Case Study on Digital Human Technology Empowering Retail Banking to Reduce Costs and Improve Efficiency: The Example of China Merchants Bank's Digital Human "Xiao Zhao"

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Abstract. Against the triple backdrop of advancements in digital technologies such as big data, artificial intelligence, mobile internet, cloud computing, IoT, and blockchain; the national push for digital transformation; and the scale expansion of retail banking, the role of digital technologies in empowering the digital transformation of retail banking has emerged as a critical research focus. This study employs a case analysis based on China Merchants Bank's annual reports for the years 2021-2024, examining the effectiveness of digital customer service agents across both financial and non-financial dimensions. Findings reveal that after implementing a digital customer service agent, labor cost ratios decreased while revenue per employee and live agent connect rates increased. This stems from digital customer service agents handling standardized services, freeing human staff to focus on complex and personalized tasks, thereby enhancing service quality and customer loyalty. This study provides reference points for empowering retail banking with digital humans and offers empirical support for advancing digital human technology.

Keywords: Digital Customer Service Agent, Retail Banking Industry, China Merchants Bank, Cost Reduction and Efficiency Enhancement.

1. Introduction

In recent years, against the backdrop of China's slowing economic growth, financial disintermediation, and weakened public financial demand, banks have shifted their business focus from wholesale and corporate banking to retail banking [1]. The 2020 edition of the *McKinsey China Banking CEO Quarterly* revealed that retail banking's contribution to China's banking sector revenue rose from 29% in 2015 to 33% in 2019, with projections reaching 38% by 2025.

Concurrently, the rise and maturation of digital technologies—including big data, artificial intelligence, mobile internet, cloud computing, IoT, and blockchain—have made digital transformation an inevitable trend for the financial sector. For retail banking specifically, this transformation stems from both internal pressures to innovate and find new profit growth points, as well as external drivers such as expanding customer demand fueled by economic growth, technological advancements, and intensifying competition from fintech firms [2, 3]. In March 2025, the State Council issued the *Guiding Opinions on Advancing the Five Major Financial Initiatives*, designating "digital finance" as one of five key financial service areas. It explicitly called for "accelerating the digital transformation of financial institutions and improving the digital finance governance system," marking digital transformation as a core component of the national financial strategy. Regarding challenges in banking digital transformation, Vasiljeva T et al. (2016) identified five major obstacles for commercial banks: squeeze effects and disruptive business models triggered by fintech competition; shifting customer behaviors and the need to rebuild trust mechanisms; resistance to transformation stemming from internal operational and technological alignment; strategic dilemmas in resource allocation and investment decisions; and structural alignment issues with external regulation and the industry environment [4]. Regarding transformation pathways, Sajić M et al. (2017) suggest advancing call center development, establishing information systems, and adopting big data technologies [5]. Olutimehin D O et al. (2021) propose introducing AI for wealth management services, using big data to analyze customer habits, and leveraging blockchain for transfers [6]. Regarding transformation outcomes, Alonge E O et al. (2021) contend that digital

transformation in retail banking significantly enhances cost efficiency, customer experience, and profitability through the use of automation, AI, machine learning, and other digital technologies [7]. In summary, most existing research focuses on analyzing challenges in banking digital transformation, designing transformation pathways, and evaluating the comprehensive effects of applying various digital technologies.

During the digital transformation process of banks, digital humans utilize technologies such as 3D modeling, large language models, and natural language processing to create virtual avatars with highly realistic appearances and visual interaction capabilities [8]. They have become a core component of retail banking digital transformation, currently widely applied in business scenarios such as personal information inquiries, transaction processing, risk assessment, and personalized financial advice, providing 24/7 uninterrupted service [9].

This study employs a case study approach, analyzing the technical composition, service functions, and cost-saving and efficiency-enhancing effects of the digital customer service agent "Xiao Zhao" on China Merchants Bank's retail operations. Data is sourced from the bank's annual reports covering 2021-2024. As a leading enterprise in China's retail banking sector with substantial retail operations, China Merchants Bank offers strong industry representativeness for this case study. This research helps address the lack of in-depth studies on how individual digital technologies empower banks' digital transformation and provides potential references for future practices of empowering retail banking operations with digital agents.

2. China Merchants Bank Case Background

2.1. Overview of China Merchants Bank's Retail Business Development

CMB's retail business development has progressed through three strategic phases. The initial transformation in 2004 introduced the "One Card," "One Network," and credit card services, establishing a modern retail service system. The 2.0 phase commenced in 2013, implementing the "One Core, Two Wings" strategy to strengthen retail core operations and lightweight banking. The 3.0 phase began in 2017 when CMB actively advanced fintech-driven intelligent and data-driven transformation [10]. Through continuous strategic innovation, CMB has significantly enhanced its retail business competitiveness: By 2024, its retail customer base exceeded 200 million, with total assets under management reaching RMB 14.97 trillion, solidifying its reputation as the "Retail King."

2.2. Technical Composition and Service Offerings of the "Xiao Zhao" Digital Customer Service Agent

2.2.1 Technical Components of "Xiao Zhao"

As can be seen from Fig. 1, by 2024, "Xiao Zhao" had undergone multiple iterations, integrating technologies including natural language processing, speech recognition and synthesis, and knowledge graphs. In 2023, it incorporated CMB's self-developed large language model, "Yi zhao," significantly enhancing its intent understanding, complex problem analysis, and personalized recommendation capabilities. Natural language processing technology underpins deep semantic understanding and multi-turn dialogue management. Speech recognition and synthesis technology enable closed-loop voice interaction workflows. Meanwhile, knowledge graphs integrate financial knowledge systems, providing the knowledge foundation for precise question-answering and reasoning.

2.2.2 Service Offerings of "Xiao Zhao"

Xiao Zhao, CMB's wealth assistant, delivers online services through the China Merchants Bank app. Its primary offerings include intelligent wealth management consultation, personalized product recommendations, asset allocation analysis, and market insights. Services are categorized into standardized offerings and complex scenario services.

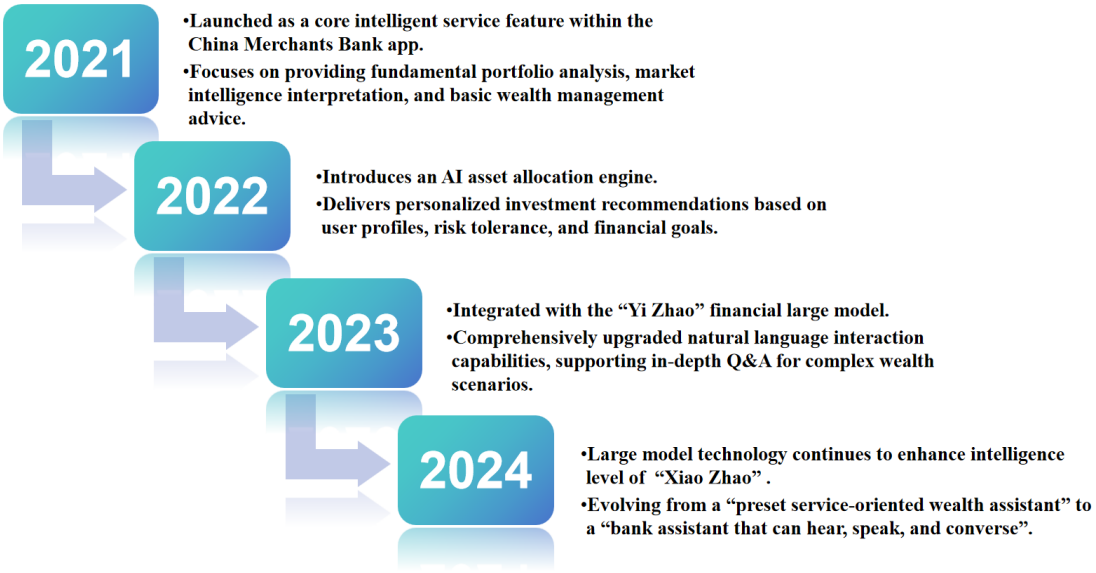

Figure 1. Evolution of "Xiao Zhao"

(1) Standardized Services

Standardized services typically follow fixed processes with clear rules, addressing simple information queries and transaction processing needs. For example, the "Transfer and Remittance" service requires "Xiao Zhao" to follow a predefined transfer workflow, identifying details like amounts and account information to complete the transaction. Similar services include "Credit Card Limit Adjustment," "Asset Inquiry," and "Exchange Rate Inquiry."

(2) Complex Scenario Services

Complex scenario services address personalized user needs, requiring deeper analysis and cross-scenario integration. For instance, the "Credit Card Statement Analysis" service necessitates "Xiao Zhao" to deconstruct statement components, analyze expenditure rationality by integrating user spending habits and credit card records, and interpret multidimensional data. Similar services include "Fund Return Analysis," "Market Trend Interpretation," and "TREE Portfolio Configuration."

3. Cost Reduction and Efficiency Enhancement Analysis of "Xiao Zhao"

3.1. Cost Reduction Dimension Analysis

3.1.1 Per-Employee Staffing Cost

As shown in Table 1, regarding per-employee staffing costs, from 2021 to 2024, CMB's retail business saw a 16.47% increase in total retail staff, while retail business staff expenses rose only 2.48%. This resulted in per-employee staffing costs decreasing from ¥660,300 to ¥580,900, representing a cumulative reduction of 12.02%. This trend indicates that the deployment of the digital customer service agent "Xiao Zhao" effectively curbed cost increases associated with workforce expansion, achieving a significant reduction in per-employee staffing costs.

Table 1. Per-Employee Staffing Costs in CMB's Retail Banking

Year	The ratio of retail employees to total employees	Retail Business Employee Expenses (RMB 100 million)	Total Number of Retail Employees (10,000 persons)	Per-Employee Staffing Cost (10,000 RMB/person)
2021	45.04%	297.39	4.50	66.03
2022	45.60%	322.20	5.15	62.53
2023	45.34%	318.96	5.28	60.37
2024	44.76%	304.76	5.25	58.09

3.1.2 Labor Cost Ratio

As shown in Table 2, regarding the proportion of labor costs, CMB's retail business labor cost ratio first increased and then decreased between 2021 and 2024, reaching its lowest point of 47.61% in 2024. In 2022 and 2023, the growth rates of employee expenses (8.34%, 7.25%) compared to 2021 significantly outpaced those of operating costs (2.20%, 3.78%), becoming the primary driver of the rising labor cost ratio during this period. This is likely attributed to increased staffing demands resulting from business expansion. By 2024, the proportion of retail personnel began to decline (as shown in Table 1). The likely reason is that the upgraded "Xiao Zhao", powered by large-model technology, demonstrates enhanced capabilities in intent comprehension, complex problem analysis, and personalized recommendations. This enables "Xiao Zhao" to further replace traditional labor, resulting in a 2.08 percentage point decrease in the labor cost share compared to 2021 and effectively reducing its reliance on human resources for retail operations.

Table 2. Labor Cost Proportion in Retail Operations

Year	Retail Business Employee Expenses (RMB 100 million)	Retail Business Operating Costs (RMB 100 million)	Retail Business Labor Cost Ratio
2021	297.39	598.45	49.69%
2022	322.20	611.59	52.68%
2023	318.96	621.10	51.35%
2024	304.76	640.11	47.61%

3.1.3 Cost-to-Income Ratio

As shown in Table 3, regarding the cost-to-income ratio, CMB's retail business operating revenue grew steadily from 2021 to 2024, with a cumulative increase of approximately 10%, while operating costs rose by about 7%. As revenue growth outpaced cost growth, the cost-to-income ratio decreased by 0.91 percentage points. This indicates that "Xiao Zhao" effectively controlled costs while driving revenue growth. Calculations show that operating costs were cumulatively reduced by RMB 1.791 billion (RMB 196.835 billion×0.91%) during this period. Considering the proportion of labor costs in retail operations in 2024 (47.61%), it is estimated that total labor cost savings amounted to approximately RMB 853 million, with an average annual savings of RMB 284 million.

Table 3. Retail Business Cost-to-Revenue Ratio

Year	Retail Business Operating Revenue (RMB 100 million)	Retail Business Operating Costs (RMB 100 million)	Retail Business Cost-to-Revenue Ratio
2021	1790.15	598.45	33.43%
2022	1914.22	611.59	31.95%
2023	1943.36	621.10	31.96%
2024	1968.35	640.11	32.52%

3.2. Efficiency Dimension Analysis

3.2.1 Per-Capita Revenue Generation Capacity

As shown in Table 4, during 2021-2023, CMB's retail business experienced a continuous decline in per capita revenue generation. This was primarily due to a 17.3% increase in the number of employees, which significantly outpaced the 8.5% growth in operating revenue. This reflects that during this phase, "Xiao Zhao" was in its promotion and maturation stage, and the contribution of digital customer service agents to performance was insufficient to offset the dilution of per capita revenue caused by workforce expansion. In 2024, with the deepening of the "AI+Finance" strategy and the empowerment of large model technology, in 2024, with the deepening of the "AI+Finance" strategy and the empowerment of large-model technology, "Xiao Zhao's service capabilities have been enhanced and its application scenarios expanded, enabling it to effectively reduce banks' retail

business reliance on human resources. Despite a slight decrease in employee numbers, operating revenue continued to grow, driving per capita revenue back up to 3.75 million yuan per person. This demonstrates the positive impact of digital customer service in optimizing human resource allocation while maintaining service efficiency.

Table 4. Per-Capita Revenue Generation in Retail Business

Year	Total Number of Retail Employees (10,000 persons)	Retail Business Operating Revenue (RMB 100 million)	Retail Business Revenue Per Employee (RMB million)
2021	4.50	1790.15	3.97
2022	5.15	1914.22	3.72
2023	5.28	1943.36	3.68
2024	5.25	1968.35	3.75

3.2.2 Live Agent Connection Rate and Customer Satisfaction

As shown in Table 5, between 2021 and 2024, CMB's live agent connection rate increased overall, reaching 98.13% by 2024. Customer satisfaction also rose steadily, climbing to 99.69% in 2024, reflecting continuous improvements in remote service quality. "Xiao Zhao" made a significant contribution: by pre-processing standardized high-frequency tasks and handling complex scenarios, thereby reducing the volume of human consultations and alleviating agent workload, which improved the live agent connection rate. Additionally, it synchronized conversation records when users were transferred to human agents, avoiding repetitive inquiries and significantly enhancing service efficiency and customer satisfaction.

Table 5. Live Agent Connection Rate and Customer Satisfaction

Year	Live Agent Connection Rate	Customer Satisfaction
2021	97.56%	97.61%
2022	98.00%	98.53%
2023	97.26%	99.1%
2024	98.13%	99.69%

4. Conclusion

This paper uses China Merchants Bank's digital customer service agent "Xiao Zhao" as a case study. By comparing financial and non-financial metrics in retail banking before and after the implementation of digital human technology, it demonstrates the tangible impact of this technology on cost reduction and efficiency enhancement in retail banking. Research findings indicate that the digital assistant "Xiao Zhao" plays a significant role in both cost reduction and efficiency enhancement. In terms of cost, "Xiao Zhao" effectively reduced the proportion of per-capita employee expenses in labor costs and the cost-to-income ratio. Regarding efficiency, its implementation significantly improved per-capita revenue generation, live agent connection rates, and customer satisfaction. Further analysis of potential reasons suggests that "Xiao Zhao," utilizing large language models, natural language processing, speech recognition and synthesis, and knowledge graphs, replaces human agents in repetitive and standardized services while partially addressing complex scenarios. This frees up human resources, enhances response efficiency, enables 24/7 uninterrupted service, and expands customer reach. Simultaneously, freed-up human resources can focus on delivering high-value, personalized services, further enhancing service quality and strengthening customer relationships.

Through long-term, multidimensional metric evaluations, this study provides practical guidance for digital human applications in retail banking and empirical evidence for the ongoing development of digital human technology. Future research should focus on areas currently lacking, such as human-

machine collaboration mechanisms, digital emotional computing, and the maintenance of long-term customer relationships.

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