

ANALYZING CUSTOMER RELATIONSHIP
MANAGEMENT USING MACHINE LEARNING

ZHANG ,MENG

UNIVERSITI KEBANGSAAN MALAYSIA

ANALYZING CUSTOMER RELATIONSHIP MANAGEMENT USING MACHINE
LEARNING

ZHANG , MENG

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MENGANALISIS PENGURUSAN HUBUNGAN PELANGGAN
MENGUNAKAN PENGAJARAN MESIN

ZHANG , MENG

PROJEK YANG DIKEMUKAKAN UNTUK MEMENUHI
SEBAHAGIAN DARIPADA SYARAT MEMPEROLEHI
IJAZAH SARJANA SAINS DATA

FAKULTI TEKNOLOGI DAN SAINS MAKLUMAT
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2025

DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged.

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ZHANG MENG
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ABSTRAK

Dalam industri perbankan, pelanggan telah menjadi sebahagian penting daripadanya, dan pengurusan hubungan pelanggan menjadi lebih penting lagi. Untuk bank, aspek paling penting pengurusan hubungan pelanggan adalah pengkelasan pelanggan dan prediksi penghulu pelanggan. Kajian ini memilih model DT, RF dan SVM untuk prediksi pengelasan, membandingkan keputusan tiga model dan kemudian memilih ANN dan memilih kaedah SMOTE untuk ramalan kerugian. Penyelidikan ini juga menggunakan model Kmeans untuk menggumpalkan data untuk mengelompokkan beberapa ciri data. Dengan mengelompokkan pelanggan yang serupa bersama, bank boleh menyesuaikan perkhidmatan mereka lebih efektif, yang menyebabkan kepuasan pelanggan dan penghulu yang meningkat. Keputusan menunjukkan bahawa model DT lebih berkesan dalam mengelaskan pelanggan, dan model ANN boleh menggunakan kaedah SMOTE untuk menyeimbangkan data apabila menghadapi masalah bilangan tidak seimbang. Kajian ini juga menawarkan cadangan tentang arah pengembangan pengurusan hubungan pelanggan bank pada masa depan. Melalui penyelidikan masalah yang sedia ada dan arah pengembangan masa depan, disertasi ini menyediakan pendapatan yang relevan mengenai pengembangan pengurusan hubungan pelanggan bank. Penemuan ini menyumbang kepada pemahaman yang lebih luas bagaimana bank boleh mengambil keuntungan dari pengaturcaraan mesin untuk meningkatkan inisiatif CRM mereka dan bentuk strategi masa depan mereka..

ABSTRACT

In banking, customers have become an important part of it, and customer relationship management has become even more important. For banks, the most important aspect of customer relationship management is the classification of customers and the prediction of customer churn. This study selects the DT, RF and SVM models for classification prediction, compares the results of the three models and then selects ANN and selects the data or SMOTE method for loss prediction. The research also uses Kmeans as model to cluster the data to get some features of the data. By grouping similar customers together, banks can tailor their services more effectively, leading to improved customer satisfaction and retention. The results show that the DT model is more effective at classifying customers, and the ANN model can use the SMOTE method for data balancing when dealing with an uneven number of problems. The research also puts forward suggestions on the development direction of the bank's customer relationship management in the future. Through the research of the existing problems and the direction of the future development, this dissertation provides relevant opinions on the development of the bank's customer relationship management. These findings contribute to the broader understanding of how banks can leverage machine learning to enhance their CRM initiatives and shape their future strategies.

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LIST OF ABBREVIATIONS

ANN	Artificial Neural Networks
BSI	Bank Syariah Indonesia
CEM	Customer Experience Management
CLV	Customer Lifetime Value
CRM	Customer Experience Management
DT	Decision Tree
ICT	Information and Communication Technology
LDA	Linear discriminant analysis
LoT	Internet of Things
MI	Marketing Intelligence
PAM	Partitioning Around Medoids
PLS	Partial Least Squares
PCA	Principle Component Analysis
RF	Random Forest
SCA	Sustained Competitive Advantage
SEM	Structural Equation Modeling
SMOTE	Synthetic Mine Over-sampling Technique
SVM	Support Vector Machine
UKM	Universiti Kebangsaan Malaysia
WSS	Within-Cluster Sum of Squares

CHAPTER I

INTRODUCTION

1.1 RESEARCH BACKGROUND

One significant problem that the banking sector must address is customer attrition. Numerous professionals from academia and allied industries have conducted extensive studies on the significance of customer churn management concerns in China's business management in recent years, and they have produced certain research findings. Commercial banks have acquired a significant amount of customer data through direct or indirect means during the course of customer management and maintenance, given the backdrop of the Internet. Achieving customer happiness has become an imperative requirement for all firms in the contemporary global economy (Sarin & Gupta 2023). Building solid and constructive relationships with customers is how this is accomplished. Customers' demands and desires are being given special consideration by businesses, and Customer Relationship Management (CRM) is thought to be the most effective guiding principle for building positive relationships with future customers (Alchalabi & Chitbeer 2024).

This presents both a rich source of information for analyzing and mining customer characteristics and significant challenges for the commercial bank's customer management and analysis work. The fast popularization of various information technologies has reduced the life cycle of products in today's swiftly evolving and fiercely competitive international market environment. A new generation of products is emerging, but the difference in price between them is getting less. It is necessary to change the core competitiveness from the traditional product-oriented to customer service-oriented, to continuously improve customer satisfaction, to increase customer stickiness, to decrease customer turnover, and so to increase the

market competitiveness of commercial banks, especially for the banking industry, which is based on customer service and relatively small price differences. Banks have come to understand that maintaining good relationships with customers is crucial to their success (Apampa 2016).

With the correct management system and the implementation of customer-focused tactics, CRM is a tactic that can assist them in creating enduring ties with their clients and boosting their earnings. CRM is strategically important in the banking industry. ICT advancements have compelled banks to implement electronic CRM, or e-CRM, to enhance client relationships and boost profitability while achieving customer satisfaction and loyalty (Abu-Shanab & Anagreh 2015).

The quick advancement of Internet technology is necessary for data availability, and data is a necessary byproduct of e-commerce enterprises. The social economy's traditional business models are being altered by e-commerce, particularly those that pertain to the interaction between businesses and their clientele. Due to the intense competition in the market today, businesses must complete the shift from a "product-centered" to a "customer-centered" core business philosophy. This means that if an organization can anticipate its customers' needs and act swiftly to meet them, it will be able to draw in new business, keep hold of its current clientele, and eventually draw in new ones. CRM provides a solution to this problem; the two different flows of value flow of the interaction between the creation of the process of management is the core of CRM; one is the value of the enterprise flow to the customer, and the other is the value of the customer flow to the enterprise; in fact, these two types of value are complementary and interdependent. Customers bring profits and development power to firms, which generate value and deliver services to them (Choudhury 2023).

Customer classification is the most important issue of customer relationship management, customer classification can be divided into no-value customers, high-value customers, so that enterprises can be based on the different value of the customer to develop a different category of services, in this research high active customers means buy more products from the bank, medium active customers means

saving money in the bank, and inactive customers means just an account in the bank, using different marketing methods, the limited enterprise resources highly used for high-value customers, so that the enterprise's profits to maximize. In this research, the classification is about the active level, customer with different active levels has different meaning to the bank, so the cluster method is better for this problem. And in this research if a customer chooses to leave the bank that he has no meaning to the bank.

Despite the fact that CRM systems share many similar or identical components, different banks must choose which architecture works best for them and what additional features are necessary given their unique set of circumstances. It can be said that CRM is a system closely related to the bank's own situation because different banks collect and store different data, have different research and architecture models, and calculation processes; in particular, the output of the support strategy is even more necessary and affects their own operations (Sarin & Gupta 2023). To determine whether the final architecture structure is the best, the system and the bank must be tightly linked. The system's effectiveness is determined by the vendor of the internal carrier that supports it, as well as the caliber of the bank's staff who operate it and their ability to explore and improve it, and the core key to its effective use is the collaborative effort of top management and operating staff. The system must be thoroughly investigated by the staff involved, and the best use of the CRM system necessitates the collaborative efforts of everybody (Apampa 2016).

The ultimate purpose of CRM is to maximize customer value, allowing businesses to make the most money in the market. So, in order for firms to make the maximum profit, it is required to study and assess the value of customers, starting with a wide number of consumers and narrowing down to the most valuable ones. To develop various sorts of promotional strategies, to provide more distinctive services, to do the enterprise's best to retain high-value clients, and to achieve the most economic profit with the least amount of investment (Abu-Shanab & Anagreh 2015).

1.2 PROBLEM STATEMENT

The acquisition, maintenance, and development of customers form the foundation of a bank's services as a significant provider of financial services. How to properly classify and manage clients, increase customer loyalty, and successfully lower customer turnover has become a crucial issue for banks in a highly competitive market. In addition to helping banks improve market competitiveness and allocate resources as efficiently as possible, customer churn analysis and classification also encourage service innovation and risk management(Choudhury 2023).

Nowadays, many banks do not work well in customer classification, can not get different levels of customers through customer classification, so they cannot achieve customer loyalty judgment and match their needs, may lead to banks to use the wrong marketing strategy for customers(Apampa 2016).

At the same time, banks are concerned about the churning of customers. But a long time ago, because of the lack of data analysis capabilities, the model was not mature enough and the bank did not have sufficient customer information, and made insufficient level of prediction of customer churn. But today, machine learning has grown and progressed so much that it can effectively solve this problem(Meehyang Chang et al. 2017).

1.3 RESEARCH OBJECTIVE

The goals of this study can be encapsulated thus:

1. To provide a method for predicting the active level and of different customers in the bank by using data analysis methods.
2. To evaluate the quality of the augmented data by using different models.

1.4 RESEARCH QUESTION

1. How to accurately categorize collected users? Now, banks can get many information of customers, but how to use the information is a big problem. You

need to understand which customers are loyal and which ones are going to be lost. So, it's not difficult to get the information but it's difficult to understand and use the information.

2. How to make a prediction of customer churning? The problem of customer churning has plagued commercial banks for a long time. It has become important to make reasonable predictions about users' future loyalty or lack thereof.

1.5 RESEARCH SCOPE

This study will concentrate on the data analysis of the prediction of active level and churning rate. The study aims to get a better method to enhance the ability of bank customer classification and prevent the customer churning. For the classification the study uses decision tree (DT), random forest (RF) and support vector machine (SVM), and the artificial neural network (ANN) model for the churning prediction. The study will use the dataset of bank customer found on Kaggle.com. The dataset contains data like gender, geography, balance, card type and so on.

1.6 THESIS ORGANIZATION

The study chapters are organized as follows:

Chapter I: Introduce the research background and find the problem that bank customer relationship management facing. In the face of existing problems, this study sets the goal of improving the ability to classify customer activity and predict customer churning. At last present the research objectives, scope and overall research approach.

Chapter II: This chapter will describe the meaning and impact of CRM used in bank industry. And then the study will show the different classifiers and neural network technologies used. The chapter will compare the 3 classifiers' difference and introduce neural network. Finally, it will present related research on the classification and prediction of bank customers.

Chapter III: This chapter mainly shows the experimental design and the methods used in this study process. First, provide the data quality report and the statistic report and

show the data pre-process for the bank customer dataset. Then use 3 classifiers, decision tree, random forest and support vector machine to predict the classification of active level. Compare the output and find the best classifier. And next will use the artificial neural network to predict the churning of the bank customer, in this part there is a problem that the data is imbalance, so we take 2 different methods to handle this. One is using SMOTE method and the other is selecting data manually.

Chapter IV: This chapter provides a detailed description of the experimental details and results. In the experimental details, the study shows the dataset and some important data situation. And then provide the parameters of the model to have a better understanding of the models. Then the study uses results and the tendency to compare and find the limitation of the study and summarize.

Chapter V: The results are concluded to show the achievement of the objectives. Then conclude the limitations and finally some future work is proposed.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will provide the impact and meaning of bank customer relationship management. The main focus of this part is to show the importance of customer relationship in bank industry. The study also shows that a bank's service quality has a positive impact on its efficiency and customer satisfaction. And banks located in regions with higher economic development tend to have lower customer satisfaction, as customers in these areas have higher expectations for service quality (Meehyang Chang et al. 2017).

Additionally, this chapter will show the classifiers and neural network models that relevant to this study, including the Decision Tree (DT) (Amzile & Amzile 2022), Random Forest (RF) (Apampa 2016), Support Vector Machine (SVM) (Zhao et al. 2014), as well as Artificial Neural Network (ANN) (Ilie et al. 2017). This part will also introduce the situation that the data facing, the imbalance problem and the methods can solve this.

Finally it will present the related research of the bank customer relationship management using different models. The structure of this chapter is as follows: 2.1 Chapter Introduction 2.2 Bank Customer Relationship Management 2.3 Data Pre-processing 2.4 Algorithm for Data Mining 2.5 Related Work 2.6 Summary.

2.2 BANK CUSTOMER RELATIONSHIP MANAGEMENT

In commercial banks, management activities are closely integrated with daily operations. Here are three key points: First, focus on attracting more potential customers. Second, retain existing customers while encouraging them to upgrade their services. This involves identifying and prioritizing customers who contribute less to overall growth.

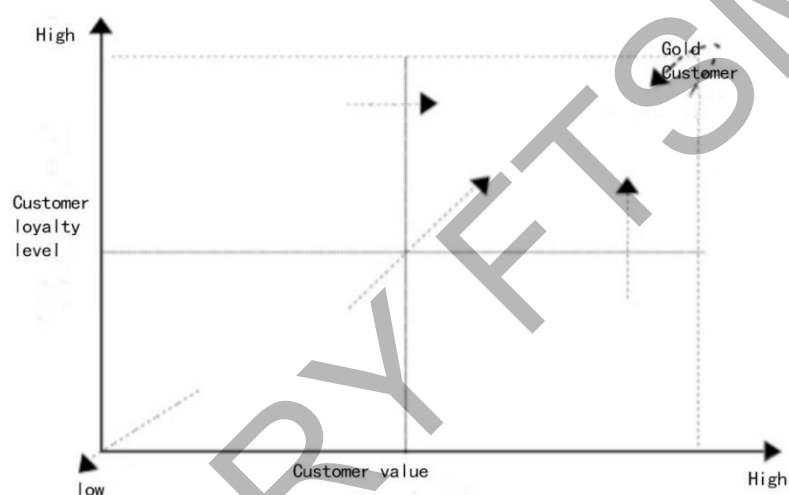


Figure 2.1 CRM management strategy diagram

In general, the main content of customer management are four aspects.

The first step is to manage customer information. This involves two key tasks: first, collecting data on existing customers to create a small customer database. Then, customers should be evaluated and ranked based on the profits they generate, ensuring an organized and efficient delivery process.

Next, focus on overseeing the bank's marketing model. This includes tracking customer interactions from their first contact with marketing channels to the completion of their activities. Traditional methods like counter services and phone consultations, combined with modern digital tools and platforms, have revolutionized marketing in the Internet era, making processes faster and simpler.

Third, manage sales. This task is typically handled by a dedicated manager who ensures customer needs are met and oversees all aspects of the sales process.

Lastly, provide ongoing customer care and service management. Many companies establish integrated call centers to handle customer inquiries and resolve issues, acting as a vital link between the business and its clients.

There are 2 important theories about customer relationship management:

The first is customer lifecycle theory. A customer's presence is vital to an organization, serving as both a requirement and a guarantee for its continued existence. The whole customer relationship lifecycle, from the beginning to the end of the business-customer connection. This relationship is dynamic and can accurately capture the traits of the relationship that develops over time between the company and its clients. Four stages can be distinguished: investigation, initial formation, intermediate stabilization, and subsequent disintegration. The relationship goes through five stages: the synthesis phase, the development phase, the more stable and mature period, and the reversal of the relationship (Óskarsdóttir & Árnason 2023).

The second theory is customer loyalty theory. The customer will be dependent on the business or merchant offering the product and service once they have paid for the pertinent product and service content and are able to satisfy their physical and other demands. This is a feeling that the business feels for the customers, and it may also be an indication of how happy the customers are with and appreciate the goods and services the business offers. A later product's price adjustment or modification will increase customer loyalty and, to some extent, lessen underlying consumer competition. Thus, this level represents both the future earnings of the company and the purchasing habits of its customers (Närvänen et al. 2020). The advantages of the company are directly related to this devotion. This paper's concentration is also on this. The three primary facets of so-called customer loyalty are the client's emotion, behavior, and awareness. At this point, the customer's interest in continuing to use the company's products or services is reflected in their conscious loyalty, which reflects their emotional recognition and satisfaction with the company's business philosophy,

behavior, and visual form. Behavioral loyalty, on the other hand, reflects customers' repeated selection of the company's goods and services when they consume them again. This is how the theory of customer loyalty marketing, which is made up of emotion, action, and consciousness, concentrates on assessing the trend of customer behavior and, by conducting these evaluation activities, reflects the competitive advantage of the business in subsequent marketing endeavors (Elansari et al. 2024).

A devoted customer may show themselves in the following ways: One is the customer's plan to repurchase things, as they continue to acquire goods and services straight from the original source; Second, the goal of cross-sourcing, which is the customer's plan to acquire products, services, or increase the size of the company from current suppliers in a way that has never been done before; Third, the objective of the customer recommendation is for the supplier to introduce new consumers after the customer has offered to do so through their own contact introduction; The fourth is price endurance, a psychological measure of a devoted customer's final readiness to spend (Hemetsberger & S 2020).

The factor that determines customer loyalty: First, it may show how positively the client feels about the company's goods or services. Because of the variety of services they receive that suit their individual consumption preferences and consumer psychology, customers are extremely satisfied and form a spiritual tie with the company's brand; Second, customer pleasure and service recognition; Third, transfer costs, which mostly refer to the customer replacing the goods and services, need service providers to consider the future expenses of the whole; fourth, customer trust. Of these four factors, the customer's perceived value, satisfaction, and confidence have a significant influence on the four indicators of customer loyalty, whereas the transfer costs are unrelated to the customer's quotation and cross-purchase intent, and they only slightly affect the repeating intent and affordability of the purchase (Närvänen et al. 2020).

In the banking industry, CRM strategy improves customer loyalty. According to research, CRM strategy can influence client loyalty, which in turn affects customer happiness and competitive advantage. Effective CRM strategy execution can assist

banks in developing effective client interactions, improving customer loyalty, and, ultimately, increasing customer happiness(Lestari et al. 2023).

2.2.1 The Development Process of CRM

CRM was introduced by Gartner Group Inc Ltd in 1999. In its previous recommended ERP definition, Gartner Group Inc. gave total supplier management a lot of weight(Zablah et al. 2004).

Customer information management technology (such as data information warehousing, business intelligence, knowledge discovery, and other technologies) advanced rapidly in the late 1990s as a result of the growing use of the network and CTI. Gartner Group Inc developed the China CRM concept market in response to the needs of rising economies and the tendencies in China's future generation of information technology. Since the late 1990s, China's CRM market has experienced tremendous growth(Zhang & Chen 2017).

Traditional commercial banks' profit margins shrank in the 1990s as market competition and the gradual refinement of external restrictions weighed on them. Through modern means, all types of organizations have created a set of policies and practices for CRM, making it more sophisticated and sensible.

Commercial Bank of China began to prioritize customer management in the 1990s as a result of fierce market competition and gradual refinement of external regulations. Domestic and foreign commercial banks have developed a series of management plans and CRM techniques to improve and streamline CRM. The National Customer Service Information System was established by ICBC in 2001, with the International Consulting Company leading the effort. In June 2000, China Construction Bank introduced a customer service system. By the end of 2005, the Industrial and Commercial Bank of China (ICBC) had implemented a major customer relationship regulatory system at its headquarters and branches, as well as a comprehensive customer service data collection mechanism. China Construction Bank successfully adopted a synergy-based analytical management system and management system at the end of 2006(Zhang & Chen 2020). The satisfaction of commercial banks

will also be impacted by a number of seemingly needless reference criteria, including professional skill levels of staff, financial services goods and service systems, service level, and surveys conducted among high-end consumer demographics. Some academics contend that in order to apply and implement the customer hierarchy management system in the individual unsecured credit risk management system article, it is necessary to classify consumers into distinct levels. Only then, they argue, can we allocate our limited resources to the most valued of these customers. Furthermore, numerous studies have been conducted by the local and international customer relationship supervisors of various banks, in conjunction with social reality, from various angles to assess issues, make attempts to identify answers, and provide the necessary outcomes (Meehyang Chang et al. 2017).

2.2.2 Implications of CRM

In the banking industry, CRM strategy improves client happiness. CRM strategy influences customer loyalty and competitive advantage, which in turn affects customer happiness. Furthermore, CRM components have a substantial impact on customer happiness and loyalty. Thus, the CRM strategy in the banking business is thought to have a favorable impact on customer satisfaction (Özdemir et al. 2022).

Corporate CRM is around the rational and efficient management and allocation of assets related to customer relations. Customer value is not the same as model value or potential value in the enterprise management process. In conjunction with a single customer service to cater to the various needs of clients, to increase client credibility and loyalty. By doing this, the business can acknowledge the ongoing value it provides to the customers. To increase the business's overall profitability as a whole. CRM content is a thorough examination of client information with the goal of raising customer happiness. The consumer base and risk considerations are the primary focus. Information resources take into account long-term market shifts, client happiness, and their needs. And the number of customers and the methods and measures to conquer them, and then the specific sales controls. In order to ensure that customers have timely access to the appropriate tailored goods and services based on their needs, CRM may logically integrate and restructure a

variety of customer resources. This allows customers to learn and master these resources throughout the customer's product lifecycle. From a commercial standpoint, firms must aggressively match their marketing efforts with their customers in order to effectively progress the job and business of their workers. We must concentrate on resource allocation and related processes in order to rationally reduce management costs, fully increase company management benefits, fully adapt to customer diversification needs, and further improve company-customer links and communication methods. CRM can also be thought of as a means of customer control (Payne & Frow 2017).

Depending on the type of business management customer, B2B and B2C CRM may be referred to as CRM together. B2B CRM enterprise management customers are general enterprise customers, whereas B2C CRM enterprise management target audiences are individual corporate clients. Most CRM on the market today include a B2B CRM system, which is quite useful for businesses who provide corporate products and services. And the main supply to businesses is individual and home consumption of large firms, with B2C CRM as the demand. According to CRM, enterprise management work focuses on different mental, as well as job types and CRM data analysis. Most CRM are operational CRM that support day-to-day activities, whereas data analysis CRM are primarily focused on data analysis and processing (Özdemir et al. 2022).

2.2.3 Influencing Factors of CRM

Numerous factors can significantly affect how bank customers are managed, but two categories of external effects can typically be identified in this context:

1. The factors influencing CRM in banks can be analyzed through various trends and developments in the financial industry. With the globalization of international finance, the expansion of the global financial network has played a major role in shaping CRM models in China's commercial banks. These banks are increasingly focusing on the development and innovation of CRM systems to adapt to the changing financial environment. One key factor is the advancement of the knowledge economy and computer technology. The integration of computer

technology into commercial banking services has become essential for enhancing CRM (Alsharif & Alsharif 2021). Another factor is the rapid evolution of information and Internet technologies. These technologies have enabled the quick implementation of network-based banking services, reducing costs and eliminating traditional time barriers. As a result, large commercial banks are developing new digital platforms to increase revenue from intermediary operations. Additionally, the emergence of non-bank financial operations has influenced CRM in commercial banks. These non-bank operations have gradually integrated into traditional banking activities, prompting commercial banks to modify their operational and management models to better align with market demands (Choudhury & Kaur 2020). Finally, the entry of foreign banks into China, particularly after the country joined the WTO, has created a highly competitive environment. This competition has disrupted traditional banking practices and forced domestic banks to innovate and refine their CRM strategies to remain competitive. The key factors influencing CRM in banks include the globalization of finance, advancements in technology, the rise of digital banking, integration with non-bank financial services, and increased competition from foreign banks. These factors collectively drive the need for continuous innovation and improvement in customer relationship management strategies (Huang & Wang 2018).

2. Commercial banks exploit homogeneity and comparative advantage. This largely has to do with the variety of financial services offered by commercial banks. Even though the different loan instruments and associated operating modes don't fundamentally differ from one another, commercial banks are nonetheless able to make the essential distinctions. Incorporate cutting-edge technology with energy and enhance and optimize business processes. This not only enhances commercial banks' attributes but also appropriately and successfully lowers their utility homogeneity. Banks can effectively provide personal financial services given the size of their market and the realities of their customer. Since CRM enables both parties to develop their own distinct comparative advantages, it is an essential tool for commercial banks looking to bolster their own comparative competitive advantage (Ghosh & Kaur 2019).

3. A major determinant of consumer engagement and loyalty is customer satisfaction. Customer engagement will be directly impacted by the effectiveness of problem solving, customer recognition of service quality, and overall experience, regardless of whether the bank's products and services satisfy the demands of the client. Customers are more likely to stick with the bank's products and be less likely to switch if they are happy with the services they receive. Customer loyalty and customer satisfaction are tightly linked. Customers that are happy with the bank's offerings are more likely to stick with it over time. In this research, this factor is the aspect that major area, this research uses active level and churning rate to judge the satisfaction (Payne & Frow 2017).

Additionally, the following underlying factors have a major detrimental effect on bank CRM:

1. Commercial banks' competitiveness has improved, beginning with the benefits of regional resources. This is frequently caused by the linguistic and cultural norms of China, and foreign banks' entry into the local market takes time, which significantly affects their profitability; second, the market advantage is evident. It is generally accepted that China's commercial banks have broadened their operations to encompass the major cities following years of expansion. Even though this type of company network and pattern is illogical, the resources are nevertheless vital for more thorough market division or even reorganization. The leaders of China's commercial banking industry should currently make reasonable use of the time spent by international banks in the localization and CRM processes in order to increase the overall operational efficiency of the country's commercial banks as well as the overall quality of the company (Liu 2013).
2. Integration of bank resources, both internal and external. Commercial banks should prioritize the successful integration of multiple network resources, with an emphasis on internal integration, in order to improve their competitive edge, competitive position, and profitability. External integration aims to improve the reputation of commercial banks by increasing client loyalty and contentment (Ghosh & Kaur 2019).

3. The bank's ability to continuously increase efficiency is its main asset. The vast amount of financial data held by commercial banks can be categorized and compiled through the use of effective and scientific CRM. This improves the supply chain and market value of the commercial banks while also bolstering their core competitiveness. Commercial banks will be able to set up a methodical and effective management system as a result, and communication within the information system will be seamless(Liu 2013).
4. Effective improvement of banking capability. Enterprises can accomplish orderly operation of varied capabilities by implementing a customer information management system. To properly analyze customers, they must investigate their differences based on relevant product kinds and characteristics, as well as their individual financial services consumption behavior, and pay close attention to their responsibilities in banking operations at every level. To be fully clear about the financial service requirements and specific business demands of the business, attention must be paid to the applicable solutions, so that potential operational risks in the banking industry may be reasonably controlled. In order to achieve a two-way exchange of market information, businesses must simultaneously actively investigate market sales and pay closer attention to the various information reflected by users. If an enterprise provides high-quality business information, users won't choose to do business with another. To ensure that businesses remain unbeaten in the global competition, business managers should actively investigate the growth of enterprises, monitor changes in the financial market, concentrate on financial institution products, and foster the development of a variety of businesses.

2.2.4 The Necessity of Data Analysis for Bank CRM

The in-depth analysis and mining of customer data information using data mining techniques, turning it into a customer knowledge model, and assisting bank decision-makers in making better decisions and gaining more market competitive advantages are the reasons behind the necessity of the bank CRM system(Chen et al. 2021) .Since a big amount of target data is the broad definition of data analytics, emerging information technologies that effectively gather, discover, and analyze data

to enable increased value from massive quantities of data are also considered data analytics. As a result, there is a huge value and density of pertinent data. Data analytics serve as the foundation for corporate choices. It also demonstrates how data analytics assesses if a business's choices are in line with its goals for growth. However, data analytics provides relatively little economic data analysis for more targeted business decisions. This is primarily because of its extremely low density. Adopting a more macro data control system will help you enhance the practical value of data analysis by increasing the integrity of data extracted from data extraction. It will also assist banks in increasing the effectiveness of client transactions. The effect of CRM on customer satisfaction is usually assessed via empirical analysis and research. According to research, CRM significantly affects customer happiness because it helps businesses better understand their clients' demands and offer higher-quality services, both of which increase customer contentment. Additionally, by ensuring that customers are happy with the products and services the business offers through suitable techniques, CRM can assist businesses in gaining and maintaining customer loyalty (Budi Jaya Sugiato et al. 2022).

The data analysis era is bound to bring about a comprehensive change to the banking system and its business management methods, which shows that it is necessary to apply data analysis technology to the CRM of commercial banks:

1. This has resulted in considerable changes in the way banks handle client relations and management. In the early stages of banking development, the majority of them analyzed data in detail using sample surveys, which was usually static and incomplete, so that the person in charge did not fully understand the needs of customers, and the classification was inaccurate. CRM must be tailored to the actual development needs of commercial banks. However, as capitalism continues to advance, the emergence of the data analysis era has fundamentally altered human perceptions. People are becoming more and more concerned with the dynamics of data, we value our customers' changing needs, and we are increasingly concerned with our customers' rising profits. You should pay more attention to the specific needs of each customer and propose corresponding management countermeasures. These are deeply reflective of this age and how