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Research on using Six Sigma management to improve bank customer satisfaction

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Abstract

In the banking industry, which aims to serve customers, management level and service level are one of the criteria for measuring the core competitiveness of banks. An important indicator of management and service levels is to ensure customer satisfaction with the bank used. Six Sigma management is customer-centric, based on data and facts, adopting improvement measures for the process, focusing on preventive control, emphasizing borderless cooperation, continuous improvement, and the pursuit of quality and efficiency management mechanisms. In this paper, we empirically analyze the reasons why banks affect customer satisfaction and design the bank's Six Sigma service process based on empirical analysis. Finally, in the "Conclusion and discussion" section, the research suggestions for improving bank customer satisfaction are given.

Keywords: Bank, Six Sigma management, Customer satisfaction, Analysis of variance

Introduction

Customer satisfaction and loyalty are vital differences between better performing and underperforming businesses in most markets [1]. Customer satisfaction refers to how customers feel about their happiness, depending on the comparison and differences between the customer's expectations and the products/services they receive. This difference is also referred to as the difference between "cognitive quality" and "perceived quality" when the perceived quality is equal to or greater than the cognitive quality, customer satisfaction, or loyalty achieved, and the customer is not satisfied [2, 3]. Previous research has made service quality, expectation, uncertainty, performance, desire, influence, and fairness an essential cause of customer satisfaction [4–8]. In the banking industry aiming at serving customers, the core and relationship dimension of service quality and customer satisfaction is relevant [9]. Therefore, management level and service level have become one of the criteria for measuring the core competitiveness of banks. An important indicator of management and service levels is to ensure customer satisfaction with the bank used.

The customer-oriented service concept has become the company's purpose. Therefore, the demand for banking services by users is getting higher and higher. At present, due to the large population of China, the drawbacks caused by poor banking services are becoming more and more apparent, especially for the long-term waiting time for consumers. According to statistics, from the queuing or taking the number to the

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counter to handle business, the average waiting time for bank outlets exceeding 30 min is more than 30%. The opening of the window of banks is unreasonable. The working day is only about 60% open rate and only a 50% open rate on non-working days. This work is inefficient, resulting in generally low customer satisfaction.

We used to do business at Bank of X and found that the bank only opened two processing windows. The customer was noisy because of the long waiting time and asked to open a few windows. We consider whether we can find a scientific method to optimize the management of banking business processes, which constitutes the research topic of this paper. Among all the business of the bank, the most important thing is the counter service. The quality of the counter service directly reflects the strength of the bank's overall service level and affects customer satisfaction with banking services. So we mainly strengthen banking business process management through Six Sigma management, to shorten customer waiting time and improve bank customer satisfaction.

Six Sigma management is a new process of a process change that reduces customer operating costs and cycles while improving customer satisfaction [10]. Six Sigma is a management model that enhances the profitability of an organization by improving the quality of its operations. Six Sigma is an effective management strategy for companies to gain competitiveness and sustainable development in a new economic environment [10, 11]. Relevant scholars have studied customer satisfaction, but these studies involve not many banks, and the use of Six Sigma for research is even rarer [12–16]. Based on the field survey, we designed the Six Sigma process for commercial bank customer satisfaction, and applied the method to retail bank customer management, enriched the customer satisfaction theory, and had a specific theoretical value for the development of customer satisfaction theory.

The research structure of this paper is as follows:

Introduction: This section mainly introduces the problems in customer satisfaction and bank customer satisfaction and the main issues to solve in this paper.
Literature review: This section mainly introduces the research status of customer satisfaction and the application of Six Sigma management in the financial industry.
Empirical research: This section uses empirical analysis to illustrate the issues affecting customer satisfaction.
Six Sigma process design: This section uses the Six Sigma principle to design a bank to improve customer satisfaction.
Research conclusion: Based on empirical analysis and the Six Sigma process design, we propose research recommendations.

Literature review

The situation of customer satisfaction is closely related to the core competitiveness of the bank. Therefore, many experts and scholars have conducted a series of studies on this. Rust and Zahorik constructed a mathematical model for urban retail banks to assess the value of customer satisfaction [17]. Hallowell studied the relationship between customer satisfaction and customer loyalty and customer loyalty to profitability through the use of multiple measures of achievement, reliability, and profitability [11]. Moutinho and Smith used a linear structure approach to construct a model that plays a

crucial role in assessing bank customers' attitudes toward manual tellers and electronic banking and can adjust banking factors/perceived satisfaction vinculum of convenience [18]. Rod et al. studied the nature of the relationship between customer perceptions of first-line employee services, satisfaction, and selected behavioral intentions by using the customers of Russian commercial retail banks as their background [19]. Ndikubwimana and Berndt believes that the physical environment and facilities of the bank are conducive to providing excellent services, that customers are satisfied with the tangible aspects of the service, and that they are prepared to reflect this satisfaction in their actions [20]. Jalali et al. found that the consequences of greater competition and financial crises mean that banks are increasingly focusing on improving service quality and achieving higher levels of customer loyalty [21]. The research proposes and tests a comprehensive model based on cognitive mapping and multi-criteria decision analysis (MCDA), which combines metacognition and psychometric decision-making methods to create a framework for assessing bank customer loyalty [21].

Although these experts and scholars studied the bank's customer satisfaction and built related models, however, these studies do not design processes using Six Sigma principles. We mainly use Six Sigma management to optimize customer satisfaction.

The core idea of Six Sigma was born in 1970 because the senior leader Art Sundry criticized Motorola for its poor production quality [22]. Geoff uses Six Sigma quality management to control long-term defect levels to 3.4 in the short term DPMO within the above, and based on this, the "Six Sigma flow chart" was established [23]. Cmglee according to calculations in the process performance study, if people achieve six standard deviations between the process average and the most recent specification limits, there will be no defective products (Fig. 1) [24, 25].

As can be seen from the flow chart, the normal distribution graph is the root of the Six Sigma model. The Greek letter σ (Sigma) on the horizontal axis marks the distance between the arithmetic means, μ, and curve inflection point, and the greater the distance, the greater the difference encountered. In the green curve above, $\mu = 0$ and $\sigma = 1$. The above and below parameters define (USL and LSL) the distance from the mean within 6σ. Stamatis summarizes several ways to influence quality improvement over the past few decades, including quality control, total quality management(TQM), and zero defect method, forming a Six Sigma quality management theory [26]. Gygi & Williams, and El-Haik perfected the Six Sigma management theory and studied the long-term

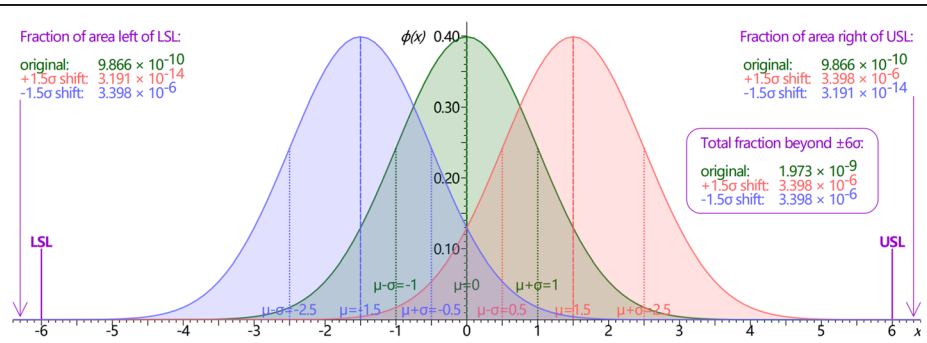

Fig. 1 Six Sigma Normal distribution [24]

Sigma level DPMO value (Table 1) and control chart, DanielPenfield draws DPMO control chart of Six Sigma based on their research (Fig. 2) [27–29].

In the field of banking services, Fornell et al. proposed a customer satisfaction index model. As a new measure of performance, the customer satisfaction index model is the match between customer expectations and customer experience [12]. Riley et al. demonstrated through case studies that financial institutions use Six Sigma (DFSS) to develop policies and procedures to eliminate compliance gaps and improve the lending process for banks and customers [13]. Antony studied the role of Six Sigma in a bank customer call center, where the metric-based environment complements Six Sigma's application of process improvement [14]. Sunder emphasizes the importance of LSS in the banking industry through real-time process improvement research and provides a theoretical contribution to the Bank's detailed introduction to customer-oriented metrics and the processing of key performance indicators (KPIs) that require Lean Six Sigma [15]. Bazrkar et al. designed the overall quality model of the "accounting process" of Ghavamin Bank [16].

The true essence of lean is to leverage the enthusiasm and knowledge of frontline employees and enable them to focus on ensuring that as much activity as possible in the end-to-end process supports delivering value to customers [30]. Therefore, we believe that customer identification is a valuable intangible asset of commercial banks, and customer satisfaction surveys are closely related to the development of commercial banks. Thus, the introduction of the Six Sigma method for the design of bank management processes is of strategic importance.

Empirical research

Although the overall service level of the Chinese banking industry has significantly improved in recent years, there is still a big gap with the leading international banks in terms of customer satisfaction, overall banking service level, and management level.

We randomly investigated the counter business of a branch of X Commercial Bank and found that there were a series of problems such as long waiting time for customers to handle business, unreasonable window opening, and inefficient bank staff. That is also a common problem for many banks.

According to the survey data, we randomly selected data sample from four time periods (9:00–11:00, 11:00–12:00, 12:00–14:00, 14:00–17:00) (Table 2).

Referring to the research of related scholars [31–33], we use the method of hypothesis testing in probability theory and mathematical statistics to analyze data. Before a data analysis, we first analyze the basic principles of the relevant methods.

Table 1 DPMO table of Six Sigma (Gygi and Williams 2012)

Sigma level	Million error rate	Percentage of debris	Percentage of output	Short-term C_{pk}	Long-term C_{pk}
1	691,462	69%	31%	0.33	−0.17
2	308,538	31%	69%	0.67	0.17
3	66,807	6.7%	93.3%	1.00	0.5
4	6210	0.62%	99.38%	1.33	0.83
5	233	0.023%	99.977%	1.67	1.17
6	3.4	0.00034%	99.99966%	2.00	1.5

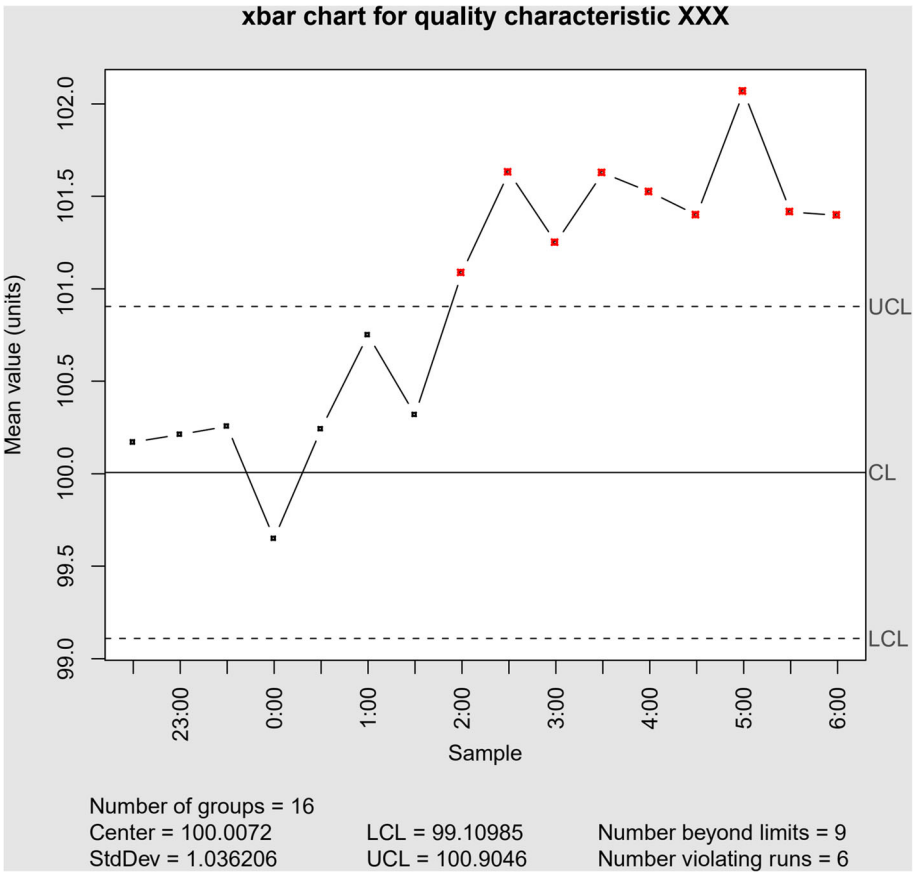

Fig. 2 X-bar chart for a paired X-bar and s Chart [29]

Under the condition of $\sigma_a^2 = 0$, F obey normal distribution of the degree of freedom $df1 = k - 1$ and $df2 = k(n - 1)$. Then

$$\frac{\mathrm{MS}_t}{\mathrm{MS}_e} \sim F(df_1, df_2)$$
$$df_1 = k-1, df_2 = k(n-1)$$

If the calculated F value is greater than $F_{0.05}(df_1, df_2)$, the F value is significant at the level of $\sigma = 0.05$. We conclude that the overall variance of MS_t is greater than the total variance of MSe with 95% reliability (i.e., 5% risk). That is, the method $\sigma^a{}_2 \neq 0$, which uses the magnitude of the probability of occurrence of the F value to infer whether the population variance is greater than the other population variance, is called the F-test.

The analysis of variance for a single-factor completely randomized design test data:

Invalid hypothesis H_0: $\mu_1 = \mu_2 = \cdots \mu_k$.

Table 2 Customer waiting time

Time periods	Data sample				
9:00–11:00	0	3	5	10	8
11:00–12:00	13	27	32	26	24
12:00–14:00	6	9	4	7	2
14:00–17:00	5	7	15	11	15

Alternative hypothesis H_A: each μ_i is not equal, then,

$$H_{0:}: \sigma\frac{2}{a} = \frac{\sum_{i=1}^{k} a_i^2}{k-1} = 0, H_A: \sigma_a^2 = \frac{\sum_{i=1}^{k} a_i^2}{k-1} \neq 0$$

$F = \frac{MS_t}{MS_e}$, that is, to determine whether the mean square between treatments is significantly larger than the intra-process (error) mean square.

Based on the randomly selected sample data, to verify the results of the random survey, we propose the following three research hypotheses:

H1: Assume that the period for handling business has a significantly affected customer waiting time.

According to the survey data, the customer's waiting time is randomly selected from four time periods (9:00–11:00, 11:00–12:00, 12:00–14:00, 14:00–17:00). Assume that the waiting time of the customer in each period obeys the normal distribution, assuming that the test H0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, obtained by the analysis of variance (Table 3):

From 3.33 > 3.24, H0 is rejected at the level of $\alpha = 0.05$ significance, that is, the waiting time of customers at different periods is significantly different at the 0.05 level.

H2: Assume that business content has a significantly affected on processing time.

According to the survey data, four different business contents (receipt and deposit, account opening/banking, loss reporting, transfer) and the teller's processing time are randomly selected, assuming that each business processing time is subject to normal distribution, hypothesis testing H0: $\mu_1 = \mu_2 = \mu_3 = \mu_4$, obtained by the analysis of variance (Table 4):

From 4.07 > 3.24, H0 is rejected at the level of $\alpha = 0.05$ significance, and the business content has a significant difference in the processing time at the 0.05 level.

H3: Assume that different window numbers have a significantly affected on processing time.

According to the survey data, the waiting time of three windows is randomly selected (in the case that the business is for deposit and withdrawal and transfer), assuming that the processing time of each window follows a normal distribution, assuming H0: $\mu_1 = \mu_2 = \mu_3$ using the analysis of variance (Table 5):

From 3.56 < 3.68, H0 cannot be rejected at the level of $\alpha = 0.05$ significance, that is, different window numbers have no significant effect on the processing time.

Through hypothesis verification, it can found that X commercial banks have different differences in different services at different times. Different windows have not been significantly affected on the processing time. That shows problems in the management of banks, and there is room for improvement. How to improve management level and service level, and growing customer satisfaction has become the management problems that banks need to solve urgently.

Table 3 Variance analysis results of H1

Source	Sum of square	Degree of freedom	Mean square	*F* ratio
Factor A	208.07	3	69.36	3.33
Error e	332.89	16	20.82	
Sum	540.96	19	$F_{0.95}(3,16) = 3.24$	

Table 4 Variance analysis results of H2

Source	Sum of square	Degree of freedom	Mean square	*F* ratio
Factor A	194.15	3	64.72	4.07
Error e	254.4	16	15.9	
Sum	448.55	19	$F_{0.95}(3,16) = 3.24$	

Process design of Six Sigma in improving bank customer satisfaction

Six Sigma management is customer-centric, based on data and facts, adopting improvement measures for the process, focusing on preventive control, emphasizing borderless cooperation, continuous improvement and the pursuit of quality and efficiency management mechanisms. It always revolves around customer satisfaction and loyalty. Based on the empirical analysis, we designed the bank's service flow using the Six Sigma theory and plotted the SIPOC diagram.

Define stage (D)

The main content of the definition phase is to determine the flow chart of the banking service and the needs of the customer. We have developed a project plan based on the characteristics of the bank's business processes: the project plan includes the setting of goals, the definition of scope, the division of labor, and the collaboration of team members. At the same time, according to the characteristics of customers' needs, the leading indicators affecting customer satisfaction are determined.

Drawing a SIPOC diagram (Fig. 2): the elements of a SIPOC diagram are the supplier (S), input (I), process (P), output (O), and customer (C).

The main task of this phase is to determine the bank's customer satisfaction improvement project. The goal of the project is to eliminate various factors that are not conducive to process performance and improve customer satisfaction. According to the results of the empirical analysis, in this step, the following questions should be clear: What are the customer's needs? What is the critical quality factors (the essential elements of quality refer to the core standards required by the customer for the product or service)? What is the definition of a project's defect (a defect is "anything that cannot meet the criteria required by a critical quality element")?

Measurement phase (M)

This stage further describes the whole process based on the SIPOC diagram. Develop data collection and sample collection plans and measure process capabilities by identifying key quality characteristics that affect process performance. The measurement content mainly includes two aspects: the service efficiency of the banking outlets and the customer service of the banking outlets. There are four main measurement methods, including manual field measurement, counting machine statistics, viewing

Table 5 Variance analysis results of H3

Source	Sum of square	Degree of freedom	Mean square	*F* ratio
Factor A	32.11	2	16.06	3.56
Error e	67.67	15	4.51	
Sum	99.78	17	$F_{0.95}(2,15) = 3.68$	

monitoring video and background data extraction, and measurements mainly taken by random sampling.

At this stage, after making the conditions of the project clear, the following things need to be done according to the customer's requirements:

- Select evaluation indicators: According to the critical quality factors of the customer and the essential quality factors of the project, the impact points and specific requirements on the quality of the business process are derived, that is, the particular needs of the customer for the products and services are translated into the standards to be achieved by the bank process.
- Identify the measurement objects and develop a data collection plan: Conduct an assessment of an existing process to understand the process capability or level of a current method; at the same time, develop a data collection plan that plans a data collection plan based on the selected measurement object. The data collected during the measurement phase laid the groundwork for the analysis phase.
- Verify the measurement system: With the data collection scheme, data collection activities cannot implement immediately. Before the measurement, it is necessary to verify whether the measurement system is available because the measurement data is the primary input in the analysis stage. If the data quality is not high, it will affect all subsequent activities.

Analysis phase (A)

The main task of this phase is to identify key influencing factors and analytical work on the data. The raw data were obtained by designing customer satisfaction questionnaires and field research, and the causal relationship was established and verified through data analysis. According to the results of the empirical study, identify the critical defects and causes that affect performance indicators.

The analysis phase is the most critical part of the process improvement process, designed to identify and validate the root cause of the original problem. At this stage, the project team needs to analyze and improve the most critical objectives of the various objects (variables) that cause defects. It should note that experience and intuition cannot replace the work of the analysis phase. Because the root cause of the problem buried deep in the file heap and the old program is not intuitive and empirical, therefore, the analysis stage is to use a variety of useful tools and methods to analyze existing data and processes and identify solutions to project improvements.

The analysis phase is a process of continuously cycling the root cause, which can be represented by Fig. 3.

- Perform data or process analysis: Its purpose is to detect the data collected during the measurement phase to help the team find relevant clues about the cause of the problem to be improved.
- Establish assumptions or models of the cause of the incident: That is, based on the analysis results, all possible hypotheses that may lead to the problem are raised as much as possible, and a model for the cause of the problem is established. Brainstorming methods are often used at this stage [34].

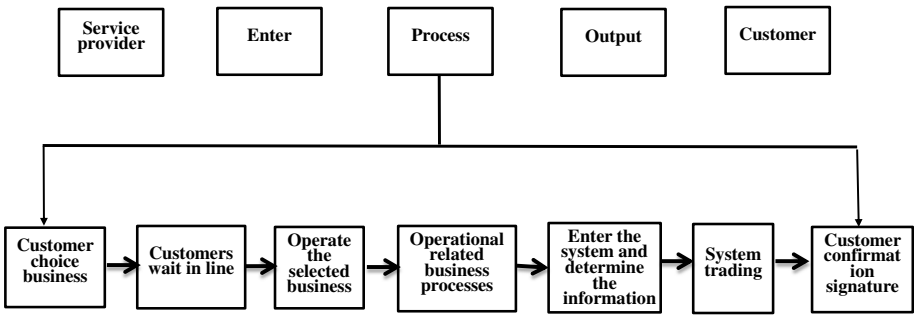

Fig. 3 Service operation SIPOC diagram [14]

- Perform data and process analysis again: This phase of work is similar to the first phase, but it is not a simple repetition. After listing the possible causes through the brainstorming method, the project team will use the data collected during the measurement phase and the new data collected during the analysis phase (Fig. 4) to re-analyze the development trend of the problem and other related factors, proposing new hypotheses or models.
- Revise the hypothesis or model: After another data and process analysis, the goal of this phase is to reduce or eliminate a large number of causes in brainstorming to a more manageable amount. If the result of the reduction does not achieve satisfactory results, it is necessary to start the first phase and re-make the hypothesis until the goal of confirming the root cause can be made.

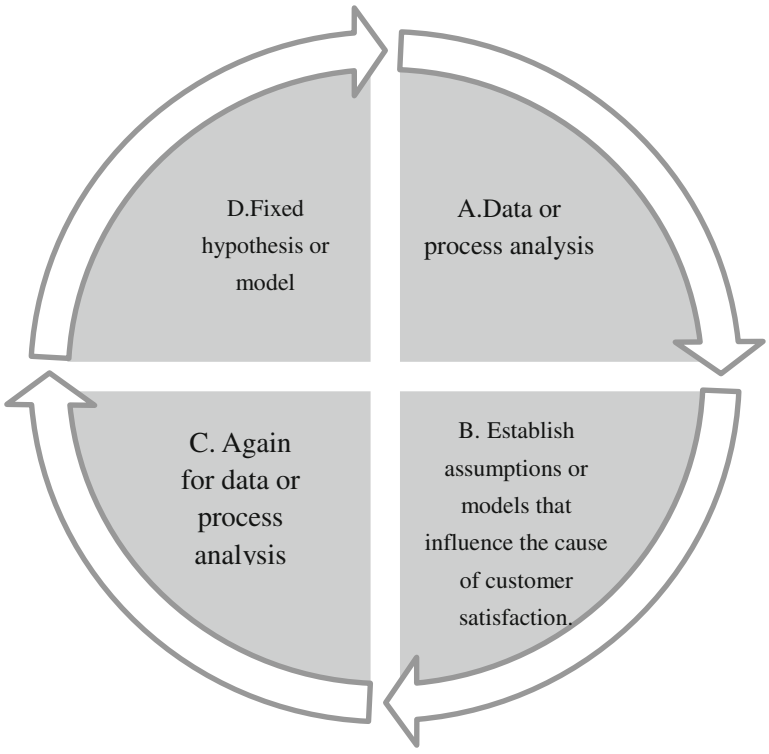

Fig. 4 Analysis phase cycle diagram [26]

- Identify and select several key reasons: That is, analyze the root cause of the problem.

Improvement stage (I)

Suggestions for improvement are proposed based on facts and data, and improvement plans are determined. A partial test run can be performed to verify the improvement. The improvement scheme can be given in the form of an improved strategy table. After the improvement plan is formed and the improvement plan specification is written, the improvement plan implementation process is entered.

That is the core process of the Six Sigma project. The work during the definition, measurement, and analysis phases are all prepared for the improvement phase. Therefore, the main task of the improvement phase is to find the optimal solution that will enable the bank to improve customer satisfaction. The steps in the improvement phase are:

- Seek creative customer satisfaction improvement programs: Similar to the analysis phase, in this step, brainstorming can help the group gain more opinions on how to solve the problem.
- Identify the solution and develop an implementation plan: In this step, all the ideas and suggestions put forward by the brainstorming activities are discussed and classified, and the repeated and excluded are not feasible, and the most likely to form a solution is selected and organized merely. The team then revisits and evaluates the selected ideas and decides the most promising and practical solutions based on cost and possible benefits. After that, develop a detailed implementation plan.
- Full implementation of the solution: If not implemented, the best solution is just a piece of paper. Therefore, the team's next job is to overcome the obstacles and achieve improvement activities throughout the process.

Control phase (C)

Incorporate the improvement phase measures into daily management, and carry out lean and traditional control of banking business processes by establishing work performance appraisal standards and improving incentive measures.

Control activities enable the organization to continue to maintain the initial improvement activities of the project team and ensure that continuous improvement is achieved after the unit is disbanded. The long-term impact on people's working methods and the sustainability of their needs, not only the measurement and monitoring results, but also the constant persuasion and marketing of ideas, are both necessary. Therefore, in the control phase, the work of the project team includes explicitly:

- Confirm performance improvement and compare the results with improvement goals.
- Establish a rapid response mechanism to adjust strategies, products, and services promptly based on changes in vital information.
- Build a Six Sigma management culture and establish an organization that will continue to promote Six Sigma management.

The final success of the Six Sigma project lies in those who work well in the areas of interest to the project. Only when these people see the value of generating a new solution through the DMAIC process and begin to understand and believe the potential that the Six Sigma system can provide can the goal of continuous improvement be genuinely achieved.

Conclusion and discussion

Conclusion

Six Sigma is a new management strategy that has achieved great success in many areas of the world. Six Sigma is a management model that continuously improves and breaks through and pursues excellence. It creates a "customer satisfaction" Six Sigma quality culture through Six Sigma management, continually improves process design, reduces process defects, achieves excellent customer satisfaction, and achieves higher customer requirements. We believe that in the specific practice, attention should be paid to the following aspects:

- Establish and adhere to a quantitative analysis culture: Six Sigma emphasizes the concept of data, pays attention to data and quantitative analysis, and strictly divides management activities based on statistical analysis of data collection. It uses objective data and quantitative indicators to objectively reflect the current situation of the bank and analyze the crux of the problem. Therefore, strong data support and a complete measurement system are the basis for the successful implementation of Six Sigma.
- Build an efficient Six Sigma infrastructure and establish a Six Sigma work management and incentive mechanism: Six Sigma-specific organization implementation is usually delivered and implemented by executive leaders, advocates, black belt masters, black belts, green belts, and project teams. Commercial banks should establish a Six Sigma organizational structure, clarify important responsibilities and authorities, select an efficient group with a good business foundation, be familiar with business processes, have a strong sense of change and teamwork, and start to eliminate the reasons for customers getting defective products or dissatisfied services, prioritize actions, and solve problems.
- Master the critical links of the DMAIC process: Six Sigma management is a flexible and comprehensive system and business improvement method system. All operations and activities are usually carried out according to the process. The first is the definition phase. It is defined to identify and identify goals that need improvement. The second is the measurement phase. It requires employees to be trained in basic statistics and probability theory and can use data as a benchmark to measure the gap between current conditions and customer needs. The third is the analysis phase. It is applying many statistical tools to explore the critical causes of the difference between the status quo and the demand and identifying the potential variables that affect the outcome. The fourth is the improvement phase. Statistical tools are used to analyze the entire system and determine the gaps between existing systems and process performance and established goals and solutions, requiring the use of project management tools to find useful improvements. The fifth is the

control phase. The focus is on how to monitor new system processes, correct and standardize the effectiveness of the entire process, make the improvement measures long term at a new level, and continue to improve the results.

- Adhere to continuous improvement: continuous improvement is also a management and cultural foundation for Six Sigma management. The DMAIC process of the Six Sigma project itself is a cyclical process of discovering problems, solving problems, rediscovering problems, and resolving issues. That is an endless process of perfection and continuous improvement. It is necessary to avoid the Six Sigma as a "one gust of wind" quality movement, to establish the so-called "no best, only better" continuous improvement concept, and ultimately to form a corporate culture.

Discussion

The customer-oriented service concept has become one of the most fundamental codes of conduct in all walks of life. Banks that are strictly related to the production and growth of the general public are increasingly aware of the importance of "customer-centric" and realize the value of the company in the process of pursuing customer satisfaction: improve service quality, improve service management, optimize the investment environment, actively develop financial derivatives, and connect with leading international banks. That is also the direction that all joint-stock banks including X commercial banks are working hard. Based on this, we propose the following suggestions and improvement strategies.

- Implement a flexible working system and some windows to meet the peak period of customers in different periods fully: The degree of leisure and leisure in the banking hall is different, and there will be several peak periods. The number of windows at peak times does not meet the needs of customers. In this regard, the problem can be solved by the flexible working system and the number of windows to meet the needs of customers.
- Defining functional areas, conducting customer diversion management, and vigorously developing electronic channels: Banks can identify various functional areas, which effectively divert customers through the establishment of consulting service areas, automated service areas, customer lounge areas, wealth management service areas, and customer manager offices. Banks should actively guide customers to use electronic channels to handle business and ease the pressure on the business hall window.
- Improve service efficiency and continuously optimize services: Increasing the ability of the staff can shorten the waiting time for customers. The bank shortens service time by identifying the best work routes and steps, unifying service standards and processes.
- Establish a feedback mechanism for customer satisfaction and timely adjust the management plan of the work system: Banks can establish customer feedback mechanisms. Through feedback from customers, the bank improves service processes and enhances customer satisfaction.
- In the process of applying Six Sigma management, the following points should also be noted: The value of customer satisfaction in different periods is drawn into a control chart to obtain dynamic information on customer satisfaction. Every improvement should find the most critical factors affecting customer satisfaction, each time improving for one element.

Abbreviations
et.al.: And others; i.e.: Id est

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The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Author's contribution
The author read and approved the final manuscript.

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