5 Control

As the last step of DMAIC, the purpose is to keep improving performance and prevent problem from recurring.

## Chapter 5 Conclusion

Through questionnaires and interviews, data analysis and calculation, the customers arriving rate of the bank follows Poisson distribution. Majority customers accept eight minutes waiting time. To satisfy customers, the bank managers should take some actions:

1. Flexible service desk implementation of the appointment system. According to the customer arrival rate and the average service rate, the average waiting time per desk number can be calculated. The employees have more flexibilities during work.
2. Categorizing customers into different service counters. This may increase some people's waiting time, but the overall waiting time will be reduced. It can also reduce the number of customers waiting for service, and thus reduce congestion service in the bank.
3. During the waiting service, customer service staff can complete some ancillary work (such as filling the necessary blanks of the deposit form). Also, they can collect information for customers (for instance, filling out loan application forms) and introduce the business office products and services (offering related brochures to customers), in order to shorten the time of core services.
4. Improve the level of service. Using of high-tech innovations such as automation equipment to accelerate the service speed. Optimizing service process time has great practical significance for banks to improve service quality, reduce costs, improve customer satisfaction level and increase market share rate.

In conclusion, minimizing waiting time and improving customer satisfaction level can enhance the competitiveness of financial services. They are not only the requirements for social development, but also for human civilization. Establishing a scientific, workable and efficient banking system improves efficiency and enhances the competitiveness for banks to be an important society role. This is a requirement for banking industries own development, and a new inevitable challenge for modern Chinese commercial bank to increase the bank management development.

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## Appendix

### Survey on Banking Service Waiting Time of Bank of China Lotus Branch

Dear customers:

We are doing a short and simple survey regarding with the banking service waiting time of Bank of China Lotus Branch with the aim of improving our current service. We assure you the protection on your privacy. Thanks for your support.

1. Your age:

A: 18-30 B: 31-45 C: 45-60 D: Over 60

2. Your occupation

A: Student B: Employee C: Employer D. No jobs E: Others__________

3. Which kinds of service do you usually take in the bank? (Pleas rank according to frequency)

A: Deposits and withdraw B: Remittance Service

C: Consumer Credit D: Trade Service

E: Capital management F: Forex trading Services

G: Bank card business H: Retail Mortgages

I: Others___________

4. How many minutes you can accept for waiting banking service?

A: 8 min B: 15 min C: 20 min D: 30 min E: Over 30 min