INSTITUTO
UNIVERSITÁRIO
DE LISBOA

Network Service Quality Management of MC Operator: A SERVQUAL Perspective

ZHANG Sichi

Doctor of Management

Supervisors:
PhD Álvaro Rosa, Associate Professor,
ISCTE University Institute of Lisbon
PhD LIANG Decui, Professor,
University of Electronic Science and Technology of China

December, 2021

BUSINESS
SCHOOL

Marketing, Operations and General Management Department

Network Service Quality Management of MC Operator: A SERVQUAL Perspective

ZHANG Sichi

Doctor of Management

Supervisors:
PhD Álvaro Rosa, Associate Professor,
ISCTE University Institute of Lisbon
PhD LIANG Decui, Professor,
University of Electronic Science and Technology of China

December, 2021

BUSINESS
SCHOOL

Marketing, Operations and General Management Department

Network Service Quality Management of MC Operator: A SERVQUAL Perspective

ZHANG Sichi

Doctor of Management

Jury:
PhD Fernando Alberto Freitas Ferreira, Associate Professor with Habilitation,
ISCTE University Institute of Lisbon
PhD Margarida Saraiva, Assistant Professor with Habilitation,
Universidade de Évora
PhD António Manuel Ramos Pires, Coordinator Professor,
Instituto Politécnico de Setúbal.
PhD Liu Lei, Full Professor,
University of Electronic Science and Technology of China
PhD Nelson José dos Santos António, Emeritus Professor,
ISCTE University Institute of Lisbon
PhD Álvaro Augusto da Rosa, Associate Professor with Habilitation,
ISCTE University Institute of Lisbon

December, 2021

Declaration

I declare that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university and that to the best of my knowledge it does not contain any material previously published or written by another person except where due reference is made in the text.

Signed:  Date: 2021.12.30

Name: ZHANG Sichi

作者申明

本人郑重申明：除了论文致谢中明确说明并致以谢意的部分外，所呈交的论文不包含任何他人或作者本人已用于获得任何教育机构的学位和证书而使用过的材料。同时尽我所知，除了文中特别加以标注引用的内容外，本论文不包含任何其他个人或集体已经发表或撰写的成果作品。

作者签名：  日期：2021.12.30

姓名(拼音)：ZHANG Sichi

[This page is deliberately left blank.]

Abstract

Facing the fierce competition inside and outside the telecom industry and the pressure of policy as well as technology development, telecom network operators must adapt to customer needs to protect the interests of both operators and customers. This thesis attempts to examine the network service quality of operators from the perspective of quality management, and puts forward improvement measures.

This study uses SERVQUAL method to construct the network service quality evaluation system through questionnaire and result statistical analysis. Then, the gap analysis of network service quality index and Importance – Performance Analysis (IPA) are carried out to give the optimization suggestions of telecom network service quality management. Main conclusions are as follows:

1. The current situation of network service quality is not optimistic, and the average expectation value of customers for network service quality indicators is higher than the actual perceived average value;

2. The operator should improve from three aspects: network service system design, network service quality management at the operator level and guarantee measures of management implementation.

Keywords: Telecommunication network service; Service quality; Quality management; SERVQUAL

JEL: L86; L15

[This page is deliberately left blank.]

Resumo

Em face à competição tanto interna como externa à indústria das telecomunicações, bem como, da pressão da política e do desenvolvimento tecnológico, os operadores das redes de telecomunicações são obrigados a adaptar-se à mudança com o fito de proteger os seus próprios interesses como também dos seus clientes. A presente tese proporciona um exame da qualidade do serviço de rede de telecomunicações na perspetiva da gestão de qualidade e apresenta várias medidas de melhorias.

Este trabalho socorre-se da metodologia de SERVQUAL para construir um modelo de avaliação da qualidade do serviço de rede e, como tal, a investigação é por questionário seguido de tratamento estatístico. São feitas, ainda, uma análise de divergências com base no índice de qualidade de serviço de rede e uma análise IPA (Importance – Performance Analysis) a fim de prover recomendações de otimização da qualidade do serviço de rede. E, as principais conclusões são:

1. A qualidade de serviço da rede ainda não é ótima e, a expectativa de valor por parte dos clientes é superior à perceção dos mesmos;

2. Existem três áreas por onde se pode desenvolver melhorias: o desenho do sistema de rede, a qualidade de serviço de rede ao nível do operador e, a garantia da qualidade na implementação de medidas administrativas.

Palavras-chave: Serviço de rede de telecomunicações; Qualidade de serviço; gestão de qualidade; SERVQUAL

JEL: L86; L15

[This page is deliberately left blank.]

摘要

面对电信行业内外部的激烈竞争以及政策、技术发展的压力，电信网络运营商必须适应顾客需求以保障彼此利益。本文试图从质量管理角度审视运营商的网络服务质量，提出改进措施。

本研究通过问卷调查和结果统计分析，采用 SERVQUAL 方法构建网络服务质量评估体系。随后进行网络服务质量指标差距分析和 IPA 分析，以给出电信网络服务质量管理的优化建议。主要结论：

1. 网络服务质量现状不乐观，顾客对网络服务质量指标的期望均值高于实际感知均值；

2. 运营商需要从三个方面进行优化：网络服务体系设计、运营商层面的网络服务质量管理以及实施管理的保障措施。

关键词：电信网络服务；服务质量；质量管理；SERVQUAL

JEL: L86; L15

[This page is deliberately left blank.]

Acknowledgements

In the finalization stage of my doctoral thesis, I want to take this opportunity to extend my heartfelt gratitude to all the people who have rendered support to me.

First of all, I would like to express my sincere thanks to my supervisor Professor Álvaro Augusto da Rosa, a wise and loving scholar whom I am so lucky to meet. Professor Álvaro Augusto da Rosa has impressed me with his noble character and profound scholarly attainments, and he will always enlighten me with clear thoughts and words when I have doubts in mind. I admire his way of instructing students and communicating with others, and he is my role model.

Second, I would like to thank Professor Liang Decui, my Chinese supervisor, who put forward strict suggestions on revision after I finished my first thesis draft; without his meticulous scholarship, I could not have so much focused on the writing of this thesis.

Third, my thanks go to the professors of the doctoral program. Thanks will be given to Dr. Virgínia Trigo for her efforts, especially she helped me sort out my writing ideas in the middle phase check, the scene is still fresh in my mind. Thank Dr. Xiao Wen, Dr. Sun Ping, Ms Gao Xiaoli and Ms Chen Yang. It is their suggestions and help that make me keep working hard. I would like to single out my thanks to Xie Jingling, who is an English major in Chongqing University of Posts and Telecommunications and Huang Xiaoyu from Southwestern University of Finance and Economics for their great help in English translation and data analysis. In addition, I would like to extend acknowledgements to all my classmates of the Program 2015 because they are all friendly and their generous help is tremendously beneficial, and to my colleagues for their support and help during my thesis writing.

The writing of this doctoral thesis is one of my achievements accomplished with hearts, which has tremendously benefited me and I am so appreciative that I have had the precious opportunity to experience the highest degree of study.

[This page is deliberately left blank.]

致谢

在博士论文定稿之际，感慨万千，想对很多人说谢谢。

首先要感谢的是我导师 Álvaro Augusto da Rosa 教授。遇到这样一位博学慈爱的导师，我是特别幸运的。Álvaro Augusto da Rosa 老师的高贵品质和学术造诣时刻影响着我，他总能在我百思不得其解时用清晰的思路、明确的言语让我茅塞顿开。他指导学生、与人交流的方式的让我钦佩，是我学习榜样。

感谢中方指导教师梁德翠教授。记得在我初稿完成后，梁老师向我提出了严格的修改建议，他的治学严谨让我更加专注地投入到论文写作。

感谢博士课程的各位授课教授。感谢 Virgínia Trigo 博士，尤其在中期检查时她帮助我梳理了写作思路，场景记忆犹新。感谢、肖文博士、孙平博士、高小丽老师、陈阳老师，感谢他们给我提出的建议和给予的帮助，是这些建议与帮助让我一直努力到现在。感谢重邮英语系谢婧灵、西南财大黄笑雨两位同学在英文翻译和数据分析方面给予的帮助。感谢 2015 级博士班全体同学，全班同学都很友好，我从他们身上学到很多。另外，在论文写作过程中，得到公司同事的支持和帮助，一并在此感谢。

博士论文写作是我用心投入做成的一件事，收益良多，感谢有这个机会让我经历了最高学位阶段的学习！

[This page is deliberately left blank.]

Contents

[This page is deliberately left blank.]

List of Tables

[This page is deliberately left blank.]

List of Figures

[This page is deliberately left blank.]

List of Abbreviations

CNKI	China National Knowledge Infrastructure
QoS	Quality of Service
GSM	Global System For Mobile
EESAA	Energy Efficient Sleep Awake Aware
ISO	International Organization for Standardization
CCITT	International Telephone and Telegraph Consultative Committee
ISP	Internet service providers
PZB	Parasuraman, Zeithaml and Berry
SERVQUAL	Service Quality
PQ	perceived score
EQ	expected score
SQ	SERVQUAL score
PLS-SEM	partial least squares structural equation modeling
MCDM	multiple-criteria decision-making
PDCA	Plan-Do-Check-Act
TQM	total quality management
ASQ	American Quality Association
ACSI	American Customer Satisfaction Index
CS	Customer Satisfaction
SCSB	Swedish Customer Satisfaction Barometer
ECSI	European Customer Satisfaction Index
IPA	Importance-Performance Analysis
TQM	Total Quality Management
KMO	Kaiser-Meyer-Olkin
TCSI	Telecommunication Customer Satisfaction Index
AHT	average handle time

[This page is deliberately left blank.]

Chapter 1: Introduction

1.1 Research background

With the expansion of information, users have a strong demand for Internet-based integrated business. Currently stimulated by users' demand, coupled with the rapid development of communication and Internet technology, the business integration of computer, telecommunications, radio and television and other industries which have a clear division of labor has started.

In the process of rapid business and technology growth, China's telecommunication industry has undergone many reforms and reorganizations, and there are presently three operators: China Mobile, China Telecom and China Unicom. The reform is divided into several stages: from 1993 to 1998, it was the stage of market-oriented reform of the telecommunication industry. In 1995, the General Post Office and the General Administration of Telecommunications under the former Ministry of Posts and Telecommunications were established. From 1998 to 2000, the reform focused on "separation of government and enterprises, elimination of monopolies, and introduction of competition"; from 2001 to 2008, the situation where the market was shared by these three operators was formed; from 2008 to 2018, it was the full-service operation phase of transformation from 3G to 4G and the integration of communication network, the Internet, and the broadcasting and television; since 2019, we have entered the era of 5G commercialization and deepened full-service strategy. The operators' business striving to cover multiple business areas such as telecommunications, the Internet, multimedia, entertainment, consumer electronics, finance, health, and communities to comprehensively meet the needs of users' life and work, and provide a cross-industry, cross-regional operation model of communications, content, applications and services.

Expanding telecommunications business to other industries and developing integrated, convenient and efficient comprehensive services is the requirement of the times raised by technology changes for network services.

At the China Mobile Global Partner Conference 2013 held on December 18, 2013, President Li Yue officially released the new business brand "AND". In the 4G era, "AND" icon is seen as a 4G brand of China Mobile (H. Xu, 2013).

In December 2014, China Mobile obtained the fixed network and broadband operation license issued by the Ministry of Industry and Information Technology and officially became a full-service telecommunications operator. Utilizing a leading 4G network as a foundation and supported by "the world's largest mobile operator", China Mobile Group Sichuan Co., Ltd. (hereinafter referred to as MC) has officially entered the era of full-service operation (Sina Sichuan, 2014).

On November 27, 2015, China Mobile announced that its wholly-owned subsidiary China Mobile Tietong had signed an acquisition agreement with Tietong and then it provided fixed network telephone service nationwide in China (Tencent Technology, 2015).

In 2016, China Mobile and the People's Government of Sichuan Province signed a strategic cooperation agreement to take Sichuan as a key support area for network infrastructure construction and business development.

In 2017, the Sichuan Provincial Party Committee and the Government signed an agreement with China Mobile Communications Group in Beijing, making it clear to establish a collaborative innovation platform for government-industry-university-research for 5G technology and business applications, deeply expand new areas such as IDC, cloud computing, big data, and the Internet of Things so as to promote the digitalization of production with informationization. In the same year, Sichuan Mobile fully implemented the "big connection" strategy, and insisted on the innovation-driven guideline, as well as promoting economic transformation and upgrading with informationization. More than 1,500 items of data are stored in the enterprise-level big data center constructed by Sichuan Mobile and an average data of 90T is accessed daily, making the center the largest data platform in the west of China (Sichuan Mobile Service Work, 2017).

At the beginning of 2018, the government work report stated that "comprehensively implement the strategic emerging industry development plan, accelerate the research and development and transformation of new materials, artificial intelligence, integrated circuits, biopharmaceuticals, and fifth-generation mobile communication technologies to enlarge and strengthen industrial clusters." The government work report mentioned 5G for the first time, which showed that 5G would play an important role in the future economy. China Mobile announced in March 2018 that it planned to build a 5G pilot network in major cities and it would fully commercialize 5G in 2020. China Telecom stated that 5G would be pre-commercialized in 2019 and officially commercialized in 2020. China Unicom also stated that it would achieve 5G pre-commercial deployment in 2019 (Mu, 2019).

On December 7, 2018, the highly anticipated 5G spectrum resource allocation plan was

finally announced, marking the basic formation of the spectrum resource pattern in the 5G mid-low frequency band of these three operators and the initial formation of 5G pattern (Ren, 2018). With the promotion of endogenous power in the industry, China's communications industry will move towards a new era led by 5G. Wireless, optical communications, the Internet of Things, edge computing and other fields will develop with the improvement of industry competitiveness and the core support of national policies, bringing accelerated development and value enhancement of the overall industry.

China Securities Journal 2019 Several Policies and Measures to Promote Accelerated Development of 5G Industry in Chengdu was published on the website of Chengdu Municipal People's Government on February 1, focusing on supporting ultra-high-definition video and smart medical, intelligent driving, drones, industrial Internet and other areas with comparative advantages to first carry out 5G pilot demonstration applications, which will be extended to the areas of urban management, livelihood services, and social governance. For 5G new technology, new products, new business models, and new model demonstration projects with obvious industrial driving effects, a subsidy of up to 3 million yuan will be given based on 20% of the investment (J. Yang, 2019). According to The White Paper on 5G Economic and Social Impacts by the China Academy of Information and Communication Technology (2017), direct and indirect output driven by 5G in 2030 will reach 6.3 trillion and 10.6 trillion yuan, respectively.

In summary, the above three major full-service operators after the restructuring of telecommunications have entered a new status quo with close competition. The services of China Mobile, China Unicom and China Telecom have been homogenized. Since the full-service operation, the operators' advantages in traditional customer groups have also faced challenges in the transition period. The two fiercest competitions among operators are the integration of fixed and mobile networks and the integration of mobile and the Internet. In the mobile Internet industry, major giants are pouring in. Terminals, systems and applications have become the focus of competition. Data has overtaken voice as a core business. The status of content, services, software integration, and even terminal manufacturers have been improved. While the operators who build the platform have earned relatively small profits.

Users can have more options. The change in the supply and demand relationship of the domestic telecommunications market has led to a fundamental change in the relationship between enterprises and customers. On March 5, 2019, Premier Li Keqiang of the State Council stated in The 2019 State Council Government Work Report that "number portability (customers are free to choose telecommunication operators and retain their original numbers)" would be implemented throughout the country to standardize the package settings, so that the consumers

would benefit from a real reduction of fees (Xinhuanet, 2019). In March 2019, the Ministry of Industry and Information Technology issued the Guiding Opinions on the Construction and Rectification of Work Style in the Information and Communication Industry in 2019, emphasizing the need to deepen the standardization of the "number portability", with no additional conditions or obstacles as well as vicious competition (Zhen, 2019).

Under the pressure of industry and policies, telecommunications operation needs to change their service concepts from "what kind of telecommunications services can they provide" to "what kind of services do users need" to better adapt to customer needs and make leaps in new ideas and consciousness. In March 2018, The MC user satisfaction index released by the Sichuan Provincial General Administration of Telecommunication reached 79.39, which was a "relatively satisfactory" level. During the same period, the Telecommunication Customer Satisfaction Index (hereafter referred to as TCSI) in Sichuan Province was 79.82 (Sichuan Communications Administration, 2018).

Service quality, as the core of competition in the future market, has become a consensus. As operators expand their operation content, telecommunications services should focus on creating value while being customer-oriented. The Service Quality (SERVQUAL) model is a tool for measuring service quality. In the past decade, the model has been widely accepted and adopted by managers and scholars. The model is based on the difference theory, that is, the disparities between the customers' expectations for service quality and the services that customers obtain from the service organization. The model uses five scales to evaluate the service quality of diverse services received by customers. Research shows that SERVQUAL is an effective tool for evaluating service quality and determining actions to improve service quality.

This research will be founded on SERVQUAL, total quality management and service management theories, and take China Mobile Sichuan Company (MC) as a case for empirical research. The research results will help improve customer perceived service quality, enhance corporate competitiveness, and ultimately form a win-win situation.

1.2 Research problem and questions

1.2.1 Research problem description

In the process of the third technological revolution which drives the rapid modernization of the economy, the service industry is gradually replacing the manufacturing industry as the pillar

industry of the economy. The output value of the service industry in developed countries accounts for an absolute proportion of GDP (Figure D-1 of Annex D Taking the United States as an example). In the modern service industry, service quality, as the core competitiveness of enterprises, is increasingly valued by scholars and practitioners.

On CNKI (China National Knowledge Infrastructure), a precise search is performed with "service quality" as the keyword. The time is limited from 1999 to 2018, and more than 69,000 results can be searched. The publication volume of the results generally shows an upward trend, as shown in Figure D-2. These include a number of papers published in domestic authoritative journals such as Management World and Nankai Management Journal.

From the first generation of mobile communication technology (1G) to the fourth generation of mobile communication technology (4G), each upgrade of mobile communication solved the most important needs at the time and also greatly promoted the development of the telecommunications service industry (Y. Yang, 2019). With the rapid deployment of emerging Internet technologies and applications, the rapid popularization of smart terminals based on smart phones and computers, the development focus of the telecommunications service industry also changed from the original communication service to network service (G. C. Ma, 2013).

After years of development and multiple rounds of reform and reorganization, China's telecommunications service industry has gradually formed a situation of tripartite (China Mobile, China Telecom and China Unicom) confrontation. In order to compete for users, especially existing customers in a market that is close to saturation, the three major rivals have been conducting a series of three-dimensional offensive and defensive battles, such as network superiority and inferiority, terminal superiority and inferiority, channel warfare, price warfare. These battles are based on the constant penetration of public opinion warfare on the Internet (Ben, 2017). But regardless of the public opinion warfare, the trend of increasingly homogenized operators' networks is undeniable. Under the influence of the state's "faster and more affordable Internet connections" policy, seemingly differentiated package tariffs and network services have been involved in a price war under homogeneous competition (Ben, 2019).

At the same time, the users' requirements for the quality of network services have also become higher and higher with the enrichment of material life. This problem has attracted the attention of scholars in recent years. Nearly 4400 results can be found by searching the keyword "network service quality" in the CNKI. As can be seen from Figure 3 in Annex D, "network service quality" has always been a hot topic in the academic circles during the period of 4G network considerable development and full-service operation phase of the integration of

communication network, Internet, radio and television network from 2008 to 2018.

Entering 2019, the fierce competition among the three major operators confronted new challenges. On March 5, 2019, Premier Li Keqiang of the State Council stated in The 2019 State Council Government Work Report that "number portability" would be implemented throughout the country to standardize package settings, so that the consumers would enjoy a real reduction of fees. The Guiding Opinions on the Construction and Rectification of Work Style in the Information and Communication Industry in 2019 was issued subsequently by the Ministry of Industry and Information Technology, which directly indicated that in the process of number portability, operators cannot set up additional conditions and bundle packages to prevent users from number portability (Y. Liu, 2019). As a continuation of the national "faster and more affordable Internet connections" policy, the number portability is an important measure for information and communication services to better protect users' choice rights and benefit the people. For the country, it can also effectively save number of resources and force operators to provide better products and services, instead of pursuing data growth as before, thereby improving the competitive pattern, service quality and promoting the sustainable and healthy development of the industry (X. Gao et al., 2019).

While facing pressure from the internal competition, telecom operators also confront external shocks, especially in the 5G commercial era when Internet companies, mobile phone manufacturers and other industry stakeholders with innate resources and technological advantages are also seizing opportunities to promote digital layout. Take Huawei as an example, Huawei, which has been doing 5G research and development since 2009, has more than 2,500 basic 5G patents, accounting for 20%. It is the only manufacturer in the industry that can provide 5G end-to-end products and solutions (Qiu, 2019). In addition, as a platform, under the circumstance where the business model is not very clear, the huge investment in infrastructure construction in the early stage of 5G has increased the pressure on operators who have already experienced a financial crisis. How to find a balance point during the transition period is a common dilemma for operators (J. Zhang, 2019).

But it is undeniable that 5G business is a major opportunity for operators facing collective growth difficulties. As of October 9, 2019, the total number of 5G subscription users of the three major operators exceeded 10 million. It can be seen that 5G will be a huge opportunity for user growth for operators (Securities Times, 2019). For good measure, for operators, 5G is undoubtedly a starting point for transformation and upgrading as well as the layout of industrial ecology. When the industrial ecology advances the Internet of Things, operators have already laid out. For instance, China Telecom owns a "Tianyi Internet of Things Platform" and China

Mobile possesses OneNET platform. These platforms need to establish contacts with related enterprises. However, companies that may have demand for the Internet of Things do not have the ability or do not want to invest in building networks. Therefore, the scale of industrial ecology is not large so far (J. Y. Tang & Zhang, 2019). Xu Zhijun, Deputy Chairman of Huawei, stated in public that there are two major needs in the Chinese market in the 5G era: eMBB and digitalization of the industry. The innate advantages of operators in base station construction and platform construction make them likely to take the preemptive opportunities by virtue of 5G in the industry digitalization (J. Zhang, 2019).

Generally speaking, no matter whether operators are engaged in homogeneous competition or faced with external shocks, opportunities and challenges coexist, especially the "number portability" policy and the development of 5G technology will bring a host of variables to industry structure. Actively improving the quality of network services will be the focus of reshaping the industry structure.

1.2.2 Research questions

Based on the research background and the discussion of the current dilemma, this thesis focuses on the research of solving the status quo of operator network service quality management. However, the present research on the quality of network services of operators has many limitations, they are as follows:

Firstly, the quantity of literature focusing on the quality of network service is generally small. Although there are over 4,400 search results with the key word being "network service quality" in CNKI, the quantity of literature centering on network service quality rather than incorporating it as a part of the literature is less than 1,000.

Secondly, related literature assesses the quality of network services, but little refers to influencing factors. For instance, G. C. Ma (2013) conducted research on the optimization and innovation of telecom operators' network services based on PPDIOO, but its core was on the analysis of the business environment of telecom operators' network services; J. Wu (2015) evaluated the service quality of Xi'an mobile communication network, and the situations were summarized through a questionnaire, but the influencing factors were only mentioned at the end. Sun and Qi (2019) constructed the comprehensive network service quality assessment model based on a cloud-improved gray correlation analysis model by measuring performance parameters of network service quality to achieve the real-time and fast classification of measurement data, and it only solved the efficiency problem of network service quality assessment. Popoola et al. (2018) studied the key performance indicators for the quality of

service of Global System For Mobile (GSM) networks in Nigeria, but they did not study further into the factors that can affect QoS (Quality of Service) of GSM networks. Horvat et al. (2017) gave the evaluation of service quality provisioning in large-scale pervasive and smart collaborative wireless sensor and actor networks which was too technical. Lee et al. (2015) tried to focus on application-based quality assessment of Internet access service and the research on the factors is founded on a narrow aspect. Lacking research on influencing factors of network service quality and the inability to explore the transmission path of these influencing factors, it is difficult to make effective suggestions for improving the network service quality.

Thirdly, we are starved of paths to elevate network service quality from the perspective of network service quality management. Current literature on improving the quality of network services mostly focuses on the mobile communication technology itself and explores the possibility at the technical level. For example, X. C. Ma (2019) discussed the network service quality detection and control in communication engineering intending to optimize the network technology system so that it could ensure the effectiveness of the entire network management, improve the management level, and lay the foundation for the later network system. Q. Wang et al. (2019) conducted modeling and analysis of network service quality reliability for remote calibration of power test devices. L. J. Xie et al. (2018) studied the dynamic deployment strategy of proactive network functions for service quality. Salama and Saatchi (2018) focused on the probabilistic classification of service quality in wireless computer networks and they found that by accurately determining the network's QoS, an improved understanding of its performance was obtained. Besides, Ennaciri et al. (2019) proposed an algorithm that improved the service quality based on a clustering approach and tried to load balancing protocol (with the protocol of Energy Efficient Sleep Awake Aware [EESAA]) to advance service quality in the wireless sensor network. Kozainski and Kneevi (2014) introduced some of the commonly used service quality mechanisms and analyzed their impact on network traffic in order to better its performance, mainly packet delay.

Certainly, mobile communication technology is the foundation for network quality improvement, but how operators can make advanced mobile communication technology serve users is a considerable part of technological progress to benefit the people, which cannot be ignored.

Based on the foregoing background, this thesis is aimed to answer the following four questions: Firstly, what constitutes the quality of network service? Secondly, what the current status of network service quality evaluation is? Thirdly, what factors may influence the network service quality evaluation results? Fourthly, how can the management level of network service

quality be improved based on the influencing factors?

1.3 Research methods

This thesis will conduct survey research which is derived from literature research, and then conduct empirical analysis based on survey data, give relevant conclusions and recommendations. Therefore, the main research methods used in this research are as follows:

1. Literature analysis

The author has read myriads of related documents by consulting domestic and foreign literature databases to enhance the concept and theoretical cognition involved with the research topic sorted out and summarized the research of domestic and foreign scholars in related fields, providing effective guidance and a solid theoretical foundation for the research of this thesis.

2. Questionnaire survey method

This thesis will make a questionnaire based on the SERVQUAL scale and the actual situation of network service quality, conduct online and offline questionnaire feedback collection, sort out and organize the collected questionnaire data. Effective questionnaire data obtained can reflect the quality of network service of the current situation, especially the disparity between customers' perception and expectation of network service quality, provide a basis for quantitative research on empirical analysis.

3. Quantitative analysis

This thesis will use the quantitative analysis method of mathematical statistics to perform statistical analysis and score calculation on the collected valid questionnaire data, including descriptive statistical analysis, validity test, reliability test, product scaling method, weighted calculation method. Quantitative analysis can more accurately reflect the actual situation of network service quality and has universality and reliability so that the author can better conduct in-depth research.

4. Qualitative analysis

This thesis qualitatively analyzes and defines the correlative concepts of network services, including service, service quality, telecommunication service quality, service quality evaluation model, service quality management methods, customer satisfaction and other concepts. For good measure, this thesis also qualitatively analyzes and infers the reality of network service quality reflected by the questionnaire data, with a view to combining qualitative and quantitative analysis to achieve a more comprehensive analysis process and all-around conclusions.

5. Interview survey method

In the process of designing the network service quality evaluation system, this thesis conducted relevant interviews with typical network service users and operator employees who are available for the author due to the work convenience, so that the designed network service questionnaire and evaluation system can be closer to the respondents. In addition, in the process of questionnaire collection, the author also conducted on-site questionnaire collection, supplemented by the method of interview survey.

1.4 Research framework

This thesis will be derived from the background research on the network service provided by operators, and put forward research questions; on the basis of combing relative literature and theories of network service quality, a network service quality evaluation system based on the SERVQUAL method and design questionnaires is established; use data collected from the questionnaire to carry out empirical analysis to obtain the current status, influencing factors of the operator's network service quality; then give optimization suggestions from multiple perspectives such as network service system design and network service quality management, and finally conduct a research summary.

The research framework of the thesis is shown in Figure 1.1.

Chapter One is the introduction, which mainly depicts the research background of this thesis, proposes research questions based on it, and then explicates the research methods and research frameworks that will be used.

Chapter Two is the literature review, centering on the definition of quality, the definition and characteristics of service, the definition and characteristics of service quality, and the evaluation and management of service quality. The theory of customer satisfaction is briefly introduced.

Chapter Three is the design of the network service quality evaluation system based on the SERVQUAL method. It mainly presents the process of network service quality evaluation, the indicators, statistical methods and advantages of the SERVQUAL scale in detail. The evaluation index system of network service quality is established and the questionnaires are designed based on the SERVQUAL method and the characteristics of network services. Some research tools are also introduced.

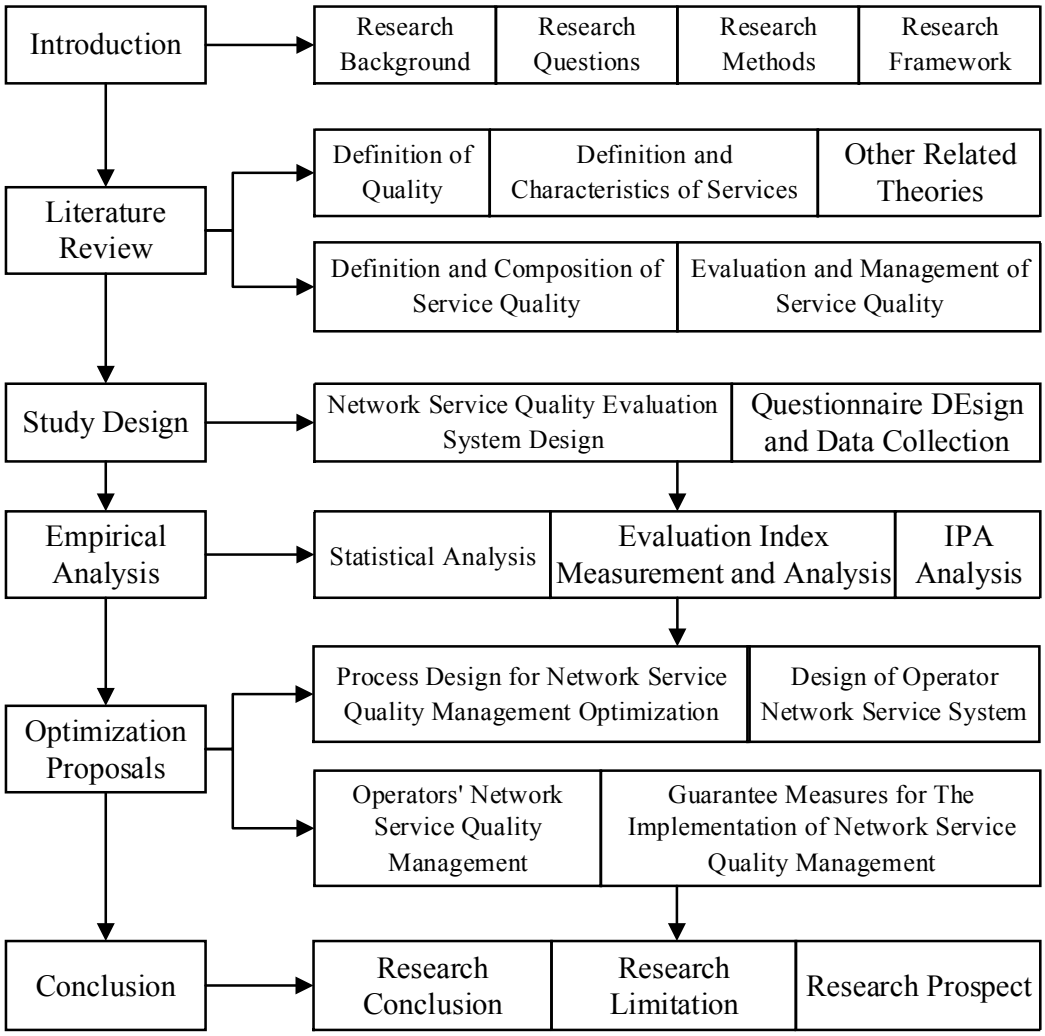

Figure 1.1 Thesis research framework

Source: elaborated by the author

Chapter Four is an empirical analysis founded on the data collected from the questionnaire. First, the author conducts sample statistical analysis including sample feature analysis, reliability and validity analysis, to test the reliability of the sample data, and then calculate the differences between customer perceived value and expected value of network service quality grounded on the unweighted and weighted SERVQUAL indicators respectively, and introduces Importance – Performance Analysis (IPA) method to analyze the influencing factors of the network service quality, and finally summarizes the empirical analysis.

Chapter Five is the optimization suggestions for network service quality management, which mainly illustrates from these aspects: management optimization process design, operator network service system design, operator network service quality management, and network service quality management implementation guarantee measures. Relevant suggestions are given, and suggestions on optimization are summarized in the final.

Chapter Six is the conclusion, which summarizes the research conclusion of this thesis, points out the research limitations and the future research direction.

Chapter 2: Literature Review

2.1 The definition of quality

2.1.1 The standardized definition of quality

The word “quality” is derived from Latin, which originally means the nature of a given entity. At first, it only describes the facts without value judgment or distinction between good and bad. Later, the Longman Modern English Dictionary interprets “quality” as “grade, degree of excellence” (Watson, 1976), while the Chinese Dictionary interpreted quality as “the quality of things, products or jobs” (Chinese University Dictionary Editing Committee, 2000). It can be seen that, in the process of change of times, quality is not only used to describe facts but also evaluate something and make a value judgment. In 1986, the ISO8402:1986 “Quality-Vocabulary” issued by the International Organization for Standardization defines “quality” as the sum of the characteristics and characteristics of a product or service that meets regulations or potential needs (Qiao, 2005). In the ISO8402:1994 “Quality- Vocabulary” revised by the International Organization for Standardization in 1994, “quality” and “trait” have the same definition, namely “the sum of the characteristics that reflect the entity’s ability to meet requirements or potential needs” (Y. N. Li, 1995). It can be seen that compared with the definition in 1986, the subject of quality has changed from product or service to entity. However, the concept of entity is extremely broad and can refer to all “things that can be individually described or studied”, which can be personnel, activities or processes, products, organizations, systems and otherwise (X. G. Li, 2011). Therefore, the scope of “quality” is no longer limited to products and services but expanded to a wider range.

In ISO 9000: 2000 Quality management systems-Fundamentals and vocabulary, “quality” is defined as: “the degree to which a set of inherent characteristics fulfils the requirements”. In this phrase, “inherent characteristics” refers to the characteristics that exist in something (or a certain object), especially the permanent distinguishable features. They can be either qualitative or quantitative; “requirements” refers to “need or expectation that is stated, generally implied or obligatory” (International Organization for Standardization [ISO], 2000). ISO (2015) defines “quality” as the “degree to which a set of inherent characteristics of an object fulfils requirements”. The term “quality” can be used with adjectives such as poor, good or excellent.

"Inherent", as opposed to "assigned", means existing in the object. Based on the above definition of quality, we can conclude that quality mainly includes three elements, namely inherent characteristics, requirements and degree of satisfaction. Inherent characteristics emphasize the inherent stipulation of quality to things themselves, requirement emphasizes the external demand and expectation of quality, and degree of satisfaction emphasizes the consistency between the internal regulation of things and external demand and expectation. The three elements of quality connect the inherent characteristics of things with external needs and expectations and realize the unity of internal and external. The aforesaid standardized quality definitions are generally proved before the 21st century, summarized in Table 2.1.

Table 2.1 Standardized quality definitions

Representative/Year	Viewpoints on the definition of quality standardization
Longman Modern English Dictionary (Watson, 1976)	Grade, degree of excellence
ISO8402:1986 "Quality-Vocabulary" (1986)	The sum of the characteristics and characteristics of a product or service that meets the specified or potential needs.
ISO8402:1994 "Quality-Vocabulary" (1994)	The sum of the characteristics that reflect the entity's ability to meet requirements or potential needs.
ISO9000:2000 "Quality management systems—Fundamentals and vocabulary" (2000)	The degree to which a set of inherent characteristics fulfils the requirements.
"Chinese Dictionary" (2000)	The good and bad aspects of things, products or jobs

Source: elaborated by the author

2.1.2 The classic and authoritative definition of quality

Over and above the standardized definition of quality in dictionaries and by authoritative organizations, experts in the field of quality management have conducted long-term and multi-angle research on the definition of quality. With the development of society and technology, the connotation of quality has been continuously expanded. The mainstream quality definition is based on the applicability of consumers, specifically referring to products or services that meet customers' expectations. The definition of applicability quality is proposed by Juran (1974): "Quality includes product characteristics that lead to satisfaction with the product, and also includes the degree of free from shortcomings... Quality is best defined by the term 'fitness to use'." Among the numerous implications of quality, He perceives that two definitions matter most to quality management. Firstly, quality means those product features that satisfy the users' demand to realize the satisfaction of the users. Secondly, it means being immune to defects, that is, errors that do not require repetition (rework) or result in on-site failures, customer dissatisfaction, customer complaints and otherwise (Juran et al., 1974).

In the past, Shewhart (1931), the founder of modern quality management, mentioned similar quality concepts earlier in his book Economic Control of Quality of Manufactured Product, which is recognized as the origin of the basic principles of quality. He declared that the qualities of pieces of the same kind of product differ among themselves, or in other words, the quality of a product must be expected to vary. The causes of this variability are generally unknown. But we can understand variation by using simple statistical tools such as sampling and rate analysis. The book presents a scientific basis for determining when they have gone as far as it is economically feasible to eliminate these unknown or chance causes of variability in the quality of a product. When this state has been reached, the product is said to be controlled because it is then possible to set up limits within which the quality may be expected to remain in the future.

In 1967, W. Edwards. Deming once asserted that the quality of any product or service can only be defined by customers. Quality is a relative term that will change in meaning depending on customers' needs. To meet or exceed customers' needs, managers must understand the importance of consumer research, statistical theory, statistical thinking, and the application of statistical methods to processes (Deming, 2000).

Deming (2000) also gives a comprehensive quality definition from the development perspective of "norm", "process", "management" and "continuous improvement", emphasizing the basic concepts of quality management such as process and continuous improvement. This comprehensive definition method is somewhat similar to that of Armand Feigenbaum, the father of total quality control. Feigenbaum (1983) defined the quality of products and services as "comprehensive features of products and services in marketing, engineering, manufacturing, and maintenance, customer expectations are met through these various aspects."

Based on Juran's view of quality definition, O'Neil and Palmer (2004) proposed that quality can only be defined by users, and quality is whether the goods or services provided by the company meet the needs of customers. Chinese scholar Yu (2005) believed that quality is the degree to which the inherent characteristics of an entity meet the requirements of related parties. Slack et al. (2010) defined quality as "the fit between customer expectation and customer perception of products or services". If the product or service is better than expected, then the customer will think the quality is high and vice versa. If the product or service is worse than expected, its quality will be considered low, which may lead to customer dissatisfaction. Therefore, if customers' expectations are met, they will think the quality is acceptable.

The above applicable quality definitions are summarized in Table 2.2.

Table 2.2 Classic and authoritative quality definitions

Representative/Year	Viewpoint of Applicability Quality Definition
Shewhart (1931)	The qualities of pieces of the same kind of product differ among themselves, or in other words, the quality of the product must be expected to vary.
Deming (1967)	The quality of any product or service can only be defined by the customer.
Juran (1974)	Quality includes product characteristics that lead to satisfaction with the product, as well as the degree of free from shortcomings.
Feigenbaum (1983)	The comprehensive characteristics of products and services in marketing, engineering, manufacturing, and maintenance customer expectations are met through these various aspects.
O'Neil and Palmer (2004)	Quality is whether the goods or services provided by the company meet the needs of customers.
Yu (2005)	Quality is the degree to which the inherent characteristics of an entity meet the requirements of related parties.
Slack et al. (2010)	The fit between customer expectations and customer perception of the product or service.

Source: elaborated by the author

2.1.3 Quality definition branch

Apart from the more mainstream applicability quality definition, there is likewise a conformity quality definition branch, which refers to the characteristics of a product or service that meets the given specifications from the perspective of the producers. Crosby (1980) believes that there must be an accurate definition of quality and declares that "quality is to meet requirements". This is also true in enterprises. "The requirements must be clearly expressed so that they cannot be misunderstood. Then they should be continuously measured to ensure compliance with these requirements. Wherever there are non-conformities, it indicates the quality is not good. In this way, the quality problem is converted into whether there are non-conformities." A practical application is Henry Ford who has adopted advanced mechanical techniques to achieve high-quality standards and absolute interchangeability in car making, aiming at high-volume production (Atack, 1984). Some researchers have defined quality as excellence, among which Pirsig is the typical one. Pirsig (1992) mentions that quality is "a direct experience independent of and before intellectual abstractions". Shewfelt (1999) has viewed quality as an absence of defects or a degree of excellence.

With the development of the economy and society, scholars have gradually diversified the definition of quality. Taguchi (1986) examined the quality level from an economic point of view, and defines quality as "the characteristics of avoiding causing losses to society after a product is launched". He believes that the poorer the product quality is, the greater the social loss will suffer; on the contrary, the better the product quality is, the smaller the social loss will sustain. Quality is understood from the perspective of the negative effects of products or services on society (Z. J. Han et al., 2008).

Some scholars even point out that the definition of applicable quality and conformity quality has been unable to meet the new requirements of economic development for the long term. They emphasize that quality refers to meeting the potential needs of consumers to achieve an unexpected new quality of new products or services. Its representative, Kano (2002), pointed out that "product quality has become a basic requirement, not a competitive advantage. The organization's quality behavior focuses on developing products that meet the clear needs of consumers, which cannot be used as a competitive advantage in today's society. Enterprises also need to explore potential needs of consumers and add unexpected new quality for consumers when creating products or services."

Established on theoretical literature research on the evolution and refinement of conformity quality and applicability quality, scholars' increasingly diversified and broad definitions of quality are summarized into five types: (1) The quality perceived by the customers, that is, the customers' subjective perception of the product, which is product quality; (2) Satisfying customer expectations, namely, the quality meets the customers' expectations, which is completely evaluating the product from the perspective of customers; (3) The value of the product is the quality. For individuals, it is the ratio of the benefits paid by the customers to the benefits received; and for the company, it refers to the ratio of various costs of producing the product to the benefits the company obtains; (4) Quality refers to compliance with technical specifications, that is, quality is an objective attribute of products, which can be measured and judged by a wide range of technical standards and specifications, and unified technical standards can be formulated to regulate production procedures and results; (5) Quality is excellent, which can be understood as the pursuit of maximization of product value; among these five types of quality definitions, excellence is the most general definition (Hansen, 2010; Luan, 2016). The bias of the five types of quality definitions is in Figure D-4.

To sum up, although various experts and scholars have different opinions on the definition of quality, in general, they cannot be separated from the specification of products and services themselves and the requirements of meeting human expectations. With the evolution of the times and the structural transformation of the economy and society, the service industry has gradually become an important field that fosters economic growth and social progress. People will also put forward new requirements for the quality of service as a "product form" that cannot be described concretely.

2.2 Definition and characteristics of services

2.2.1 Definition of service

The service is all intangible economic activities that realize the interaction between service providers and consumers. It plays an increasingly important role in the national economy and modern human life. Regarding the definition of service, there is no conclusion in the academic circles. Different scholars have put forward diversified views from various perspectives.

1. The definition of service concept in classic principles of marketing

Among the different schools of service definitions, the most representative one is the research, definition and development of service concepts in marketing. Table 2.3 summarizes the core views of marketing scholars on service in different periods.

Table 2.3 The definition of service concept in classic principles of marketing

Representative/Year	Views on service
American Marketing Association (1960)	Services are activities, benefits or satisfaction that are sold alone or together with products.
Regan (1963)	Service is an intangible satisfaction result obtained when customers purchase products or services or an activity that combines tangible and intangible satisfaction results.
Judd (1964)	Service is a market transaction activity, and the biggest feature of this activity is that it does not involve changes in ownership.
Rathmal (1966)	Service is a behavior, a performance, and an effort.
Bessom (1973)	For consumers, a service is an activity that can provide them with any benefits or satisfaction. Consumers are personally unable or unwilling to provide such activities.
Blois (1974)	Service is a sales activity that can bring benefits or satisfaction to customers.
Lovelock (1980)	Service is not a real thing, but a process or a performance.
Lehtinen (1982)	Service is a kind or a series of activities, which are completed in the process of interaction between customers and service providers or equipment, and satisfy customers.
Gronroos (1990)	Service is an activity or a group of activities with intangible characteristics. The most important function of service is to provide customers with solutions to problems.
Dutka (1994)	From the perspective of customer satisfaction, service is characterized by sincerity, empathy, trustworthiness, value, mutual interaction, perfect performance, and full authorization.

Source: elaborated by the author

1. The development of service concepts since the 21st century

After entering the 21st century, the service industry plays an increasingly cardinal role in the economy, and the understanding of services by various organizations and scholars has become more scientific and comprehensive.

In 2000, Professor Christian Gronroos, one of the founders of the Nordic Service

Management School also formed a new viewpoint on the basis of his definition of service in 1990, which describes that service is a series of more or less intangible activities and it constitutes a process carried out in the interactive relationship among customers, employees and tangible resources. These tangible resources (or tangible products, tangible systems) are provided to customers as solutions to customer problems (Gronroos, 2000). In 2015, ISO (2015) defined service as "output of an organization with at least one activity necessarily performed between the organization and the customer." The dominant elements of a service are generally intangible. Service often involves activities at the interface with the customer to establish customer requirements as well as upon delivery of the service, and can involve a continuing relationship. Service is generally experienced by the customer.

Ye (2001) defined the concept of service in 2001. He believed that service is a series of activities that provide consumers with certain benefits or generate satisfaction. At the same time, the service is intangible, but can be transferred with compensation or transacted. Z. P. Chen (2001) put forward the concept of service from divergent angles in 2001, and believed that the essence of service is for transactions, and has the characteristics of intangibility and no ownership transfer. Z. Y. Xu (2002) defined service from the perspective of supply chain analysis. He believed that the greatest significance of service is to provide customers with incremental benefits and value. The process of service provision is accompanied by a supply chain system of knowledge and technology.

Wei (2005) integrated the standpoints of myriads of foreign scholars and defined service as "A more or less intangible activity or process, which is completed in the process of interaction between service providers and recipients. The service behavior subject is providing benefits to another subject. At the same time, service is also the main means for an enterprise to implement a differentiation strategy. Through service differentiation, the enterprise can create its own long-term competitive advantage."

Based on the theory of Professor Gronroos, J. L. Han and Dong (2006) put forward that "service is not only an intangible special activity but also a concept. Its essence is to better communicate with customers, find their existing or potential customers and meet the needs to the greatest extent, gain profits, so as to create wealth, and gain competitive advantages."

Zeithaml and Valarie (2008) defined service as "the output of non-physical products, which provides added value with the time spent on the product, such as essentially intangible entertainment, convenience, comfort and health that can be felt by buyers".

Taken together, scholars continue to supplement and improve the definition of service. For example, the service definition of early marketing scholars mostly focused on service activities,

and the initial definition also has the shadow of products, but then gradually touches the features of the service itself, for example, intangibility, making traditional service definitions go beyond specific narrow service categories. As for definitions of recent years, scholars have expanded the connotation of service to a new level, such as using service as a means of competition for organizations, and measuring the added value of service.

2.2.2 Characteristics of the service

As an intangible and elusive concept, service can usually be deeply understood through its features. Although the academic circles have various opinions on the definition of service, the understanding of the characteristics of service is basically the same. This thesis mainly summarizes the intangibility, the simultaneity of production and consumption, non-storability, and heterogeneity of service.

1. Intangibility

Intangibility is the basic feature that distinguishes service from general tangible products, because service is essentially a performance or an action, not a physical object, and has no fixed form of its own functional attributes. We can understand the intangibility of services from two aspects: the spatial form of services is basically not fixed and the practical value of some services cannot be felt in a short term (G. Yan, 2014).

2. Simultaneous production and consumption

The production and consumption processes of services usually occur concurrently, and service products together with their sources of supply are mostly inseparable. Therefore, in most cases, customers must intervene in the partial or the main production process. Only when customers start to consume services can they be produced. However, customers can only participate in the service or enjoy the effect of the service through cooperation with service personnel, but they do not possess ownership of the service.

3. Non-storability

The non-storability of the service is also called perishability. Since services are intangible and cannot be separated, services cannot be stored like tangible goods. In other words, the production and consumption of services must be carried out at the same time and the same place. This feature determines that if the service is not consumed immediately, it will cause losses.

4. Heterogeneity

Services are highly heterogeneous. Even the same kind of service is greatly affected by factors such as time, space and personnel who provide such service. Because service is the interaction between the service provider and customer, all the changing factors that accompany

this process lead to service differences. There are disparities mainly in two aspects: one is the variation caused by different qualities of service managers or specific providers, and the other is the difference caused by varied types of customers, their own conditions and the degree of participation in the service production process.

2.3 Definition and composition of service quality

2.3.1 Definition of service quality

The concept of service quality is introduced from the conception of product quality. Due to the intangibility, non-storability, heterogeneity and other characteristics of service, service quality is affected by suppliers, consumers, and the environment and is difficult to be measured. The definition is a more complicated issue.

In ISO 9000:2015, quality entities include product, service, process, person, organization, system, resource and other things, and the characteristics of these things embody physical characteristics, sense, behavior, time and function (ISO, 2015). These standardized definitions of service quality are relatively general and abstract, which are not enough to explain the connotation of service quality from a perceptual and practical perspective.

In academia, the concept of service quality was first proposed by Lewis in the early 1970s. Berry et al. (1983) defined service quality as to whether the service can reach a preset standard, and claimed that service quality is compared with enterprise quality standards. Hence, service quality means that the service result meets the quality standards set by the enterprise. When the enterprise sets the quality standard, then there are judgment standards and relevant bases for the service provided by the enterprise to the customer. From the perspective of psychological perception, Swan and Combs (1976) believed that service quality is the customers' perception of the performance of the service provided by the enterprise, including mechanical performance and expressive performance.

Sasser et al. (1978) raised that service quality includes not only the final result, but also the way of providing services, emphasizing that measuring service quality must start from different attributes of the service. Then, Rosander (1980) pointed out the service industry needs a broader concept of quality than the manufacturing industry. Service quality includes personnel performance quality, equipment quality, data quality, decision-making quality and result quality;

Contemporaneously, Lehtinen and Lehtinen (1982) proposed the concepts of output quality and process quality, and later divided the service quality into three aspects: entity quality,

interaction quality and enterprise quality. Entity quality refers to the quality of the physical part of the service process, including the product itself and the physical support throughout the service, such as the quality of the material and the quality of the equipment, The quality of interaction refers to the consumers' feelings during the contact between the consumers and the company's service personnel, and the quality of the enterprise mainly refers to the corporate image quality, that is, the overall evaluation of the service quality of the organization by the consumers.

Since the time the research on the definition of service quality emerged in the 1970s, the theory of customer perception of the definition of service quality has gradually become mainstream, and a large number of expert opinions and classic literature have been concentrated in related fields.

The concept of customer-perceived service quality was first proposed by Gronroos (1982) who believed that service quality is essentially a perception, which is determined by the comparison between the customers' service expectations and the perceived actual service performance. The service quality should be determined according to the wishes and needs of the consumers, and will not vary with changes in objective conditions. It is determined by consumers' subjective perception of the services they enjoy. The ultimate evaluators of service quality are the customers, not enterprises. The concept proposed by Gronroos has made it possible to understand the characteristics of services for the theoretical and business circles within a basic theoretical framework.

Garvin (1983) proposed that service quality is the subjective response of customers to things. It is a perceived quality rather than an objective quality, and he believed that service quality is often not quantifiable.

Based on the research of Gronroos, Parasuraman et al. (1985), a combination of well-known service quality scholars of the North American school, through exploratory qualitative investigation and research, concluded that the consumers' evaluation of service quality can reflect the degree of difference in consumer perception and expectations, and showed that the service perceived by consumers is not only the service itself, but also the influence of the process of providing services, this is, the service quality not only includes the dimension of service, but also contains multiple dimensions, and the gap between what consumers expect before receiving the service and the actual perception of the service after receiving the service is used to define the service quality, which is called the perceived service quality.

Parasuraman et al. (1985) also proposed in the same year that service quality is a consumer's assessment of the superiority of a certain service in the whole process, which

reflects the consumer's attitude, and is the comparison between the consumer' s expectations of the service and the actual service experience. Lewis and Barbara (1989) also elaborated on similar notions. It is believed that the perceived service quality is a judgment of consumers, which comes from the comparison between consumers' expectations of service and actual service performance received. Ghobadian et al. (1994) believed that service quality is used to measure service delivery and the extent to which customers' expectations can be met. Nitecki and Hernon (2000) mentioned that service quality is defined as exceeding customer expectations or the gap between customer perception and expected service.

Ultimately, the definition of service quality is complex and diverse, but basically contains the connotation that service quality is the customers' subjective perception of service, that is, the customers' evaluation of service providers after comparing service expectations with actual perceptions. Such connotation indicates the important characteristic of service quality, namely, service quality is formed during the interaction between service providers and service recipients; service quality is heterogeneous and experiential, and the good or bad interaction process between service providers and customers directly affects the customers' evaluation of service quality and determines the level of service quality. Over and above the basic factors of service interaction, researchers have conducted a more detailed discussion on the composition of service quality.

2.3.2 Composition of service quality

The composition of service quality goes hand in hand with the definition of service quality. Scholars in related fields have undertaken in-depth deconstruction of service quality from varied perspectives.

As the "father of service marketing theory", Gronroos introduced the concept of customer perceived service quality in 1982, and by introducing the basic theories of cognitive psychology in 1983, he proposed a model of customer perceived service quality and defined two elements of service quality : (1) Technical quality: means the result of the service or the question of "what is provided"; (2) Functional quality: appertains to the method of service delivery and related issues, "how to provide services". The former is convenient for objective evaluation, while the latter can only be judged by the customers' subjective standards. This division makes people's understanding of customer consumption no longer limited to result in consumption, but also involves process consumption, and plays an important role in strengthening the concept of full-staff marketing and even establishing the theory of service quality (Gronroos, 1983).

In 1988, Gronroos determined six criteria for acceptable perceived service quality, namely:

(1) Expertise and skills: Customers believe that service providers, namely employees have necessary knowledge and skills to solve their problems professionally;

(2) Attitudes and behaviors: customers believe that service providers care about them and solve their problems in a friendly way;

(3) Accessibility and flexibility: Customers believe that the location, working hours, staff and operating system design and operation of service providers enable them to easily obtain services and flexibly meet their needs;

(4) Reliability and credibility: Customers know that no matter what happens, they can rely on service providers, employees, and systems because they will keep their promises and safeguard the best interests of the customers;

(5) Correction: Customers know if something goes wrong, service providers will actively take corrective measures;

(6) Reputation and credibility: Customers believe that service providers have reasonable view of value and are trustworthy (Gronroos, 1988). In 2001, Gronroos added the Serviscape standard, which is the active support experience in the physical environment and others (Gronroos, 2001).

Parasuraman et al. (1985) advanced a gap model of perceived service quality, and believed that service quality consists of reliability, responsiveness, competence, availability, instrumentation, communication, credibility, safety, as well as customer understanding and tangibility. Soon in 1988, they reduced the 10 dimensions to 5 dimensions through empirical analysis: tangibility, reliability, responsiveness, assurance and empathy which gradually becomes a classic 5-dimensional structure of service quality widely recognized and utilized by domestic and foreign academic circles (Parasuraman et al., 1988).

Rust and Oliver (1993) perfected and supplemented Gronroos' two-dimensional service quality model. They added environmental factors, and then proposed a service quality model that includes three quality elements: service product, service delivery, and service environment. The dimensional quality model is more complete so that the academia and the industrial circle have begun to focus on the physical environment of services instead of the contact and result aspects of services. The service product is similar to the result quality, the service delivery is similar to the process quality, and the service environment is similar to the tangibility in the five dimensions of Parasuraman, Zeithaml and Berry (PZB).

As scholars in the field of marketing have deepened their understanding of customer management mechanisms, some scholars have begun to notice that the composition of service quality may also be multi-layered. Dabholker et al. (1996), who first noticed this problem and

conducted special research, put forward a multi-dimensional and multi-layered structure of service quality from a multi-leveled perspective. The main dimensions of service quality comprise physical aspects, reliability, human interaction, problem solving and policies. Each main dimension has its own corresponding sub-dimensions. Brady and Cronin (2001) summarized previous studies and adopted their research results, and proposed a more general multi-dimensional and multi-leveled perceived service quality model. The main dimensions are interaction quality, physical environment quality, and result quality. The quality of the interaction is determined by the attitude, behavior and expertise sub-dimensions. The quality of the physical environment is resolved by the surrounding conditions, design and social factors. The quality of the results is decided by the waiting time, punctuality and valence. In the past decade, the multi-leveled view of service quality has been adopted and recognized by a host of scholars, and has gradually become the mainstream view of service quality.

With the rapid rise of China's economy in recent years, myriads of Chinese scholars are also conducting research in related areas of service quality. X. Q. Wu (1997) believed that service quality is composed of six attributes: functionality, economy, comfort, timeliness, safety and civility. Zhu et al. (1999), based on teeming empirical studies on multiple service companies such as hotels, restaurants, airlines, and banks, proved that service quality can be divided into five quality attributes: technology, emotion, communication, relationship, and environment. Fan (1999) proposed an extended service interaction model. He believed that service quality should include not only technical quality, but also interaction quality factors, which is the result of customer perception. Deng's research (2004) results were based on the service quality gap model and Deng believed that service quality is composed of five attributes: understanding, design, execution, communication and experience. Wei and Han (2003), through the research on measuring cross-cultural applicability of service quality by certain methods in the hotel industry to measure the applicability of service quality to cross-cultural research, proposed a series of conclusions, for instance, differences in the perception of service quality among customers with different cultural background.

Carrillat et al. (2009) found a large effect of service quality on satisfaction after summarizing 161 effects in 86 studies by using a meta-analysis. Miranda et al. (2018) mentioned that service quality is linked to customer satisfaction, attitudinal loyalty, and purchase intentions which are exactly the customer outcomes. In the same year, Joudeh (2017) pointed out that service quality reflects the difference between the expected quality prior to the process of purchase and the actual quality experienced by the consumer post-purchase.

To sum up, it is readily seen that the composition of service quality is not fixed, and it will

change with varied analysis angles, social development environments, and different times, and has a trend of being more and more refined. Increasingly, research on the constituent dimensions of service quality is conducted in conjunction with industry affairs. The mobile communications industry, as a rising industry in recent years, has also attracted the attention of many scholars.

2.3.3 Telecommunication service quality theories

2.3.3.1 The broad telecommunication service quality theories

As a typical service industry, telecommunications has common characteristics of the service industry and its own particularities. Telecommunication service refers to telecommunication functions and non-material services that can meet people's production as well as life needs and bring practical benefits to people. In such service, basic operation enterprises in the telecommunication industry (municipal telecommunication companies are typical representatives) take telecommunication customers of the whole society as main service objects and telecommunication technology as basic service means.

Telecommunications services have typical characteristics, including (1) the service is a telecommunications process, and the service status will no longer appear after the process ends; (2) the service has always been open to customers. The entire network of telecommunications companies is in production and on standby, and customers can participate in the experience at any time (L. Cao, 2012). Chinese scholar X. M. Yan (2015) once summarized the characteristics of telecommunication services as intangible, process, commodity, and monopoly. In these summaries, we can see the differences between the telecommunications service industry and general services. Therefore, the definition of telecommunications service quality should also be unique.

In 1984, The Service Quality, Network Management and Network Maintenance Manual compiled by the International Telegraph and Telephone Consultative Committee (CCITT) defined telecommunications service quality as the comprehensive effect of service performance. These performances determine customer satisfaction and can be summarized into three aspects: the first aspect is that the customer can quickly get the required service; the second aspect is that the service process can be arranged as the customer wants, and interactive real-time services can be continuously provided; the third aspect is that the charges are clear, reasonable and accurate, and the bill can truthfully reflect the service situation (S. Liu et al., 2010).

With the rapid evolvement of the telecommunications industry, designating a quality

system suitable for the industry according to the characteristics of the industry has become a common demand for the communications industry around the world. In 1997, a group of eminent companies in the communications industry, led by Bell Company of the United States, established the Forum QuEST, aiming to formulate and maintain a quality system management standard for the communications industry, TL9000, which is based on its own quality standards and practices. Considering the general operating requirements of the company, the standard highlights the concepts of reliability and customer-supplier communication. After more than ten years of development, the latest version of TL9000 was released in 2015. The standard is divided into five hierarchical structures, from bottom to top: the lowest level is the universal quality system requirements of the ISO9000 standard; then the industry's software, hardware, and service universal quality system requirements; the third is the special requirements of the industry's software, hardware and service quality system; the fourth layer is universal quality system indicators for the industry's software, hardware and service; the top layer is special quality system indicators for the industry's software, hardware and service. At the moment, this structural system is widely used in communications operation projects in major communications operators in the world (W. P. Chen, 2014).

Experts and scholars focus on empirical research on the quality of telecommunications services, including basic research founded on customer surveys. For instance, through a field survey on Greece Mobile, Santouridis and Trivellas (2010) wrote a thesis showing their research results that: customer service, pricing structure, and billing system service quality significantly and positively affect customer satisfaction, and more significantly and positively affect customer loyalty, while service recovery also affects the impact of service quality and customer loyalty. In the design of the service process of mobile operators, American scholar Elcan (1996) made use of an American mobile communications company as a case to establish a simulation model of the service process, so that service processes can be set up by service managers as needed. By tracking changes in supply and demand situations as well as performance indicators, managers can determine the quantitative impact of process changes. Chinese scholars tend to combine the qualitative evaluation of telecommunications service quality with empirical testing research. In 2008, J. Wang and Zheng (2008) built a brand-new service quality evaluation system that can measure the whole process of telecommunications services and customer perceptions. Mao and Yang (2010) proposed a customer-perceivable service quality indicator system model in 2010, and applied them in actual business scenarios. At the same time, L. Y. Tang (2010) completed the empirical test of the perception of telecommunications enterprises, and her research showed that service quality perception factors

are positively correlated with customer satisfaction. The empirical research done by Jia et al. (2010) put forward an evaluation index system for online business halls based on customer perception.

In summary, the quality of telecommunications service is a topic closely related to the actual industry. With the progress of the times, especially the rapid development of the telecommunication industry, more and more attention has been paid to the research of telecommunications service quality. Advances in quality research are also the driving forces of the telecommunications industry.

2.3.3.2 Network service quality theories

With the progress of mobile Internet technology, the network gradually becomes the service that has the supporting position in the telecommunications industry. As a result, there are more and more researches on network service quality. In a previous study, the judgment of overall service quality in the telecommunications industry comes from customers' perceptions of a stable and strong network quality (Lai et al., 2009), ready-to-serve customer support team (Aydin & Özer, 2005), informative website support (Thaichon et al., 2012) and a high level of security and privacy that is trusted by customers. But now, network service quality is one of the core service drivers in the telecommunications industry. At the beginning, the network service quality mainly means physical network quality. The QoS in wireless has been defined to include connection blocking probability and connection dropping probability by Naghshineh and Acampora (1996). Y. Wang et al. (2004) described network quality as the quality and strength of the network signals. Vlachos and Vrechopoulos (2008) regarded the network quality as not only the strength of the network signals but also the number of errors, downloading and uploading speed. Ahluwalia and Varshney (2009) proposed that the end-to-end QoS depends on several factors such as mobility and connection patterns of users, and the QoS policies in each of the wireless networks. The end-to-end QoS is also affected by multiple decisions that must be made by several different network entities for resource allocation.

Gradually, customer service becomes an important approach to evaluate Internet service quality. A study of Internet service providers (ISP) in 2003 discovered that an ISP differentiating itself from competitors by offering superior customer support and reliable service would have a sustainable strategic advantage in the marketplace (Erevelles et al., 2003). In 2005, Aydin and O¨zer (2005) demonstrated that customer complaints handling is an important factor in determining service quality in the Turkish mobile telecommunications market. Customer service can differentiate a company in the area of addressing and handling

customers' requests, queries, and complaints which is the same importance as generating revenue (Zeithaml et al., 2010). Rod and Ashill (2013) mentioned that Internet customer service teams are under constant pressure to perform their work reliably, dependably, and according to set protocols in order to meet their productivity goals and deliver quality customer service. More recently, there is a study (Thaichon et al., 2014) of service quality dimension on an ISP's customers' affective and cognitive evaluation, confirming that network quality, customer service and technical support, information quality, as well as privacy and security have different influences on perceived value, trust and commitment. In the newest studies, researchers (Jadayil et al., 2020) have again proved that market high competition in a dynamic world environment enables the services' providers to recognize the need to pay more attention to the customers' expectations and perspectives.

2.4 Evaluation and management of service quality

2.4.1 Service quality evaluation methods and models

1. Gronroos customer perception model

As mentioned in the previous literature review, Gronroos advanced the notion of customer perceived service quality in 1982. concurrently, he also proposed and established a model of perceived service quality. He believed that the total service quality consists of corporate image, functional quality and technical quality. In 1983, Gronroos revised the model. In the model, Gronroos (1983) raised that service quality should include functional quality and technical quality, at the same time, the corporate image should filter these two service qualities to a certain extent, as shown in Figure D-5. If consumers perceive that the business has a good image, then when the business makes some small mistakes, the consumers will also tolerate their mistakes without affecting their image in the minds of consumers; if the customer thinks the image of the business is very poor, then occasional mistakes will have a great impact on the service quality perceived by customers. Furthermore, in this model, consumers' perception of service quality does not vary with the differences in the technical quality and functional quality of the merchants, it is only related to the difference between the services that consumers perceive and the services they expect (R. H. Wang, 2013).

In 1998 and 2000, Gronroos (2000) revised the model twice. Regarding the content point, the 2000 model has some novel changes compared to the 1984 model. This is mainly reflected in the new model, in which special attention is given to a corporate image, as shown in Figure

D-6.

Combining the two model diagrams, it can be seen that the expected quality is affected by many factors, including marketing communication, word of mouth, price, traditional concepts, and then affects the service quality through service experience. Marketing communication can be under the control of enterprises, but enterprises cannot directly control word of mouth and traditional ideas. If an enterprise carries out excessive or inappropriate publicity, it will make the enterprise's commitment to customers deviate from the actual operation of the enterprise. Even if the enterprise implements a quality improvement plan, such as improving functional quality, the quality of service perceived by customers may still be at a low level or even continue to decline. When the quality of the product purchased by the customer exceeds his previous expectation of product quality, the customer's perceived quality will be better; if the customer's expectation is higher than the customer's perceived quality, even if the product quality is good from an objective point of view, the customer's evaluation of perceived product quality is still low. The reason is that the customer's evaluation process of service quality is actually the result of comparing his actual feeling in the process of receiving the service with his psychological expectation before receiving the service. Commitment divorced from the actual business will undoubtedly lead to the widening of the gap between the actual feeling and psychological expectation, thus leading to the decline of the customer's perceived service quality. Therefore, the quality promotion plan should not only fully consider the operation status of the enterprise, but also consider the matching problem between external marketing and operation status. The two should be organically combined to avoid excessive or inappropriate publicity, which makes the enterprise fall into passivity in the evaluation of customer perception service quality (Z. S. Zhou, 2012).

2. PZB model

Scholars in the field of marketing in the United States have also achieved fruitful results in service quality evaluation. The most influential one is the service quality project founded by the American marketing agency. Parasuraman, Zeithaml and Berry (PZB) have jointly achieved a series of research results, the most cardinal is the typical service quality gap model proposed in 1985 (Parasuraman et al., 1985). With the emergence of this model, Gronroos' customer-perceived service quality is developed. According to this model, service quality is the gap formed between customer expectations and customer experience. And this "gap" is a synthesis of the other four gaps, as shown in Figure D-7.

In the figure, the five service quality gaps expressed by the service quality gap model are defined as follows:

Gap 1: The gap between customer expectations and manager's perception; the reason for this gap is that managers lack an understanding of how customers form their expectations. The formation of customer expectations is affected by corporate publicity, such as corporate advertising, public relations processing. It is also influenced by personal needs, service experience gained and reputation of business operations. To narrow this gap, relevant countermeasures include improving the level of market research, strengthening the communication between managers and customers; adjusting and reducing management links, so that managers can be closer to customers and better understand the customers' specific or potential service expectations.

Gap 2: The gap between the manager's perception and service quality specifications refers to the manager's failure to transform customer expectations into satisfactory service standards. This may be due to the manager's lack of understanding of meeting customer expectations, or fundamentally lack of cognition. The solution is to set clear goals and standardize operations to live up to customer expectations.

Gap 3: The gap between service quality specifications and service delivery; if employees lack work responsibility, or there are shortcomings in work skills, it is very possible that there will be a gap between service delivery and service standards. Business managers should use employee training, recruit some high-quality employees that meet the requirements, or redesign business processes to reduce the appearance of performance gaps.

Gap 4: The gap between service delivery and external communication; the reasons for this gap include the company's high commitment to the market, but the commitment level is not reached in the service delivery process; or the service commitment is appropriate and reasonable, however, employees in service delivery companies fail to understand the commitment well, and there is a phenomenon that the promise is out of touch with the delivery process.

Gap 5: The gap between customer service expectations and perceived service. This gap is the result of the comprehensive accumulation of the four gaps.

The PZB group revised the service quality model in 1993 (Parasuraman et al., 1993). Compared with the 1985 model, the revised service quality model includes the tolerance zone, and the concept of expectation is decomposed and refined. Several research conclusions of the revised model are: First, customer expectations are decomposed into two parts: ideal service and appropriate service. The variation is the customer's tolerance zone. Second, among the influencing factors expected by customers, some are controllable while some are uncontrollable. For example, the service promise is controllable, but the factors or random factors related to the

customer cannot be controlled. In 1994, the PZB group revised this model again to try to explain the relationship between customer perception of service quality and customer satisfaction, and attempted to theoretically explain the inner connection between these concepts (Parasuraman et al., 1994).

3. SERVQUAL method

The SERVQUAL (Service Quality) method is advanced by PZB on the premise of the service quality gap model (Parasuraman et al., 1988). Through investigation and analysis of five service industries, they summarized the factors that determine service quality. After subsequent integration, they finally determined five dimensions with good reliability and validity, and based on these five dimensions, a service quality measurement scale with 22 questions was developed, namely the SERVQUAL scale, which measures the gap between customer perception and expectations to evaluate and improve service quality. The model diagram of the determinants of service quality is shown as follows in Figure D-8.

The SERVQUAL scale divides service quality into five dimensions: tangibility, reliability, responsiveness, assurance, and empathy. The meanings are:

Tangibility: refers to the tangible carrier that provides services, including the appearance of tools, equipment, personnel, and environment.

Reliability: refers to the ability of an enterprise to accurately fulfill its service promises;

Responsiveness: refers to the willingness to actively help customers and provide services quickly;

Assurance: refers to the confident and credible knowledge, etiquette and ability expressed by employees;

Empathy: refers to putting oneself in the shoes of customers and paying special attention to customers.

In the subsequent practical application process, PZB adjusted and consummated the SERVQUAL scale in 1991, changing the negative sentences containing words such as “can not” and “not have” in the original scale to positive descriptions containing words such as “can” and “have”, and replacing 2 easily confusing questions in the original 22 questions (Parasuraman et al., 1991). These changes allow respondents to better understand that this is a questionnaire about the gap between expectations and perceptions. When evaluating the service quality of an enterprise, the service quality score can be obtained through questionnaire survey, customer evaluation scoring and comprehensive calculation of the collected questionnaires. The SERVQUAL score (SQ) = perceived score (PQ)-expected score (EQ):

1. SQ>0, means, PQ>EQ, indicating that the service effect experienced by the user exceeds

its expectation, and high-quality service is obtained;

2. SQ=0, that is, PQ=EQ, indicating that the service experienced by the user is in line with expectations, and the service quality is acceptable;

3. SQ<0, that is, PQ<EQ, indicating that the service felt by the user is lower than expected. At this time, the service quality cannot satisfy the customer.

There are weighted and unweighted measurement methods when calculating the SERVQUAL total score.

Since its inception, SERVQUAL has been adapted to measure service quality in a variety of settings including telecommunications, financial, education, healthcare, transportation services and other aspects of service sectors. Newman and Karin (2001) used SERVQUAL to measure the service quality of UK retail banks, which gives an observation on both practical and theoretical aspects of the implementation of SERVQUAL. Kang et al. (2002) measured the internal service quality in employees in a university in Korea using SERVQUAL, which contributes managerial and practical implications. SERVQUAL is used in assessment of information technology center service quality (Badri et al., 2005), certified accountant satisfaction (Pinho et al., 2007), the airline industry (Chau & Kao, 2009) and even customer equity (Rosenbaum & Wong, 2009).

In recent years, the SERVQUAL method of measuring service quality has been gradually applied in the telecommunications sector. S. H. Zhang (2010) surveyed a highly-developed communications service corporate in China using SERVQUAL and furthermore compared the discrepancy of satisfaction level between inner employees and customers. Alnsour et al. (2014) used SERVQUAL to evaluate the quality of provided services by a very high competitive telecommunication sector in Jordan which found that firms in the telecommunications sector require realizing the local customers' expectations in the light of the unique cultural traits of these customers. R. Li (2016) studied the service quality of the service center of a Chinese telecommunications operator based on SERVQUAL, which gave some managerial suggestions. Jadayil et al. (2020) used SERVQUAL to investigate the quality of provided wireless communication services in the UAE which proved the validity of SERVQUAL in a multi-cultural society.

4. SERVPERF method

The SERVQUAL scale has been widely applied in the service industry after it was put forward, but some scholars raised doubts, believing that there is a lack of reliability and validity in measuring service quality with gap scores, and direct measurement of performance is more reliable than gap scores and with higher validity. Cronin Jr and Taylor (1992) proposed that "a

performance-based measure of service quality may be an improved means of measuring the service quality construct." It is believed that by directly measuring the customers' actual perception of the service performance provided by the service provider, the performance of the service can be measured without comparison with the service expectations, because the measurement expectations may affect the customers' judgment. Therefore, they abandon the gap comparison method adopted by SERVQUAL, but only use performance perception as a variable, replace Q=P-E with Q=P, and evaluate the service quality level by directly measuring the actual perception of the service by customers. The difference between the two measurement methods is shown in Figure D-9 of Annex D.

Weighting is not preferred in the SERVPERF method in the measurement process. It is believed that unweighted ones can illustrate more changes in service quality. Its calculation formula is:

$$\mathbf{Q}=\frac{\mathbf{1}}{\mathbf{m}}\sum_{\mathbf{i=1}}^{\mathbf{m}}\overline{\mathbf{P}}_{\mathbf{i}} \tag{2.1}$$

Among them, Q is the customer's evaluation of the overall service quality; m is the number of items on the scale; $\overline{P}_i$ is the average value of the customer's perceived performance for the "Ith" item.

SERVPERF inherits SERVQUAL's division of service quality dimensions and the setting of measurement indicators. The definition of service quality and the interpretation of the connotation of each dimension are also exactly the same as SERVQUAL. There is no substantial discrepancy in the content design of the questionnaire. SERVQUAL has the same five dimensions and 22 questions. Because it does not measure service expectations, SERVPERF reduces the number of evaluation items from 44 to 22, thus cutting down the workload by half.

Through empirical analysis, Cronin Jr and Taylor (1992) believed that the SERVPERF method can explain more information than the SERVQUAL method, and the reliability together with the validity of analysis results are also superior. SERVPERF abandons the comparison between customer expectations and perceived performance, and performance is measured only, thus reducing the difficulty of responding to the interviewee, and simplifying the data processing duration, which is superior to SERVQUAL in terms of simplicity and practicability.

Since the academic circles have not yet reached a consensus on the merits of the three evaluation methods, the SERVQUAL scale is more universally applicable in terms of representativeness, generality and applicability. Hence, in this thesis, the evaluation system of the SERVQUAL will be referred with proper adjustment on its applicability, some evaluation

indicators will be added or deleted, and the scale based on the survey data will be streamlined to make the indicators in the scale more suitable for the evaluation of network service quality.

5. Other evaluation methods of service quality

Except for the above typical methods of evaluating service quality, there are still some other methods intended to give more approaches to service quality assessment.

Brogowicz et al. (1989) presented a synthetized service quality model, which aims at presenting the main dimensions of service quality in close relationship with managerial functions of planning, implementation and control in order to guide companies' efforts in elevating their services. An expectancy disconfirmation model was proposed which allows the customers to compare their perception of performance with their standard of expected performance (Droge, 1998). Lapierre et al. (1996) studied service quality evaluation by distinguishing between professional services and standard services. They claimed that for different service quality, different evaluating methods should be conducted. A quality model for workflow Quality of Service was developed by Cardoso et al. (2004) who developed methods to compute and predict QoS. The model consists of "task time", "task cost", "task fidelity", and "task reliability" and other quality dimensions of a workflow. In recent years, there are more methods that have been introduced into the service quality assessment work. Yeo et al. (2015) conducted partial least squares structural equation modeling (PLS-SEM) to confirm the port service quality dimensions and examine their relationship with customer satisfaction. And at the same year, a systematic review of multiple-criteria decision-making (MCDM) techniques used in the assessment of service quality was presented (Mardani et al., 2015).

2.4.2 Service quality management theory

2.4.2.1 Overview of service quality management theory

As a scientific method with strong practicality, quality management has been constantly evolving with the changes of quality concept and environment, and has now developed into a more mature independent science. There are numerous ways to divide the development stages of modern quality management, and the academic circles usually divide it into three stages: (1) The quality inspection stage (from the beginning of the 20th century to the 1930s), in which strict inspection serves as the main means to ensure the quality of processes and products; (2) Statistical quality control stage (from 1940s to 1950s), which refers to the formation of a statistical quality view in quality management and the use of mathematical statistics to prevent

substandard products; (3) Total quality management stage (from the 1960s to the present), focusing on the role of people in management, emphasizing the full participation of quality, all-round and full-process management. All quality-related subjects in the quality management practice are incorporated into the management system, highlighting the attention to demands of external consumers and providing tools for quality management to better adapt to the environment (You et al., 2014).

First, we need to define what quality management is and the factors correlated with quality management. According to a quality management book (Lester, 2014), quality management is defined as the aspect of overall quality functions that determines and implements the quality policy and it can be divided into two main areas: quality assurance and quality control. Back in 1997, Raghunathan et al. (1997) selected nine critical factors in quality management: quality leadership, supplier quality, strategic quality planning, information and analysis, human resources management, quality assurance, customer orientation, quality citizenship and quality results. Later on, a study of the manufacturing and service sectors in Taiwan proved that six of the nine factors mentioned by Rao et al are efficient (Solis et al., 1998). Ferguson et al. (1999) divided the service management into technical and functional aspects, the first aspect of which is defined as the visible or physical tangibles used or experienced by the customer during the service delivery process and the second aspect of which is how the customer experienced the human interactions during the simultaneous production and consumption of the service.

How to manage the service quality becomes more important after giving the definitions. Beaumont et al. (1997) defined quality management practice as the collection of techniques, practices, policies and procedures that are simple to implement and beneficial. Ferguson et al. (1999) proposed that attention should be paid to both technical and functional aspects of service management. The technical and functional aspects of services quality and their relation to service management effectiveness, were found to be different between the core and supplementary services, between customers and service personnel and between customers with and without experience. Research (Hsu & Su, 2002) in 2002 emphasized the importance of data-driving decision-making during the quality managing process by employing statistical methods and advanced technologies to further data analysis and applications.

Into the 21st century, more attention (Weiseke et al., 2010) is paid to the organizational service systems and the employees. Employee-centered practices, organizational support strategies, empowerment strategies, and organizational identification strategies are emphasized in some tested models.

There are researches (Schneider et al., 1998) describing that service quality is the outcome

of internal organizational policies and practices and the organizational support to employees foster the service quality. Ashill et al. (2008) mentioned that by providing supportive management, servant leadership and service technology support, companies can show their efforts of enhancing service quality. Kumar and Telang (2011) proposed the importance of organizational service strategies like innovating, managing and optimizing service systems. Except for the organizational factors, the employees' factors have been more popularly studied. Goldstein (2010) mentioned that employee development has the function of managing service quality. Employee service training is a systematic, formal process of attempting to develop employees' customer service knowledge, skills and abilities (Davis & Davis, 1998) and the training has been shown to improve service delivery and prevent service failure (Boshoff & Leong, 1998). Empowerment to employees also shows a positive effect on service quality which enhances the job satisfaction (Eylon & Bamberger, 2000) and work motivation of employees (Seibert et al., 2004).

2.4.2.2 Classic service quality management methods

Undergone different development stages of quality management, far-reaching quality management methods and systems have emerged. This thesis will introduce four classic quality management methods: ISO9001 quality management system and process, Plan-Do-Check-Act (PDCA) cycle and process method, total quality management method, and fish bone analysis method.

1. ISO9001 Quality Management System and Process

In 1979, ISO established the Quality Management and Quality Assurance Technical Committee (TC/176), which is responsible for formulating quality management and quality assurance standards. In 1987, ISO/TC176 issued a series of globally recognized and unified international standards on quality management and quality assurance, ISO9000 standards for the first time across the globe. These standards summarize the practical experience of quality management in advanced enterprises in industrial developed countries, unify the terminology of quality management and quality assurance, and have been widely concerned and adopted by countries the world over (ISO, 1987).

ISO9001 quality management system is the audit standard of certification bodies and is widely adopted by various industries. Hundreds of thousands of industrial enterprises, service organizations, educational institutions, government agencies and other organizations around the world have introduced ISO9001 and passed the certification audit. T. Xiao (2013) believed that at present, whether an enterprise has obtained the ISO9001 certification has become a mark to

measure whether an enterprise's management level is standardized.

As shown in Figure D-10, the core of ISO9001 operation is to balance the relationship between customers and enterprises based on the process. The way to achieve this is to take the requirements of customers and related parties as standard input, and enterprises consider this as the goal and manage the system to improve production. When the products meet the requirements, customers and related parties are satisfied (Chen, 2014). The requirements of the ISO9001 quality management system emphasize the foundation of the process. The method shown in Figure D-10 includes the processes required by the company to identify, implement, manage and continuously improve the quality management system, the interaction of these processes realizes the overall management process of the company's objectives.

The process of determining the service quality management system is the basis for establishing the quality management system, as shown in Figure D-11. The construction of a service quality management system generally includes five stages: the first stage is the planning phase of quality management, which is mainly to unify the mental preparations of the superior and the subordinates, and make various training preparations; the second phase is the overall design stage of the quality system, including the formulation of goals and plans; the third phase is the establishment of the quality system, through investigation and evaluation to formulate the system structure; the fourth phase is the preparation of the quality system documents, of which the purpose is to establish the organizational structure of the personnel in the system and the authority setting; the fifth phase is the implementation and operation stage of the quality system, including specific implementation modules such as evaluation, implementation, and inspection. The practice has proved that after the normal operation of the five stages, internal audits, management reviews and other means are still essential to maintain and improve the normal operation of the system (L. Xiao & Liu, 2010; Hong et al., 2012).

In the design of the service quality control system in this thesis, the standardization process of service quality is considered based on the design idea of ISO9001. It is proposed to improve service requirements by understanding the changes in customer needs, taking standardized processes and phased service requirements as unified service specifications, and providing customers with a service process that meets their demands (Zhao et al., 2010). At the same time, as a feasible operating system, the service quality management and control system must implement relevant standards and requirements in the process of planning, design, establishment, preparation and operation.

2. PDCA Cycle and Process Method

The PDCA cycle, also known as Deming Circle, evolved from the PDS, Plan Do See, first

projected by Shewhat, known as the father of quality statistical control in the United States, and evolved it into the PDCA model by Dr. Deming, an American quality management expert (Shewhart & Deming, 1986). The main process of the PDCA cycle is the whole process of formulating the goal plan and organizing the realization, and the emphasis is on the cycle operation activities. The application of PDCA starts from production management (Deming, 1950). In China, the PDCA cycle is widely utilized in the performance evaluation system and quality improvement control of the medical industry. It can be applied in advanced strategic processes such as quality management system planning and management review, and it can be employed in a simple process such as the product realization process. In actual use, it is closely related to the process planning, implementation, inspection and continuous improvement of product realization and service management. Scholar S. M. Cao and Du (2008) concluded by summarizing the experience of multiple industries that PDCA is suitable for various management activities because of its rigorous operating procedures, diverse management levels, simple management methods, and outstanding management effects.

The PDCA model can be briefly described as follows: (1) P (Plan), formulate plans, guidelines, and goals, and synchronically determine the activity plan at this stage; (2) D (Do), implement, do it on the spot, and complete the activity plan (3) C (Check), check, aiming at the goal setting, check the effect of the activity output; (4) A (Act), which is the action of analyzing the results of the check, getting the effect and unresolved problems, affirming the successful experience and promoting and standardizing. For the unfinished part, enter the next PDCA cycle and continue to promote. Without standardization and institutionalization, it is impossible to make the PDCA cycle move forward (X. Liu et al., 2012).

The above-mentioned working procedures can be embodied in 8 steps, as shown in Figure D-12.

Step1: Analyze the status quo and find out the existing quality problems;

Step2: Analyze and find out the various reasons that cause the current bad situation;

Step3: Find out the main factors affecting the quality among various reasons;

Step4: Propose countermeasures and specific measures for the main factors;

Step5: Implement the established countermeasures and measures;

Step6: Check the gap between the implementation result and the target;

Step7: Summarize the implementation effects and lessons learned to form rules and regulations, and consolidate the staged results;

Step8: Transfer the unresolved issues to the next PDCA cycle to continue processing and improving, so as to continuously improve the management effect.

PDCA is a cyclic and iterative process as shown in Figure D-13 of Annex D. It has the following characteristics.

(1)The PDCA cycle is a spiraling process, each cycle is a stage, and the above eight steps are repeated in each stage, as the figure shows. The PDCA cycle is spiraling. In each cycle, part of the existing problems is solved, and phased results are obtained, and then the unresolved problems are entered into the cycle of the next promotion stage and improved again. Such repetitions have enabled organizations to implement PDCA to achieve management improvements, with stricter target-setting standards and better products. This is the main purpose of the PDCA cycle to achieve a spiral.

(2) The key to the success of the PDCA cycle is to obtain new results and form standards after analyzing and collating the inspection data, and at the same time extract new goals from the unfinished parts.

(3) Compared with the service quality management process, the PDCA cycle pays more attention to the comparison of goals and results, in order to find defects and make further improvements. Based on the study of the above theories, this thesis proposes the design of a service quality control system. Combining with the balance of interest among customers, contractors and telecommunications operators proposed by ISO9002, the goal is to achieve overall management in the service standard requirements and service standard outputs (ISO, 1994). Concurrently, combined with the relevant theories of service process management, standardized processes and phased service requirements are regarded as unified service specifications to ensure the feasibility and effectiveness of the implementation of the service quality control system.

3. Total Quality Management

In 1961, the quality management master Feigenbaum first put forward the concept of “total quality management” in his classic book Total Quality Management (Feigenbaum, 2002): “Total quality management is to be able to fully satisfy users at the most economical level. Market research, design, production and service are carried out under the required conditions, and the activities of various departments in the enterprise to develop quality, maintain quality and improve quality constitute an effective system.” Oakland (1993) believed that total quality management is an attempt to improve the competitiveness, effectiveness and structure of the entire enterprise. Besterfield et al. (2011) explained this concept by interpreting each letter of total quality management (TQM). “T” means “total”, which refers to full participation, “Q” means “quality”, which represents the degree of excellence regarding product and service quality, “M” or “management” refers to the art of processing, controlling, leading, and planning.

In general, total quality management is an art that aims at excellent quality and integrates the efforts of all employees in the enterprise. Some quality management experts, such as Juran (1974), Crosby (1980), Feigenbaum (1983), and Ishikawa (1990), from different angles, have studied the subject of total quality management. They have also given definitions or provided some temporary tools for quality management.

Furthermore, Dahlgaard-Park (2009) discussed how to use TQM and other concepts to build the necessary corporate culture for success. Cua et al. (2001) demonstrated the compatibility and effect of TQM and total productive maintenance in joint implementation.

Generally speaking, total quality management focuses on the role of people in management, emphasizes full participation in quality, all-round and full-process management, incorporates all quality-related subjects in the quality management practice into the management system, highlighting the attention to the needs of external consumers and providing tools for quality management to better adapt to the environment.

4. Fishbone analysis

Fishbone analysis, also known as causal analysis, is an analytical method of finding the "root causes' of problems.

The Fishbone analysis method is developed by Japanese management guru Ishikawa Hiro and is also known as Ishikawa Diagram. Fishbone is a way to find the "root cause" of a problem, which can also be called a "causal map."

Fishbone diagram is mainly used in business management to establish the analysis model. The characteristics of the problem being studied are always influenced by a number of factors. By brainstorming these factors, they are clearly organized with the characteristic values and are organized according to their interrelatedness. Because their shapes resemble fishbones, they are called fishbone maps as Figure D-14 showing. Ishikawa (1990) believed that, like other implements, cause and effect diagrams are tools that help people or quality management teams make quality improvement. Because of this, he advocated that open panel discussions are as important as drawing charts. Ishikawa diagrams are useful as system tools. They can be used to find, select, and record the causes of quality changes in production. They can also make the correlation between them systematically. It is an analytical method of seeing through the appearance to the essence. Ishikawa (1990) also proposed the process of drawing a fishbone diagram: determine the main feature to be analyzed (the result of a certain production process) as the fish head; classify the reasons to be analyzed into several major categories (main reasons), continue to analyze the secondary reasons on the basis; afterwards, record and sort all the reasons obtained from the analysis. A classification of the main reasons may be raw materials,

equipment, processes, personnel, environmental conditions, and measurement methods. Other division methods can also be used. The classification method of main causes is not unique, which is determined by the decision-maker according to the actual situation. The principle is conducive to the determination of causes or the solution of problems.

In recent years, as the concept of quality management control has gradually expanded from industry to other fields, fishbone diagram analysis has been used as a highly applicable system to identify causes and has been given full play in education, medical treatment, chemical analysis, and network quality evaluation of telecommunications services. For various reasons of the analyzed problems, the fishbone diagram provides a comprehensive and clear analysis framework, laying a logical analysis foundation for further quantitative analysis.

2.5 Review of others' related theories

2.5.1 Customer satisfaction

Customer satisfaction, also known as the customer satisfaction index, is a relative concept of the matching degree of customer expectations and customer experience.

Customer satisfaction research rose in the 1970s, and the earliest literature can date back to An Experimental Study of Customer Effort, Expectation, and Satisfaction published by Cardozo in 1965 (Cardozo, 1965). Early studies have taken up a lot of sociology, psychology theory, until now, most of the theories are still founded on cognitive theory as the theoretical basis. At present, customer satisfaction research in Europe and the United States has become increasingly mature.

In 1987, the US government set up the Malcolm Baldrige National Quality Award to encourage "customer satisfaction". In 1989, Sweden established a national user satisfaction index evaluation system. The American Quality Association (ASQ) started to study how to evaluate customer satisfaction from the 1990s and in 1994 began to build a nationwide, cross-industry and general index, American Customer Satisfaction Index (Angelova & Zekiri, 2011).

Customer Satisfaction (CS) is the inevitable result of the change of enterprise management concept, from "output-centered theory" to "sales-centered theory", to "profit -centered theory", then to "market-centered theory", "customer-centered theory", and then to the "customer-satisfaction-centered stage". Customer satisfaction is active and forward-looking.

Scholars' perceptions of customer satisfaction mostly revolve around the "expectation – difference" paradigm. The basic connotation of this paradigm is forming a reference point for

the comparison and judgment of products and services revolving customer expectations. Westbrook and Reilly (1983) argued that customer satisfaction is an emotional reaction that accompanies or is in the process of buying. Tse and Witon (1988) argued that customer satisfaction is the evaluation of the difference between the expected quality of products before purchase and the perceived quality after consumption. Thus, satisfaction is the pleasure or disappointment of a person's ability to form a perceived effect (or result) of a product compared to his desired value. When the actual consumption of goods achieves consumer expectations, it will lead to satisfaction, otherwise, customer dissatisfaction. Customer satisfaction is the degree to which the customer's expectations for products or services match the actual perceptions.

Customer satisfaction reflects how much the consumer's original expectations are satisfied, and customers refer to the units or individuals that purchase or use products and services, which can be called consumers, users or clients. The quality of customer satisfaction comes mainly from the comparison of the real experience in the actual use of the product or service and the expectations before use. User complaints come mainly from the actual experience of perception and their expectations of larger differences, and when the actual experience is much greater than their own expectations, the user will be surprised and become loyal customers.

Customer satisfaction level has become the core issue of enterprise management. Successful companies enhance customer satisfaction through a variety of practical activities. The use of a variety of ways is to evaluate the level of customer satisfaction and assess the level of corporate management.

2.5.2 Customer satisfaction evaluation model

1. Comparative analysis of satisfaction index model

(1) Swedish customer satisfaction index model

Fornell presented the Swedish Customer Satisfaction Index (the Swedish Customer Satisfaction Barometer [SCSB]) in 1992. The Swedish model SCSB contains five elements: Perceived Performance, Customer Expectation Quality, Customer Satisfaction, Customer Complaint and Customer Loyalty (Fornell, 1992).

(2) American Customer Satisfaction Index (ACSI) model

The American customer satisfaction index (ACSI), created by the National Quality Research Center of the University of Michigan Business School, which is based on the SCSB model, is one of the most popular models since it first appeared in the United States in 1994. The model is founded on the process of product and service consumption, forming a comprehensive evaluation index of customer satisfaction level. Compared with SCSB, this

model divides the user-perceived quality into two factors: quality perception and value perception. Value perception, as a latent variable, enables the customer satisfaction index to be compared with different departments, enterprises and industries.

The ACSI model includes six elements: Perceived Performance, Customer Expectation, Value Perception, Customer Satisfaction, Customer Complaint and Customer Loyalty. Customer loyalty is reflected in the long-term ownership of products or services, repeated purchase and recommendations to others and other acts, in the model, the price changes will have a greater impact on customer loyalty (C. Zhu, 2019).

(3) European Customer Satisfaction Index (ECSI) model

The European Customer Satisfaction Index (ECSI), which has been modified on the basis of the fundamental architecture and core concept of the ACSI model, has reduced customer complaints and added the corporate image (C. Zhu, 2019).

(4) China Customer Satisfaction Index evaluation basic model

The China Customer Satisfaction Index (CCSI) takes users as the main body of quality evaluation and user needs as the quality evaluation standard. According to the research conclusions of consumer behavior and marketing, CCSI forms a strict model from seven indicators: expected quality, perceived product quality, perceived service quality, perceived value, user satisfaction, complaint and user loyalty (C. Zhu, 2019).

2. Satisfaction index model factor analysis

(1) Customer expectation: Customer expectation is a comprehensive estimate of the program capability and the level of service achieved by the customer prior to participating in the purchase and use of the product and service and for the product or service provider to be able to solve the problem or provide a solution to the problem. Customer expectations can be guided and measured. Customer expectations have a great relationship with customers' perception of existing products and services. Users will continue to use products and services to adjust their expectations slightly higher than the current perception level.

(2) Quality perception, also known as customer service experience, is the overall experience of customers on all aspects of products and services after using or consuming products and services.

(3) Value perception generally refers to the overall evaluation of the utility of products or services after weighing the perceived gains of customers and the costs they pay in obtaining products or services. Some users are price-sensitive users, they are more concerned about the price, and some users are quality-sensitive users, they are more concerned about the quality of service. Therefore, for two different types of users, the indicators can be improved by

preferential prices and improved quality.

(4) Customer satisfaction is affected by the gap between actual feeling and expected quality, the gap between actual feeling and ideal product, and overall satisfaction. High satisfaction will make consumers loyal to the enterprise brand, so customer satisfaction will rise to customer loyalty.

(5) Customer complaints refer to the customers' dissatisfaction and censure of products or services, including formal or informal complaints. It also refers to the specific behavior of the customer when they are dissatisfied, including the customers' malicious complaints. On the one hand, the customers complain that they are still hopeful about the product, on the other hand, through complaints and other acts, they want to obtain compensation. The higher the degree of customer dissatisfaction is, the probability of complaints and the number will increase, and repeated complaints will reduce the follow-up complaints threshold.

(6) Customer loyalty is the final dependent variable of the model which expresses the willingness of the customer to buy again and recommend others. It mainly includes the customer's emotional loyalty, behavioral loyalty and awareness of loyalty. Among them, emotional loyalty is manifested in the customer's high recognition and satisfaction with brand culture, social responsibility and image; Behavioral loyalty is manifested in the customer's repeated purchase and recommendation behavior; Awareness of loyalty is the expression of the customer's specific consumption intention. Customer complaints are negatively correlated with customer loyalty. Enterprises can analyze the level of customer loyalty and control the impact of price adjustment. Users with high loyalty are often price -insensitive.

(7) Corporate image is the general impression that companies make on users or the public through a wide range of behaviors and measures to shape various product features, personnel styles, corporate ideas and other contents.

Based on the discussion of the above documents, this thesis considers that the SERVQUAL evaluation model proposed by Parasuraman, Zeithmal and Berry scholars is more complete and applicable, and is still the most commonly-used framework and method in the related QoS research. Hence, this thesis will evaluate the network service quality of MC company based on the SERVQUAL evaluation model proposed by three scholars as Parasuraman, Zeithmal and Berry.

Perceived service quality is a subjective concept expressed through a set of scales, which shows five dimensions in the evaluation system. With the development of the service, the question has been raised that people with different tendencies, needs or cultural backgrounds may perceive different levels of quality. Consequently, it can be considered that in different

situations, the dimension of service quality may increase or decrease and the dimension should be selected according to varied applications.

In this thesis, the dimension of the SERVQUAL evaluation system will be improved to adapt to the new situation by analyzing the impact of the service remediation on the perceived service.

Chapter 3: Network Service Quality Evaluation System Design Based on SERVQUAL

3.1 Network service quality evaluation process based on SERVQUAL

In the literature review in the previous chapter, the models and methods of service quality evaluation were discussed, including Gronroos customer perception model (Gronroos, 1983), PZB gap model (Parasuraman et al., 1985), SERVQUAL method (Parasuraman et al., 1988), and SERVPERF method (Cronin Jr & Taylor, 1992). These methods are in the same system, and are almost used for analysis based on the gap between customer perception and customer expectations. The academic community has not yet reached a consensus on the pros and cons of the four evaluation methods. Through the following analysis, the author believes that the three models of Gronroos customer perception model, PZB gap model and SERVPERF method are not suitable for this study:

1. In the Gronroos customer perception model, the customer service experience is determined by the functional quality and technical quality under the filtering of corporate image. This underlying logical analysis is not suitable for highly intangible objects, for example, network services. It is difficult to accurately quantify the factors such as corporate image, technical quality, and functional quality used in the model in network service quality.

2. In the PZB model, the gap between customer expectations and perceived services is deconstructed into the gap between customer expectations and manager's perception, the gap between manager's perception and service quality specifications, the gap between service quality specifications and service delivery, and the gap between service delivery and external communication. However, it is challenging to obtain or measure these four gaps in the research of network services.

3. In the SERVPERF model, to measure and improve the reliability and validity, the gap comparison method is directly abandoned, and the service quality is treated as identical to the customer's perception of service performance. The author believes that this method defines service quality too absolutely, and ignores the objective reality factors of service quality and customer psychological expectations. besides, the SERVPERF method does not weigh the service dimensions measured by the scale, and it also ignores the factors that customers attach

divergent importance to different services.

From this point of view, the SERVQUAL method is more suitable for the study of network service quality in terms of representativeness, generality, measurability and interpretability. For good measure, in the SERVQUAL method, the dimensions and specific indicators of the network service quality are determined by using the scale, which is also beneficial to answer the questions raised at the beginning of this thesis. Therefore, this study will draw on the evaluation system of the SERVQUAL scale and adjust its applicability. The specific scale indicators will be designed based on the actual conditions of network service quality, and a questionnaire will be formed based on the design of the SERVQUAL scale.

For the sample collected by the questionnaire, the research needs to test its representativeness, namely, whether the survey sample can represent the population. The question that arises from this is whether the research conclusions of the sample application to the overall network service quality evaluation. Thus, the study introduces sample feature analysis, reliability test and validity test to prove the accuracy, reliability and stability of the sample results. While analyzing the characteristics of the samples, it will also answer a research question about current status analysis, namely, “what the current status of network service quality evaluation is?”

In the exploration of the SERVQUAL method in the previous chapter, there are two calculation methods: unweighted and weighted. The disparity is that the five dimensions of unweighted service quality are equally important to customers. The weighted service quality dimensions are assigned different weights according to the degree of importance that the customer attaches to each dimension of service quality. In real life, people should value different quality dimensions differently. Therefore, this research will focus on exploring the weighted SERVQUAL calculation method and analyze the gap between network service quality indicators on the basis of it.

To answer the research questions of “what factors may influence the network service quality evaluation results?” and “how can the management level of network service quality be improved based on the influencing factors?” On the basis of SERVQUAL analysis, the IPA (Importance-Performance Analysis) method is introduced to analyze the importance and performance of each dimension of network service quality and each specific indicator, so as to explore the impact of each dimension and specific indicator on the evaluation of network service quality, and the measures that mobile operators need to take.

Derived from the above network service quality evaluation process, the following evaluation flowchart in Figure 3.1 can be drawn.

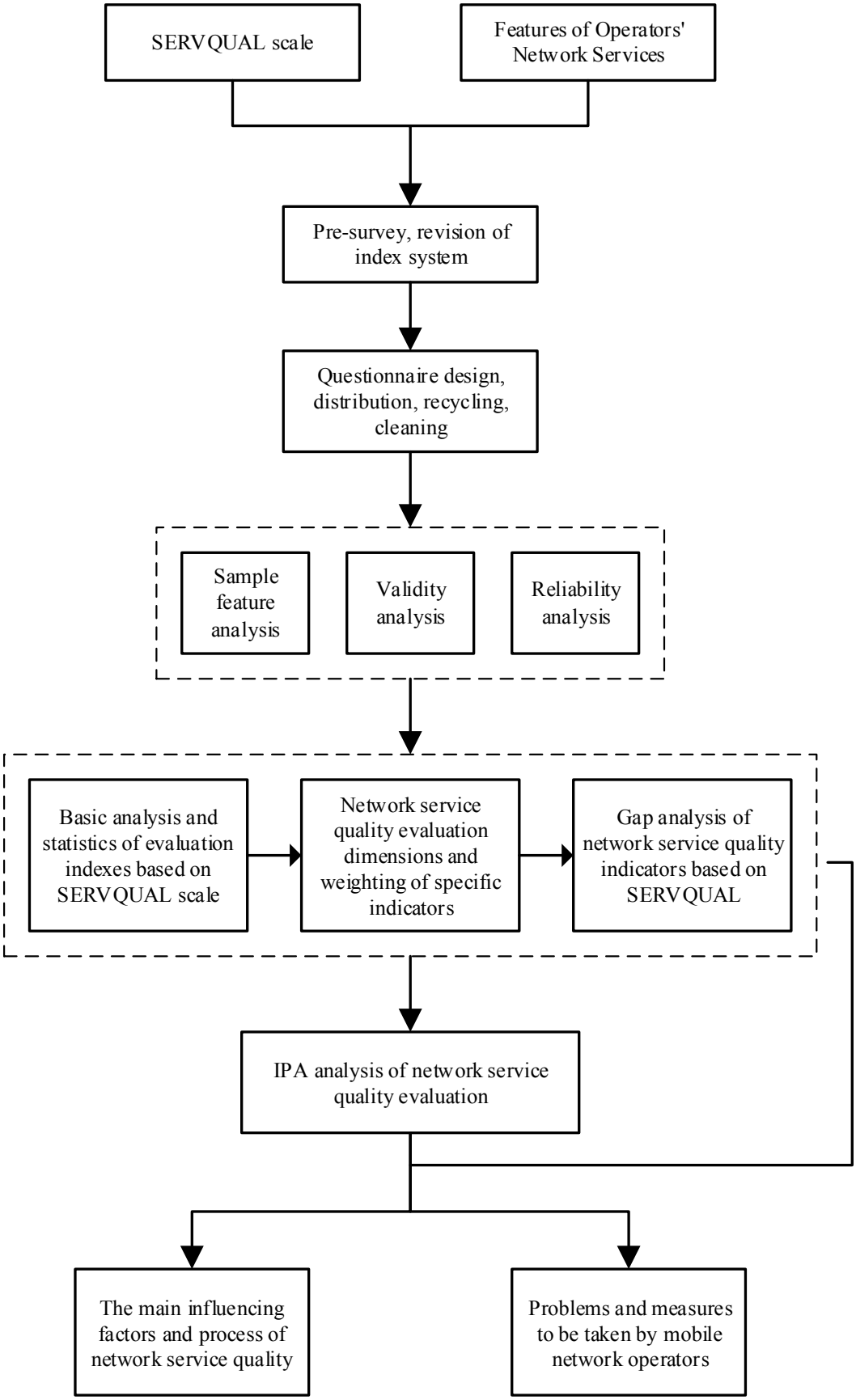

Figure 3.1 Flow chart of network service quality evaluation

Source: elaborated by the author

3.2 Model introduction based on SERVQUAL scale

SERVQUAL stands for “Service Quality”. It is a service quality evaluation model developed founded on TQM (Total Quality Management) theory. It was proposed by PZB (Parasuraman, Zeithaml and Berry) in 1988. This theory believes that service quality is determined by the difference between the actual service level perceived by users and the expected service level of users. It has been widely recognized in complex and diverse service quality evaluation methods, and has been applied in quality measurement and management research in service industries.

3.2.1 Introduction to SERVQUAL scale indicators

The service quality dimension in the SERVQUAL scale is developed on the premise of the PZB service quality gap model constructed by Parasuraman, Zeithaml, and Berry in 1985. The PZB model puts forward 10 factors for customer perception of service quality and 5 gaps in the service that make customers dissatisfied with service quality.

In 1988, based on the service quality gap model, PZB revised 10 factors that affect customers’ perception of service quality into empathy, responsiveness, tangibility, assurance and reliability, and proposed the SERVQUAL service quality evaluation system. The five dimensions of the SERVQUAL scale are explained as follows:

1. Tangibility refers to the visible part of the service provision process. Although the service is an intangible process and behavior, the tangible entity that provides the service also reflects the importance of the user such as the equipment of the service and the clothing and appearance of the service provider, and places where services are provided.

2. Reliability refers to the accuracy and trustworthiness of the company’s performance of the promised services, such as the company’s ability to complete the promised items and accurately provide services. Before the actual service is provided, the company’s service promise will affect the user’s psychological expectations. Whether the service promise can be completed reliably and accurately will affect whether the user’s expected effect is met. If the user does not get the service effect promised by the company in practice, the perceived service quality is far from the expected quality, indicating that the service needs improvement.

3. Responsiveness refers to the response speed of service personnel who can proactively help customers and provide services, such as providing timely service and clarifying the exact time to complete the service. In the process of serving customers, if service personnel show a negative state or are too busy to provide services immediately, it will increase customers’

waiting time and affect their moods. Service personnel's failure to determine the service time or delay in service time will also reduce the service quality.

4. Assurance refers to the professional attainments of service personnel and the politeness and credibility embodied in the service. Service personnel are required to be familiar with business knowledge, be able to solve problems for customers, be polite and have strong communication skills in the service process, so that clients have a sense of trust.

5. Empathy refers to the ability to put customers in their own position and provide tailored and personalized services to wide customers. Customers are very diversified with their own ideas and specific needs. If a company wants to improve service quality, it must start from the customer's point of view and be considerate of the customer.

According to the SERVQUAL scale method, a questionnaire is designed to evaluate service quality to measure the above five dimensions. In the questionnaire, there are several statements in each dimension, and the interviewee needs to evaluate the service expectations and actual perceptions of each statement. The service quality score is obtained by calculating the difference between service perception and service expectation in the questionnaire. The scale of this study is designed based on the following SERVQUAL scale (Parasuraman et al., 1988) shown in Table 3.1 and combined with the characteristics of network service quality.

Table 3.1 SERVQUAL scale

Dimension	Item
Tangibility	The company has modern facilities
	The company's appearance equipment is attractive
	Company employees are neatly dressed
	Company equipment and service are as promised
Reliability	The company can timely fulfill the commitment
	The company guarantees to solve customer problems
	The company is reliable
	The company provides appropriate services within the promised time
	Company records are accurate
Responsiveness	The company informs the service time
	Company employees can provide equivalent services
	Company employees are always willing to help customers
	Company employees will not fail to provide services to customers because they are busy
Assurance	Company employees are trustworthy
	Customers and company employees feel safe to communicate
	Company employees are polite
	The company provides appropriate support to employees
Empathy	The company provides customers with personalized services
	Company employees provide special care to customers
	Company employees understand customer needs
	Company employees put customer interests first
	Company service time can meet customer requirements

Source: Parasuraman et al. (1988)

3.2.2 Statistical methods of SERVQUAL scale

1. SERVQUAL service quality measurement method

The measurement methods of SERVQUAL service quality mainly contain gap analysis method, linear regression method and joint analysis method. The common drawback is that the customer's subjectivity in the questionnaire results is strong. PZB has repeatedly studied the gap analysis method, improved the method, and proposed the weighted gap analysis method. The calculation is relatively simple, the results are intuitive and easy to understand, and the importance of each attribute can be evaluated.

This thesis mainly makes use of the gap analysis method to measure service quality, so the linear regression method and the joint analysis method are not duplicated. The calculation method of the gap analysis method is as follows:

Through the questionnaire survey, the user's actual perception and expectations of each service are obtained, and the difference between the two can be calculated to obtain the SERVQUAL score, which is utilized to measure the service quality. The measurement methods are divided into two types: weighted and unweighted:

(1) Unweighted SERVQUAL evaluation method

Since customers' actual perceptions and expectations of service quality are often different, there will be a gap when evaluating the expectations and perceptions of the same item. This gap can be used as a basis for measuring the level of service quality and expressed by the following formula:

$$Q=\frac{1}{m}\sum_{i=1}^{m}(\overline{P}_i-\overline{E}_i) \tag{3.1}$$

Among them, Q is the customer's evaluation of the overall service quality; $\overline{P}_i$ is the average value of customer's perceived performance for the ith item, $\overline{E}_i$ is the average value of customer expectation for the ith item, and m is the number of items on the scale.

(2) Weighted SERVQUAL evaluation method

The implicit assumption of the unweighted SERVQUAL formula is that the five dimensions of service quality are of the same importance to customers, and there is no more important situation. But in real life, customers have all kinds of views on the importance of each dimension that determines service quality. Therefore, when evaluating service quality, distinct weights can be assigned to different dimensions by weighting, so as to illustrate the benchmark for customers to evaluate service quality, and then calculate the quantitative value of service quality. The calculation formula is:

$$Q=\sum_{j=1}^{n} W_j \frac{1}{m} \sum_{i=1}^{m} (\overline{P}_i - \overline{E}_i) \quad (3.2)$$

Among them, Q is the customer's evaluation of the overall service quality; $\overline{P}_i$ is the average value of customer's perceived performance for the ith item, $\overline{E}_i$ is the average value of the customer's expectation for the ith item, and m is the number of items in the table, n is the number of service quality dimensions, and W_j is the weight of the jth service quality dimension.

The SERVQUAL evaluation method is completely modelled by customer perception. Whether in a weighted or unweighted formula, when Q>0, it indicates that the actual service quality perceived by the customer exceeds the expected service level, and the service quality level provided by the enterprise is considered to be better. The customer feels very satisfied; when Q=0, it indicates that the customer's actual perceived service level is equal to the expected service level, and the customer feels basically satisfied; when Q<0, it indicates that the customer's actual perception is less than the expected service level. If a customer feels unsatisfied, it is a dangerous multiplying sign for the enterprise.

From the evaluation data, it is necessary to analyze from the evaluation data where the services provided are still short of the customer's expected level, so as to make up for and improve them.

2. Weighting method

The weight determination methods in the current comprehensive evaluation include principal component analysis method, expert consultation method, analytic hierarchy process and product scaling method, which can be summarized into subjective and objective weighting methods. The subjective weighting method is that the evaluator assigns weights artificially based on the importance of the indicators, which fully reflects the expert's experience. The expert consultation method and the analytic hierarchy process are subjective weighting methods; the objective weighting method refers to the use of objective information reflected by the indicator value to determine the weight based on actual data. Hence, the factor analysis method and the principal component analysis method are all objective weighting methods.

The analytic hierarchy process can realize the transformation from qualitative to quantitative, and systematize and hierarchize complex problems. In application, it is first necessary to clarify the final problem to be solved, and then establish a hierarchical analysis structure model including the combination and sorting of the highest layer, the middle layer and the lowest layer. Its information is mainly based on people's judgments about the relative importance of the factors in each layer.

The principal component analysis is to use the idea of dimensionality reduction, with the help of orthogonal transformation, to transform the original multiple related variables into a few new unrelated variables. Using principal component analysis can reduce the number of evaluation indicators. In actual research, the first principal component can best reflect the difference between data and the amount of information extracted is the largest. Hence, the first principal component is often utilized as a comprehensive evaluation of multiple indicators.

These methods weight indicators from different perspectives, but they all have their own limitations and certain scope of application.

The product scaling method is a more flexible weighting method founded on the analytic hierarchy process. It starts from the inherent and objective importance of the evaluation index, and uses the measured data as the basis to compare the indexes in pairs to scale their importance. The scales of indicators with the "same" importance are all set to 1, the scales of indicators with "slightly greater" importance are set to 1.354, and the scales of indicators with "slightly greater" importance than "slightly greater" are set to 1.354×1.354, and the rest can be done in the same manner (J. L. Zhang & Wu, 2003). The product scale of an indicator is taken as a weight number, and the weight of an indicator can be obtained by dividing the product scale of the indicator by the sum of all the indicators.

This thesis employs the product scaling method to assign weights to the indicators.

3.2.3 Evaluation of SERVQUAL scale

The gap between a service company and similar companies at a certain point in time can be acquired through combining the SERVQUAL model with other evaluation methods, thereby providing guidance for companies to improve decision-making. Moreover, the SERVQUAL method can also be used to specifically measure the level of each dimension, and locate the dimension that has a more significant impact on the customer's perceived service, which can help companies identify problems so that they can take precise improvement measures. Research on different customer groups can reflect the differences in the perception of service quality among consumers with different characteristics and help companies optimize services.

The SERVQUAL scale is widely accepted and authoritative in measuring service quality, and is attractive in practice due to its dimensions and operability in scoring. However, with the development of the social economy, services are constantly changing, so the dimensions and indicators of the SERVQUAL scale should be selected and supplemented in a targeted manner.

3.3 Construction of index system based on SERVQUAL scale

3.3.1 Features of operators' network services

The SERVQUAL model is a dynamic service quality evaluation system. In the light of the features of distinct industries, it is necessary to adjust the questions in the scale to ensure the accuracy and scientificity of the evaluation results.

In line with the author's experience in the network service industry for many years and by referring to relevant literature, the author concludes that, in addition to the basic characteristics of the service, network services have other characteristics as follows:

1. Remediation

Service remediation is a kind of proactive and forward-looking compensatory function and activity that the service provider adopts to improve service quality, recover customer satisfaction and reduce the loss of the customers. Network service involves an extremely wide range and can be offered to everyone, which leads to a high probability of customer complaints. Hence, service remediation is particularly important. Operators usually establish a network service mechanism to remedy the services, solve customer complaints, and learn from these to improve service quality (Y. Gao, 2009).

2. Extensiveness

With the development of the social economy, network devices such as smart phones and computers have become popular, and broadband services in homes and business areas, and personal data traffic have all stimulated the demand for network services. Besides, the purchase behavior of consumers is controlled by individuals, and everyone can purchase network services. As a result, the network service market of operators presents the characteristics of extensiveness and decentralization.

3. Scalability

Consumers' purchases of network services are affected by factors such as lifestyle, income, and macroeconomic conditions, and therefore exhibit certain scalability characteristics.

When consumers suddenly change a job that requires frequent travel, their demand for mobile traffic may increase; or when consumer income rises, it may increase consumption of network services.

4. Substitution

Currently, network service operators have achieved full-service operations, and the product

differentiation between competitors is small, so it shows alternative characteristics. Coupled with the low cost of switching operators, consumers can easily move between different brands of network services (J. H. Xie, 2017).

5. Demand diversity

Due to the wide and decentralized customer groups of network services, the demands are also diverse. Consumers have various education levels, lifestyles, economic levels, and geographic regions, so they have different demands for network services. Network service operators need to understand the market situation and provide various network packages for different consumer groups (W. J. Wang, 2014).

6. Combination of online and offline services

With the development of Internet technology, a network service business can not only be handled through offline business halls, but also through the hotlines of various operators or log in to online business halls to realize self-service business. Therefore, the level of network service quality requires a comprehensive evaluation of online and offline services (M. Liu, 2019).

3.3.2 Construction of specific index system

Combining the characteristics of the operator's network services, the five dimensions and 22 indicators of the SERVQUAL model are used to construct an evaluation system for network services. as shown in Table 3.2:

Table 3.2 SERVQUAL service quality evaluation system of operator network service

Service quality dimension	Index
Y1 Tangibility	Y11 The business hall has modern supporting equipment
	Y12 Service personnel are neat and tidy
	Y13 The overall environment of the business hall is comfortable and inviting
	Y14 The intelligent voice of customer service call is intelligent and efficient to answer questions
Y2 Reliability	Y21 The network service provided is reliable
	Y22 Customer network experience problems are solved promptly and actively
	Y23 The actual service provided is consistent with the description of the advertisement or service personnel
	Y24 Provide effective and unblocked manual customer service calls
	Y25 Service personnel can answer and solve customer problems accurately
Y3 Responsiveness	Y31 Service personnel can provide timely service
	Y32 Manual customer service calls can be quickly connected
	Y33 Customer problems can be solved within the promised time
	Y34 For complex problems, service personnel can actively seek solutions for customers
	Y35 The service personnel can determine the time to solve the problem

Service quality dimension	Index
Y4 Assurance	Y41 Service personnel are skilled at solving the problems consulted by customers
	Y42 Service personnel are competent and professional in solving various problems
	Y43 Service personnel treat customers well
	Y44 Service personnel can provide reliable solutions
Y5 Empathy	Y51 Operators can actively take into account network experience of customers
	Y52 Operators provide customers with personalized services
	Y53 Operators take measures to actively understand customer needs
	Y54 Operators put customers' interests first

Source: elaborated by the author

3.3.3 Questionnaire design

In the light of the constructed SERVQUAL service quality evaluation system and literature research, the final questionnaire is formed (see Annex A).

The questionnaire falls into two parts. The first part is a survey of the basic situation of the interviewees, including gender, age, and education, to study the relationship between characteristics of the interviewees and their evaluation of service quality. Guidance can be provided for personalized services in the segmented user market based on the service evaluation of different user groups; the second part is the evaluation of service quality, with a total of 22 questions, requiring interviewees to measure the actual perception and expectations of each service. The author puts the measurement scores of the perceived value and expected value of each service in one question for each service aiming at more convenient answering of interviewees. The measurement method adopts Richter's 5-point scale, with 1 to 5 points representing very poor, poor, average, good, and very good respectively. The difference between the actual perceived value and expected value of each service is measured to evaluate the network service quality.

3.4 Other research tools

When using the SERVQUAL scale indicators to evaluate the quality of network services, over and above the model itself, some other research tools are also made use of to prove the reliability and stability of the research, and conduct more in-depth analysis.

1. Descriptive statistics

Descriptive statistics refers to the description of data characteristics through the use of charts, classifications, and calculations of general data, including central tendency analysis, distribution, frequency analysis, dispersion analysis, and statistical graphics.

1) Frequency analysis: in the data preprocessing stage, frequency analysis and crossover frequency analysis can check outliers;

2) Central tendency analysis: which reflects the general level of the data by calculating the average, median as well as the mode and other indicators;

3) Analysis of the degree of dispersion: mainly analyzes the variance and standard deviation to reflect the degree of difference between the data;

4) Data distribution: in statistical analysis, it is generally assumed that the sample population belongs to a normal distribution, so it is necessary to calculate the skewness and kurtosis to check whether the sample data conform to the normal distribution;

5) Statistical graphs: various statistical graphs can display data more clearly and intuitively.

Through descriptive statistics, the basic traits of the questionnaire results can be analyzed.

2. Validity analysis

Validity refers to the degree to which a measurement tool or means can accurately gauge the things to be measured. Validity refers to the extent to which the measured result reflects the content of the investigation. The more consistent the measurement results are with the content to be investigated, the higher the validity, and vice versa. Validity is usually segmented into three types: content validity, criterion validity and structure validity. The test of validity usually refers to the test of structural validity in statistical methods. The commonly used methods are Kaiser-Meyer-Olkin (KMO) test and Bartlett-Test of Sphericity.

1) KMO test: KMO test statistic is an index used to compare the simple correlation coefficient and partial correlation coefficient between variables (X. Z. Chen, 2016), which is mainly used in factor analysis of multivariate statistics. The KMO statistic takes a value between 0 and 1. When the sum of squares of the simple correlation coefficients between all variables is much larger than the sum of squares of the partial correlation coefficients, the KMO value is close to 1. The closer the KMO value is to 1, the stronger the correlation between the variables, and the more suitable the original variables are for factor analysis; when the sum of the squares of the simple correlation coefficients between all variables is close to 0, the KMO value is close to 0. The closer the KMO value is to 0, the weaker the correlation between the variables, and the less suitable the original variables for factor analysis. Generally speaking, KMO > 0.9 means very suitable; KMO between 0.8 and0.9 means suitable; KMO between 0.7 and 0.8 means general; KMO between 0.6 and0.7 means not suitable; KMO < 0.5 means extremely unsuitable.

2) Bartlett-Test of Sphericity: applied to test the correlation between the variables in the correlation matrix, whether it is a unit matrix, that is, to test whether each variable is

independent (X. Z. Chen, 2016). In factor analysis, if the null hypothesis is rejected, it means that factor analysis can be done. If the null hypothesis is not rejected, it means that these variables may independently provide some information and are not suitable for factor analysis. In the results of Bartlett-Test of Sphericity in statistical software, if Sig. <0.05 (namely, p-value<0.05), indicates that there is a correlation between the variables and the factor analysis is effective.

3. Reliability analysis

Reliability appertains to the degree of consistency of the results obtained when the same method is used to repeatedly measure the same object. There are four main methods of reliability analysis: test-retest reliability method, duplicate reliability method, half reliability method and alpha reliability coefficient method. In this thesis, the alpha reliability coefficient method is utilized for reliability analysis to judge whether the evaluation model has internal consistency.

Cronbach's alpha reliability coefficient (hereinafter referred to as the α coefficient) formula is (Cronbach, 1951):

$$\left(\frac{k}{k-1}\right) \times \left(1-\frac{\sum S_i^2}{S_T^2}\right) \tag{3.3}$$

Among them, K is the total number of questions in the scale, S_i^2 is the intra-question variance of the score of the i-th question, and S_T^2 is the total score variance of all the questions. According to the formula, it can be seen that the α reliability coefficient evaluates the consistency between the scores of each question in the scale and is an internal consistency coefficient. This method is applicable for the reliability analysis of attitude and opinion questionnaires (scales), so the research scale of this thesis can make use of the α reliability coefficient method for reliability analysis.

For the total scale, the reliability coefficient is acceptable between 0.7-0.8, preferably above 0.8; and for the subscale, the reliability coefficient is acceptable between 0.6-0.7, preferably above 0.7. If the α reliability coefficient is below 0.6, we must consider reformulating the questionnaire.

4. Factor analysis

Factor analysis refers to statistical methods used to extract common factors from variable groups, find hidden and representative factors among many variables, and categorize variables of the same nature into one factor, which can reduce the variables and also test the assumptions about relationships between variables. Factor analysis methods can get into exploratory and confirmatory factor analysis methods. Exploratory factor analysis does not presuppose the

relationship between factors and measurement items, but lets the data "speak for themselves". Principal component analysis and common factor analysis are typical methods. Confirmatory factor analysis assumes that the relationship between factors and measurement items is partially known, that is, what measurement item corresponds to what factor, although the specific coefficients are not yet clear. The principal component analysis is a commonly used method, and its principle is to recombine multiple original variables into a new set of aggregate variables that are independent of each other by means of orthogonal transformation, so as to achieve data dimensionality reduction (Hao, 2005).

5. Correlation analysis

Correlation analysis refers to the analysis of two or more related variable elements to measure the closeness of the two variable factors. In practice, Pearson's correlation coefficient is often used for correlation analysis (Pearson, 1895). Pearson's correlation coefficient measures linear correlation, and the value of the coefficient r is calculated by the following formula:

$$r=\frac{N\sum x_i y_i-\sum x_i \sum y_i}{\sqrt{N\sum x_i^2-(\sum x_i)^2}\sqrt{N\sum y_i^2-(\sum y_i)^2}} \tag{3.4}$$

Among them, N is the number of samples, x_i is the sequence of the first variable, and y_i is the sequence of the second variable. If r=0, there is no linear correlation between the two variables; the greater the absolute value of the correlation coefficient is, the stronger the correlation is; the closer the correlation coefficient is to 1 or -1, the stronger the correlation is, and the closer the correlation coefficient is to 0, the weaker the correlation is.

6. Sample t test

Sample t test refers to a method applied to test the difference between the averages of two samples that are small, have unknown population standard deviation, and comply with normal distribution. T test infers the probability of the difference founded on the T distribution theory, so as to determine whether the difference between the two averages is significant. After the hypothesis test, if a significant p-value is obtained, there is a major difference between the averages of the two samples, and vice versa. T test is divided into one sample t test, independent sample t test and paired sample t test. One sample t test is used to test whether the difference between a sample average and a known population average is significant; an independent sample t test is used to test whether the difference between the average of two samples and the population represented by each is significant, and to test the difference of the data obtained by the two groups of unrelated samples; the paired-sample t test can be regarded as an extension of the one sample t test, but the object of the test is changed from a group of independent

samples of the normal distribution to the difference between the observations of two groups of paired samples (Box, 1987).

7. One-way analysis of variance

One-way analysis of variance is applied to analyze the single-factor test results to determine whether the factor has an influential impact on the test results. As an extension of the method of comparing two sample averages, one-way analysis of variance is utilized to test the difference between multiple averages to determine whether the factor has a significant impact on the test results. Factors refer to variables or indicators that affect the research object. They are usually categorical variables or can fall into several levels. After the hypothesis test, if a significant P value is obtained, there is a large gap between groups and within groups after single factor grouping, and it can be inferred that the single factor tested has a significant impact on the research object. On the contrary, if the P value is not significant, it proves that the factor has no significant impact on the research object (Scheffe, 1999).

8. IPA

Martilla and James (1977) proposed the Importance-performance Analysis (IPA) method in 1977. The analysis method was first applied to the research of industrial products, and then gradually applied to the research of education, tourism, and service quality. The basic idea is that the customer's satisfaction with the product or service comes from the degree of importance they attach to each attribute of the product or service and the evaluation of the performance of each attribute.

The IPA model structure lists the importance as the x-axis and the performance as the y-axis. The customer's attention to the product (service) attribute and the total average of the performance evaluation are used as the dividing point of the XY axis, and the space is divided into four quadrants.

In the above schematic diagram of the model architecture (see Figure 3.2), the A quadrant is the continuation zone, which is the area where the customers attach great importance to and are satisfied with the performance of the operator so the company should continue to maintain the product (service) attributes that fall into this quadrant; D quadrant is the over-supply area, where the customers do not value but are satisfied with the performance of the operator's product (service) attributes, so the company can appropriately reduce the product (service) attributes that fall in the D quadrant; C quadrant is the lower priority area where customers do not value and are not satisfied with the performance of the operator's product (service) attributes. B quadrant is the focus area for strengthening and improvement, and it is the area where customers attach great importance to but are not satisfied with the performance of the operator's

product (service) attributes. Therefore, the attributes of products (services) in quadrants B and C need to be improved. However, due to the different weights of importance, B is a key attribute that the company urgently needs to improve. The attributes of quadrant C are not valued by customers, so its priority of improvement is lower than those of B-quadrant.

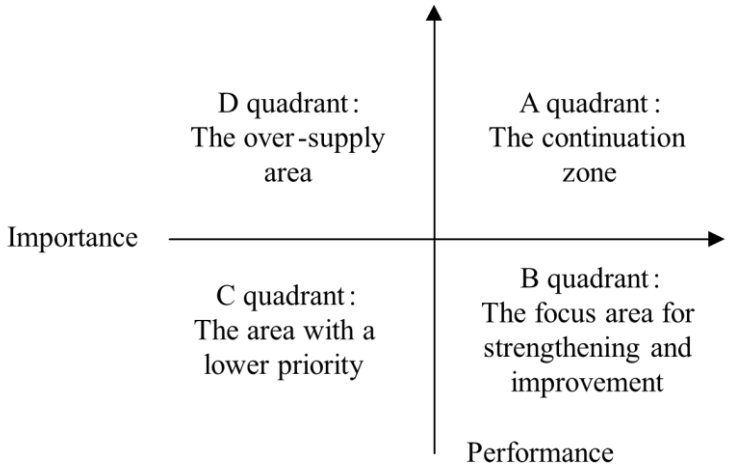

Figure 3.2 IPA model architecture

Source: Martilla and James (1977)

Based on the IPA attribute evaluation model, this thesis takes the average expected values of the network service quality dimensions and specific indicators in the SERVQUAL model as the "importance" (horizontal axis), and the average values of the actual customer perception as the "performance level" (vertical axis). The area is divided into four quadrants, and then each network service quality dimension and specific indicators are analyzed.

3.5 Pre-survey and revision of index system

3.5.1 Pre-survey and analysis of survey results

In the pre-survey stage, a total of 150 questionnaires were distributed through social platforms such as WeChat, Weibo and QQ. 134 questionnaires were recycled, and there were 29 questionnaire samples who were non- MC users, while 105 sample questionnaires were answered by MC users, of which 4 invalid questionnaires were rejected after verification of systemic deviations and vacancy rates, and 101 valid samples were finally obtained. To test the effectiveness of the network service quality evaluation index system, the author uses the pre-survey data for validity analysis mainly by virtue of the KMO test, Bartlett-Test of Sphericity, factor analysis and other methods.

The structure validity of the scale adopts exploratory factor analysis methods, generally

using KMO test and Bartlett-Test of Sphericity to verify the applicability of the structure validity factor variables. The KMO test is utilized to test whether the partial correlation between variables is small enough. Its value is between 0 and 1. The larger the value is, the more suitable for factor analysis is. Researchers usually perceive that KMO is greater than 0.5, which is suitable for factor analysis. The Bartlett-Test of Sphericity is adopted to test the correlation of various variables. The larger the approximate chi-square distribution value is, the smaller the significance level is (generally less than 0.05), the more suitable for factor analysis is. The results of KMO test and Bartlett-Test of Sphericity using Stata13.0 are shown in Table C-1 of Annex C. It can be seen that the KMO of the evaluation scale is 0.927>0.5, indicating that it is suitable for factor analysis; the approximate chi-square distribution is 2762.692 (df=231), Sig =0.000<0.05, reaching the significance level, indicating the suitability of factor analysis.

The principal component analysis method is then applied to perform factor analysis on the pre-survey data, and Stata13.0 is applied to analyze the samples directly or after the orthogonal rotation, thereby gaining the analysis of cumulative variance contribution rate in Table C-2. The analysis shows that there are 6 components with eigenvalues greater than 1, that is, 6 common factors are extracted, and the cumulative variance contribution rates of the 6 common factors are all greater than 0.65, which is acceptable in empirical research.

The rotated factor loading matrix is used to analyze the distribution of factor loading values, and the analysis results are shown in Table C-3. In factor analysis, each indicator should have only a small amount of large loading distribution (large loading distribution means that the indicator has a large loading value for the factor), and other load values should be close to 0. In empirical research, factor loading values that are greater than 0.45 will usually be considered as large loading distribution. As shown in Table C-3 (showing only the indicators with factor loading values which are greater than 0.45), the relevant indicators of the tangibility dimension obey large loading distribution on the common factor 3; the reliability-related indicators obey large loading distribution on the common factor 4; the responsiveness-related indicators obey large loading distribution on the common factor 5; the assurance -related indicators obey large loading distribution on the common factor 2; the empathy-related indicators obey large loading distribution on the common factor 1. Hence, it can be seen that the common factors 3, 4, 5, 2 and 1 respectively correspond to the five dimensions of tangibility, reliability, responsiveness, assurance and empathy of network service quality, which conform to the design of the network service quality evaluation system.

There are only five evaluation dimensions in the network service quality evaluation system. However, in the factor analysis, 6 common factors are extracted, and the matrix of rotated factor

loadings shows that the common factor 6 does not obey large loading distribution in any specific indicator. Because network services have the characteristics of remediation, extensiveness, scalability, substitution, and demand diversity, and in the light of the results of factor analysis, the author has reason to believe that the five service quality evaluation dimensions in the traditional SERVQUAL method are not sufficient to summarize all characteristics of the network services. Hence, the service quality evaluation dimensions should be expanded based on the said five dimensions.

3.5.2 Remediation of the dimension of network service quality evaluation

In the data analysis of the pre-survey results, the author finds that the factor analysis of the five dimensions of service quality evaluation in the SERVQUAL is not acceptable, which shows that the traditional SERVQUAL method is not fully applicable to the network service quality evaluation. J. L. Han and Dong (2006) also proposed the limitation of the traditional SERVQUAL method, namely, the research objects generally are banks, credit card companies, equipment repair and maintenance companies, and long-distance telephone companies. It may not be applied to all industries. Even PZB group points out that the five dimensions of service quality can be appropriately adjusted to meet the needs of all types of enterprises when SERVQUAL is applied to different industries. (Parasuraman et al., 1994).

As summarized by the author in the preceding part of the thesis, the network service is also featured by remediation, universality, scalability, substitution, demand diversity. The service process of the telecommunications network service includes pre-sale, in-sale and after-sale. The pre-sale process includes business consultation, business handling and publicity of new business; the in-sale service process includes a comprehensive consultation, payment and member plan experience; the after-sale service process includes complaint handling and comprehensive consultation (Y. Gao, 2009). On the basis of the operators' experience, only when the three sub-service processes are successfully completed and mutually assisted can lasting and stable services be achieved. However, the dimensions and indexes in the traditional SERVQUAL scale do not involve much in the after-sale service process, which makes it unsuitable to be applied in the network service quality evaluation. The after-sale service process mainly involves customer complaint handling, that is, remedying the service failure, which is often referred to as service remedy. The author thinks that taking remediation as the dimension of network service quality evaluation can make up for the limitation of the traditional SERVQUAL method when it is applied in the network service industry.

According to data of Sichuan Province, there were about 4.76 million network complaints

in 2018, 3.64 million in 2019 and 3.27 million in 2020 in Sichuan Province. It can be seen that there are a host of network service failure cases. Service remediation is necessary. The customer will raise a complaint when the service is not satisfying, so the service remediation is to correct the mistake when the customer is already not satisfied with the service, to achieve the goal of reducing customer losses and recovering customer satisfaction. If service remediation is not proper, the customer will be more dissatisfied, which will greatly increase customer agitation. In the long run, the market share and profits of the enterprise will decrease, and the reputation will be damaged, which is harmful to the development of the enterprise.

Zeithaml et al. (1985) proposed that effective service remediation can satisfy the customers and improve their impression and loyalty to the enterprise. Y. R. Gao and Li (2003) put forward that service remediation can greatly improve customer loyalty. Timely and high-quality service remediation can not only eliminate customer complaints, but also win more customers; Dong (2003) used remediation to make up for the deficiency of the SERVQUAL model in his assessment of the service quality of the banking sector in 2003; Y. Gao (2009) believed that service failure occurs for complex reasons and that service remediation is very important. Hence, remediation is added in the evaluation of mobile communication service quality based on the SERVQUAL model; Cheng and Long (2015) also applied remediation to perfect the SERVQUAL model in the study of service quality of telecom enterprises; H. J. Ma (2017) pointed out that customer dissatisfaction is infectious, and service remediation is critical to retaining customers. Remedial measures are indispensable because they are taken by the enterprises actively to correct service errors and retain customers. Based on the actual situation of the telecom call center, remediation is added to the SERVQUAL model.

It can be seen from the above data, theoretical analysis and reference from the literature that it is reasonable to add the remediation to network service quality evaluation. In the SERVQUAL model, each service quality evaluation dimension needs to be specified into indicators that can be observed and quantified. Therefore, the indicators of the remediation need to be detailed.

As a two-way and interactive action, remediation requires the customer to state the service failures, and the network service personnel to respond, handle and solve the failures. Finally, the customer may accept the handling result. During the process, the attitude of the network service personnel, the response speed, and the proper and effective processing measures matter to the success of remediation; once the customer realizes that the complaints are handled, and accepts the results, it is the most direct way for the customer to judge the service remediation.

Thus, this thesis constructs remedial indicators from the perspectives of network service

personnel and customer perception respectively. According to the previous analysis of the interactive process and influencing factors of remedial behavior, the following remedial indicators are summarized:

1. Service personnel can actively solve the customers' complaints;
2. Service personnel can take appropriate and timely measures to remedy their services;
3. Customers know the response of the complaint and its handling process;
4. Customers accept the results of complaint settlement.

3.5.3 Revision of index system and questionnaire design

After a detailed analysis of the characteristics of the network services, the author believes that the remediation, a noticeable characteristic of network service, is of major significance. Operators usually perform service remediation in the case of network service errors and customer complaints. Consequently, the effect of service remediation is particularly vital for customers' service quality evaluation. For good measure, from the perspective of indicators and questionnaire design, customers can intuitively feel the features of remediation and we can find quantitative remediation indicators. Therefore, the author will add a remediation dimension in addition to the five dimensions of SERVQUAL, and four remediation indicators are also added besides the 22 indicators of SERQUAL. Finally, a network service evaluation system with six dimensions and 26 specific indicators is built, as shown in Table 3.3:

Table 3.3 SERVQUAL service quality evaluation system with six dimensions

Service quality dimension	Index
Y1 Tangibility	Y11 The business hall has modern supporting equipment Y12 Service personnel are neat and tidy Y13 The overall environment of the business hall is comfortable and attractive Y14 The intelligent voice of customer service call is intelligent and efficient to answer questions
Y2 Reliability	Y21 The network service provided is reliable Y22 Customer network experience problems are solved promptly and actively Y23 The actual service provided is consistent with the description of the advertisement or service personnel Y24 Effective and unblocked manual customer call service is provided Y25 Service personnel can answer and solve customer problems accurately
Y3 Responsiveness	Y31 Service personnel can provide timely service Y32 Manual customer service calls can be quickly connected Y33 Customer problems can be solved within the promised time Y34 For complex problems, service personnel can actively seek solutions for customers Y35 The service personnel can determine the time to solve the problem

Service quality dimension	Index
Y4 Assurance	Y41 Service personnel are skilled at solving the problems consulted by customers
	Y42 Service personnel are competent and professional in solving various problems
	Y43 Service personnel treat customers well
	Y44 Service personnel can provide reliable solutions
Y5 Empathy	Y51 Operators can actively take into account network experience of customers
	Y52 Operators provide customers with personalized services
	Y53 Operators take measures to actively understand customer needs
	Y54 Operators put customers' interests first
Y6 Remediation	Y61 Service personnel can actively solve the customers' complaints
	Y62 Service personnel can take appropriate and timely measures to remedy their service
	Y63 Customers know the response of the complaint and its handling process.
	Y64 Customers accept the results of complaint settlement

Source: elaborated by the author

After the network service quality evaluation system is revised, the questionnaire survey design needs to be revised. In view of the good results of the pre-survey data, no changes are made to the original part of the questionnaire, and only related questions corresponding to the remediation indicators are added at the end of the second part of the questionnaire. The questionnaire is shown in Annex B.

[This page is deliberately left blank.]

Chapter 4: Empirical Analysis

4.1 Statistical analysis

After revising the network service quality evaluation index system and questionnaire design, the author started data collection. In order to ensure the coverage and effectiveness of the quality of the survey samples, a total of 500 questionnaires were sent out, of which 380 were distributed through social platforms such as WeChat, Weibo, and QQ, and 337 were recovered; In shopping malls, stations and other densely populated places, 120 paper questionnaires were randomly distributed on site, 106 of which were recovered after interviews. A total of 443 questionnaires were collected. After the questionnaires were taken back, 73 sample questionnaires that were not answered by MC users were firstly excluded and 370 sample questionnaires from MC users were obtained. Later, the systemic deviation and vacancy rate were checked. The author determined that 22 questionnaires were invalid, so 348 valid questionnaires were finally obtained. The sample recovery rate of this survey was 88.60%, and the questionnaire effective rate was 94.05%. Based on the 348 effective samples obtained, sample feature analysis, T test, one-way analysis of variance, validity analysis, factor analysis, reliability analysis, correlation analysis, and empirical analysis of the evaluation system are also subsequently conducted in this study.

4.1.1 Analysis of sample characteristics

In the sample feature analysis, descriptive statistical analysis of sample features is firstly performed, and a summary table is used to describe the frequency distribution of each feature of the sample to reflect the basic characteristics of the sample. Independent sample t test and one-way analysis of variance are then conducted to analyze interviewees' expected value for the six dimensions of tangibility, reliability, responsiveness, assurance, empathy, and remediation under different sample features, and whether there are disparities in the perceived values of the six dimensions, so as to analyze whether the sample features will affect the evaluation of network services.

4.1.1.1 Descriptive statistical analysis of sample features

The sample features of this survey include gender, age, education level, area, monthly income,

frequency and years of network use.

1. Sample statistical analysis on gender

From the perspective of the gender, among effective samples, there are 181 male individuals and 167 female individuals separately, accounting for 47.99% and 52.01%, and the proportions of male and female individuals are relatively close. The statistical data is shown in Table 4.1. It can be considered that gender difference does not have much impact on the investigation, analysis process and results; the impact of the proportion of female samples which is slightly higher than that of male samples is negligible.

Table 4.1 Sample gender structure

	Frequency	Percentage	Cumulative percentage
Male	167	47.99%	47.99%
Female	181	52.01%	100.00%
Total	348	100.00%	

Source: elaborated by the author

2. Sample statistical analysis on age

From the perspective of the age, among the effective samples, there are 10, 186, 138, and 14 individuals under 18, 18-30, 31-50, and over 50, accounting for 2.87%, 53.45%, 39.66% and 4.02% respectively.

The individuals are concentrated in the age group of 18-30 years old, mainly are young people, and the collected samples are distributed chiefly through social media; followed by the age group of 31-50 years old, mainly middle-aged people, and the samples are principally collected through the on-site distribution of paper questionnaires and social media. It can be seen from the cumulative percentage that 95.98% of individuals are aged 50 and below, which is in line with the characteristics of Internet service consumers in reality. Among them, the cumulative percentage of individuals aged under 30 is 56.32%. The statistical data is shown in Table 4.2. In reality, this group is the main consumer group of network services. Hence, the sample data has a high reference value.

Table 4.2 Sample age structure

	Frequency	Percentage	Cumulative Percentage
(Under 18)	10	2.87%	2.87%
(18-30 years old)	186	53.45%	56.32%
(31～50 years old)	138	39.66%	95.98%
Over 50 years old	14	4.02%	100.00%
Total	348	100.00%	

Source: elaborated by the author

3. Sample statistical analysis on the education level

From the perspective of education level, among the effective samples, there are 122, 177 and 49 individuals with a master degree and above, bachelor degree, and junior college degree

and below, accounting for 35.06%, 50.86% and 14.08% separately. The lowest percentage of people with various education backgrounds account for more than 14%, indicating the relatively complete coverage of the sample; among all individuals, 85.92% have a bachelor degree or above, of which 35.06% have a master degree or above. The statistical data is shown in Table 4.3. Highly educated people have a better understanding of the content of the questionnaire and can make more accurate judgments on the scale, so the data obtained will be more accurate and reliable.

Table 4.3 The education level structure of the sample

	Frequency	Percentage	Cumulative Percentage
Master Degree and above	122	35.06%	35.06%
Bachelor Degree	177	50.86%	85.92%
Junior College Degree and below	49	14.08%	100.00%
Total	348	100.00%	

Source: elaborated by the author

4. Sample statistical analysis on the area

From the perspective of the area where the interviewees are located, 136, 102, 79 and 31 individuals are respectively located in the first- and second-tier cities, non-first- and non-second-tier cities, towns, and rural areas, accounting for 39.08%, 29.31%, 22.70% and 8.91% of the total samples respectively. On the one hand, 68.39% of the interviewees have resided in cities where Internet services are more popularized. Hence, interviewees have more access to and perception of network services, so the data obtained is universal. On the other hand, 31.61% of the interviewees are living in towns and rural areas, and their data has enriched the samples and increased their credibility and coverage. The statistical data is shown in Table 4.4.

Table 4.4 Sample area structure

	Frequency	Percentage	Cumulative Percentage
First- And Second-Tier Cities	136	39.08%	39.08%
Non-First- And Non- Second-Tier Cities	102	29.31%	68.39%
Towns	79	22.70%	91.09%
Rural Areas	31	8.91%	100.00%
Total	348	100.00%	

Source: elaborated by the author

5. Sample statistical analysis on monthly income

From the perspective of monthly income, in the effective samples, there are 9, 58, 157, 101 and 23 interviewees respectively with a monthly income of 3,000 yuan and below, 3,001-5,000 yuan, 5,001-10,000 yuan, 10001-20000 yuan, and more than 20,000 yuan, accounting for 2.59%, 16.67%, 45.11%, 29.02%, and 6.61% correspondingly. There are 80.74% of interviewees with monthly income above 5,000 yuan, indicating that most of the interviewees

are middle-to-high-income groups. They have higher incomes, and usually consume more. Hence, they will theoretically buy more network services and have more experience in network service consumption, which increases the effectiveness of survey data. Between different income groups, network services will also be stratified, that is, different interviewees will enjoy different network services, demonstrating the rich and unbiased survey data. The statistical data is shown in Table 4.5.

Table 4.5 Sample monthly income structure

	Frequency	Percentage	Cumulative Percentage
3,000 Yuan And Below	9	2.59%	2.59%
3,001-5,000 Yuan	58	16.67%	19.25%
5,001-10,000 Yuan	157	45.11%	64.37%
10,001-20,000 Yuan	101	29.02%	93.39%
More Than 20,000 Yuan	23	6.61%	100.00%
Total	348	100.00%	

Source: elaborated by the author

6. Sample statistical analysis on network usage frequency

From the perspective of frequency of using the Internet, when conducting a questionnaire survey, the criteria for defining heavy users: entirely relying on the Internet for work, study, and leisure; the criteria for defining medium users: using the network for work or study when necessary; the criteria for defining light users: only using online social media for basic communication. Among the effective samples, there are 220, 109, and 19 samples for heavy users, medium users, and light users, respectively, accounting for 63.22%, 31.32%, and 5.46%. The cumulative percentage of heavy users and medium users is as high as 94.54%, indicating that most of the interviewees have rich experience in network service consumption, and can answer the questions on the scale completely based on real experience, thereby providing a strong proof for the accuracy and validity of the survey data. The statistical data is shown in Table 4.6.

Table 4.6 Frequency distribution of sample network usage

	Frequency	Percentage	Cumulative Percentage
Heavy Users	220	63.22%	63.22%
Medium Users	109	31.32%	94.54%
Light Users	19	5.46%	100.00%
Total	348	100.00%	

Source: elaborated by the author

7. Sample statistical analysis on years of using the Internet

From the perspective of years of using the Internet, 1 (0.29%), 108 (31.03%), 183 (52.59%) and 56 (16.09%) individuals have been using the Internet for over 15 years, 11~15 years, 6~10 years and 0~5 years, respectively. Over 83.91% of the interviews have been using the Internet

for over 5 years, including 31.32% for over a decade. Their long consumption of network service indicates their rich experience in the evaluation of network service and proves the effectiveness of the survey data. The statistical data is shown in Table 4.7.

Table 4.7 Sample years of using Internet structure

	Frequency	Percentage	Cumulative Percentage
Over 15 Years	1	0.29%	0.29%
11~15 Years	108	31.03%	31.32%
6~10 Years	183	52.59%	83.91%
0~5 Years	56	16.09%	100.00%
Total	348	100.00%	

Source: elaborated by the author

4.1.1.2 Independent sample t test and one-way analysis of variance for the sample features

Independent sample t test and one-way analysis of variance are conducted to identify any discrepancies between the expected values and perceived values of the six dimensions of interviews, namely tangibility, reliability, responsiveness, assurance, empathy and remediation under different sample features. Independent sample t test can detect any significant differences between the mean values of two groups of data, and one-way analysis of variance any significant differences among three or more groups. Firstly, the average value of specific indicators in every dimension is calculated as the score of such dimension, then t test for independent samples is conducted for the sample features of two categories (only for the sample feature of gender hereof); one-way analysis of variance is done for sample features of three or more categories, including the age, education level, area, monthly income, internet use frequency, and years of internet use. Each sample feature's impacts on the expected value and perceived value of six dimensions are as follows:

1. Independent sample t test for the gender feature

Table 4.8 and Table 4.9 show that, for either the expected value or perceived value of network service evaluation, the P values of all dimensions are greater than 0.05, indicating that the female group and male group have no differences in their average value, and suggesting that the gender feature imposes no momentous impact on the customer's evaluation of the network service.

2. One-way analysis of variance for the age feature

Table C-6 shows that, for either the expected value or perceived value of network service evaluation, the P values of five dimensions, namely tangibility, reliability, responsiveness, assurance and empathy are smaller than 0.05, indicating that the interviewees at all ages have a different quality evaluation on the network service from these five dimensions, while the P value of the remediation dimension is greater than 0.05, suggesting that the interviewees at all

ages have no significantly different quality evaluation on the network service from the dimension of remediation. To sum up, the age factor imposes an impact on five dimensions, namely tangibility, reliability, responsiveness, assurance and empathy, but no impact on the remediation.

The comparison of expected and perceived values between different age groups for network service quality evaluation shows in Table C-7 that, for either the expected value or perceived value, the interviewees under 18 and those between 31~50 have a significantly different quality evaluation on the network service. The different quality evaluation on the network service between the minor group and middle-aged group matches the cognitive expectation on the two groups' features.

3. One-way analysis of variance for the education level feature

Table C-8 shows that, for either expected value or perceived value of network service evaluation, the P values of all dimensions are greater than 0.05, suggesting that the interviewees at divergent education levels have no significantly different quality evaluation on the network service. To sum up, the education level feature imposes no significant impact on the customer's evaluation of the network service.

4. One-way analysis of variance for the area feature

Table C-9 shows that, for either the expected value or perceived value of network service evaluation, the P values of all dimensions are greater than 0.05, suggesting that the interviewees from different areas have no significantly different quality evaluation on the network service. To conclude the area feature imposes no momentous impact on the customer's evaluation of the network service.

5. One-way analysis of variance for the monthly income feature

Table C-10 shows that, for the expected value of quality evaluation on the network service, the P values of assurance and empathy are both smaller than 0.05, indicating that the monthly income imposes an impact on the dimensions of assurance and empathy of the network service evaluation's expected value, but imposes no significant value on other dimensions. For the perceived value of quality evaluation on the network service, however, the P values of all dimensions are greater than 0.05, suggesting the groups with different monthly income have no significantly different perception of the network service, namely the monthly income imposes no significant impact on the perception of network service quality.

The comparison of expected values of assurance and empathy between different monthly income groups for network service quality evaluation in Table C-11 and Table C-12 shows that, for either the assurance or empathy, the interviewees with monthly income between RMB

5,001~10,000 Yuan and those with above 20,000 Yuan have a significantly different quality evaluation on the network service. As the high-income group generally purchases higher-level network service, their better quality evaluation of the network service matches the cognitive expectation.

6. One-way analysis of variance for the frequency of network use feature

Table C-13 of Annex C shows that, for either the expected or perceived values of network service evaluation, all the P values are greater than 0.05, suggesting that the interviewees with different frequencies of network use have no significantly different quality evaluation on the network service, namely the sample feature of frequency of network use imposes no significant impact on the customer's evaluation of network service quality.

7. One-way analysis of variance for the years of network use feature

Table C-14 demonstrates that, for either the expected or perceived values of network service evaluation, all the P values are greater than 0.05, suggesting that the interviewees with different years of network use have no significantly different quality evaluation on the network service, namely the sample feature of years of network use imposes no significant impact on the customer's evaluation of network service quality.

4.1.2 Analysis of sample validity

Validity refers to the accuracy and authenticity of test results. It is closely related to the research goal. It can also be said to be the degree of reaching the goal, that is, the results of a study must meet its goals to be effective. In the book Standards for Educational and Psychological Tests published by the American Psychological Association in 1974, the validity is divided into content validity, construct validity and criterion-related validity according to the test objectives (American Educational Research Association et al., 2003).

Similarly, the applicability of factor variables for construct validity is first verified by KMO test and Bartlett-Test of Sphericity, to confirm whether the variables are qualified for factor analysis. The KMO test and Bartlett-Test of Sphericity results with Stata13.0 in Table C-15 of Annex C show that, the evaluation scale KMO=0.892＞0.5, and the Chi-square=1,740.755 (df=325), Sig=0.000＜0.05, a significant level, indicating that the survey data are suitable for factor analysis.

Then the principal component analysis is used for factor analysis, Stata13.0 is applied to analyze the samples directly or after the orthogonal rotation, obtaining the cumulative variance contribution rates listed in Table C-16. The table shows that, for the initial eigenvalues or the

eigenvalues for the rotation sums of squared loadings, there are 6 components with eigenvalues greater 1. That is to say, 6 common factors are extracted and the cumulative variance contribution rates of these 6 common factors are all greater than 0.65, indicating that the explanation of all variable indicators with these 6 common factors is satisfactory.

Table C-17 displays the rotated factor loading distribution with matrix analysis, as well as the large loading distribution of the indicators with factor loading values greater than 0.45 on some common factors. The data of Table C-17 show that, the relevant indicators of tangibility obey large loading distribution on the common factor 3, the reliability-related indicators obey large loading distribution on the common factor 4, the responsiveness-related indicators obey large loading distribution on the common factor 5, the assurance-related indicators obey large loading distribution on the common factor 2, the empathy-related indicators obey large loading distribution on the common factor 1, and the remediation indicators obey large loading distribution on the common factor 6. Hence, it can be seen that the common factors 3, 4, 5, 2, 1 and 6 respectively correspond to the six dimensions of tangibility, reliability, responsiveness, assurance, empathy and remediation, indicating the good construct validity of the modified indicator system for quality evaluation of network service.

The fruitful results of validity analysis and factor analysis show that it is statistically effective to divide the network service quality into six dimensions, including tangibility, reliability, responsiveness, assurance, empathy and remediation founded on the SERVQUAL method and the characteristics of operator network services. And the first research question raised at the beginning of the thesis can be answered. In other words, the network service quality is composed of six dimensions: tangibility, reliability, responsiveness, assurance, empathy and remediation.

4.1.3 Analysis of sample reliability

Reliability refers to the consistency, stability and dependability of test results. It is the degree of consistency of the results obtained when the same method is used to repeatedly measure the same object. Generally, internal consistency is adopted to express the test reliability. Cronbach's α reliability coefficient is the most commonly used reliability analysis of attitude and opinion questionnaires (scales), which is a set of psychological or educational tests proposed by American educationist Cronbach (1951). This reliability method uses a certain formula to estimate the internal consistency of the test and has become the most commonly used reliability indicator in social research. The α reliability evaluates the consistency between the scores of each item in the scale, ranging from 0 to 1. The closer the value is to 1, the higher the internal

consistency of the scale items is, the greater the reliability is.

In research practice, researchers generally believe that a reliable α coefficient needs to be at least greater than 0.6; generally speaking, an α coefficient between 0.65 and 0.70 is the minimum acceptable value; the value between 0.70 and 0.80 is better; the value between 0.80 and 0.90 is very good; the coefficient greater than 0.90 is basically difficult to reach in the questionnaire survey.

After reliability analysis through Stata13.0, the α coefficient shown in Table C-18 is obtained. It can be seen that the α coefficient of each service quality dimension is greater than 0.65, which meets the minimum reliability acceptance standard; most of them are between 0.70 and 0.80, which is at a good reliability level; the alpha coefficient of the tangible dimension is even greater than 0.8, reaching a very good reliability level. It can be concluded that the overall reliability of the scale of the evaluation system is fine, and there is internal consistency between the scale items, which can be applied.

4.1.4 Correlation analysis

Correlation analysis refers to the process of studying two or more correlated variable elements, to make the decision on the degree of correlation between them. Pearson correlation coefficient can be applied to measure the linear correlation between the dimensions and total scores of service quality and the linear correlation between specific indicators and total scores of service quality. Pearson value ranges between 0 and 1, and the more it approaches 1, the more correlated the variables are to each other. The following correspondences in Table 4.8 have been proven by the empirical studies:

Table 4.8 Pearson value and correlation

Pearson Value	Correlation
0~0.2	Highly weak or no correlation
0.2~0.4	Weak correlation
0.4~0.6	Moderate correlation
0.6~0.8	Strong correlation
0.8~1.0	Highly strong correlation

Source: Baidu Baike (2010)

In the calculation of the correlation coefficient, the score of each dimension of the service quality is obtained by summing the specific indicator value of each dimension (including the expected value and the perceived value); by summing the indicator values of all dimensions, the total expected value of network service quality and the total perceived value of network service quality are calculated respectively. The correlation coefficient is calculated by Stata13.0, and the correlation coefficient is finally obtained.

Table C-19 and Table C-20 display separately the calculated correlation (Pearson value) between the six dimensions of tangibility, reliability, responsiveness, guaranty, empathy, remediation and the total scores of quality evaluation on network service from the perspectives of the expected value and perceived value of network service quality. The tables show that, for either the expected value or perceived value of network service quality, all Pearson values are greater than 0.6, suggesting that all dimensions for quality evaluation on network service are strongly correlative to the total scores of quality evaluation on network service. With Pearson values greater than 0.8, some dimensions, like reliability and responsiveness (with expected value), and responsiveness (with perceived value), have a highly strong correlation with the total scores of quality evaluation on network service. Moreover, the Pearson value calculated for each dimension has a significance level below 0.05, indicating that the Pearson value is significant and is worth using for reference. To sum up, the dimensions of network service quality are highly consistent with the total scores of service quality evaluation, every dimension imposes an impact on the total scores of evaluation, and the network service quality evaluation index system constructed in this thesis is valid.

To further study the effectiveness of the quality indicator system of network service, based on the expected and perceived values of quality evaluation on network service, the author has also calculated the correlation between every specific indicator and the total scores of quality evaluation on network service (see Table 4.9).

Table 4.9 The correlation between the dimensions' perceived values and the total scores of quality evaluation on network service

Correlation of Indicator's Expected Value				Correlation of Indicator's Perceived Value			
Indicator No.	Pearson Value	Indicator No.	Pearson Value	Indicator No.	Pearson Value	Indicator No.	Pearson Value
E(Y11)	0.518***	E(Y35)	0.506***	Y11	0.472***	Y35	0.532***
E(Y12)	0.557***	E(Y41)	0.545***	Y12	0.479***	Y41	0.542***
E(Y13)	0.507***	E(Y42)	0.518***	Y13	0.400***	Y42	0.527***
E(Y14)	0.447***	E(Y43)	0.514***	Y14	0.458***	Y43	0.471***
E(Y21)	0.531***	E(Y44)	0.519***	Y21	0.499***	Y44	0.506***
E(Y22)	0.499***	E(Y51)	0.463***	Y22	0.523***	Y51	0.561***
E(Y23)	0.516***	E(Y52)	0.510***	Y23	0.509***	Y52	0.481***
E(Y24)	0.526***	E(Y53)	0.479***	Y24	0.404***	Y53	0.584***
E(Y25)	0.544***	E(Y54)	0.453***	Y25	0.482***	Y54	0.582***
E(Y31)	0.494***	E(Y61)	0.472***	Y31	0.500***	Y61	0.472**
E(Y32)	0.522***	E(Y62)	0.434**	Y32	0.472***	Y62	0.482**
E(Y33)	0.519***	E(Y63)	0.465***	Y33	0.505***	Y63	0.496**
E(Y34)	0.538***	E(Y64)	0.463***	Y34	0.618***	Y64	0.421***

Note: *** means p<0.05, ** means p<0.1

Source: elaborated by the author

The table shows that the Pearson values of most indicators range between 0.4~0.6, indicating their moderate correlation with the total scores of evaluation, and with Pearson values

greater than 0.6, a few indicators are strongly correlative to the total scores of evaluation. Over and above, the Pearson values which are calculated for most specific indicators have a significance level below 0.05, suggesting that most Pearson values are significant under the significance level 0.05; the Pearson values which are calculated for 3 indicators have a significance level below 0.1, suggesting that most Pearson values are significant under the significance level 0.1 and are worthy of using for reference. To sum up, every specific indicator for quality evaluation on network service imposes an impact on the total scores of network quality evaluation, and each indicator in the indicator system for quality evaluation of network service built for this thesis is valid.

4.2 Analysis of network service quality based on the index evaluation system

First, a basic and unweighted statistical analysis is carried out on the indicator evaluation scale, and then indicator weighting is performed through the order of the expected value of the sample indicators to obtain a more accurate empirical analysis.

4.2.1 Statistical analysis of evaluation indicators based on SERVQUAL scale

4.2.1.1 Basic statistical analysis of evaluation indicators based on SERVQUAL scale

In this questionnaire, the designed evaluation system, which is based on the SERVQUAL scale, evaluates network service quality in six dimensions: tangibility, reliability, responsiveness, assurance, empathy and remediation. The questionnaire designs 26 specific indicators from these six dimensions. With the collected 348 valid samples, the average and standard deviation of the scoring of the expected value and the actual perceived value were calculated, and then the difference between the expected value and the actual perceived value of each item was calculated to obtain the following statistical characteristic table.

In the light of the content of Table 4.10, the traits of the sample's network service quality evaluation can be summarized as follows:

1) The expected value of the network service quality index is high, generally around 4 points, and the standard deviation of the expected value is relatively small, making clear that the survey samples generally have high expectations for the operator's network service quality;

2) The actual perceived value of the network service quality index fluctuates between 3.000 and 3.971, concentrated around 3.6, indicating that in practice, the operator's network service quality is average, and some services are relatively poor; while the standard deviation of the

actual perceived value is relatively larger, demonstrating that the survey samples have differences in the evaluation of the operator's network quality. According to the actual survey scores, there are indeed some very low scores;

3) The expected average value of all network service quality indicators is higher than the actual perceived average value, indicating that the network service quality of mobile operators is not as ideal as expected, and the gap between the average perceived value and the average expected value is between (-1.026) and (-0.204), which shows that the gap between sample perception and expectation of different items is not the same. The smallest gap is presented in "Y43 service personnel have a good attitude towards users", and the largest gap is shown in "Y54 Operators care about user interests".

Table 4.10 Statistical characteristics of the sample network service quality SERVQUAL scale

Service quality dimension	Specific indicator	Average perceived value	St err - perceived value	Average expected value	St err - expected value	Difference between average values
Y1 Tangibility	Y11 The business hall has modern supporting equipment	3.534	1.106	4.098	0.886	-0.564
	Y12 Service personnel are neat and tidy	3.695	1.071	4.184	0.863	-0.489
	Y13 The overall environment of the business hall is comfortable and attractive	3.672	1.109	4.135	0.857	-0.463
	Y14 The intelligent voice of customer service call is intelligent and efficient to answer questions	3.764	1.098	4.161	0.980	-0.397
Y2 Reliability	Y21 The network service provided is reliable	3.489	1.088	4.011	0.969	-0.522
	Y22 Customer network experience problems are solved promptly and actively	3.624	0.975	4.092	0.931	-0.468
	Y23 The actual service provided is consistent with the description of the advertisement or service personnel	3.529	0.994	4.319	0.875	-0.790
	Y24 Effective and unblocked manual customer call service is provided	3.902	0.961	4.181	0.945	-0.279

Service quality dimension	Specific indicator	Average perceived value	St err - perceived value	Average expected value	St err - expected value	Difference between average values
	Y25 Service personnel can answer and solve customer problems accurately	3.770	1.057	4.279	0.885	-0.509
Y3 Responsiveness	Y31 Service personnel can provide timely service	3.549	1.169	4.078	0.968	-0.529
	Y32 Manual customer service calls can be quickly connected	3.790	1.065	4.181	0.923	-0.391
	Y33 Customer problems can be solved within the promised time	3.672	1.111	3.951	1.005	-0.279
	Y34 For complex problems, service personnel can actively seek solutions for customers	3.161	1.294	4.066	0.910	-0.905
	Y35 The service personnel can determine the time to solve the problem	3.494	1.135	4.175	0.902	-0.681
Y4 Assurance	Y41 Service personnel are skilled at solving the problems consulted by customers	3.529	1.127	4.218	0.871	-0.689
	Y42 Service personnel are competent and professional in solving various problems	3.606	1.070	4.066	0.960	-0.460
	Y43 Service personnel treat customers well	3.971	1.012	4.175	0.896	-0.204
	Y44 Service personnel can provide reliable solutions	3.687	1.091	4.115	0.935	-0.428
Y5 Empathy	Y51 Operators can actively take into account network experience of customers	3.445	1.203	4.101	0.989	-0.656
	Y52 Operators provide customers with personalized services	3.282	1.259	4.000	0.942	-0.718
	Y53 Operators take measures to actively understand customer needs	3.161	1.246	4.017	0.933	-0.856

Service quality dimension	Specific indicator	Average perceived value	St err - perceived value	Average expected value	St err - expected value	Difference between average values
	Y54 Operators put customers' interests first	3.000	1.288	4.026	0.928	-1.026
Y6 Remediation	Y61 Service personnel can actively solve the customers' complaints	3.764	1.098	4.161	0.980	-0.397
	Y62 Service personnel can take appropriate and timely measures to remedy their services	3.790	1.065	4.181	0.923	-0.391
	Y63 Customers know the response of the complaint and its handling process	3.534	1.106	4.098	0.886	-0.564
	Y64 Customers accept the results of complaint settlement	3.687	1.091	4.115	0.935	-0.428

Source: elaborated by the author

The disparity between the average perceived value and average expected value is plotted as the following frequency distribution histogram (see Figure 4.1). It can be seen that the difference between the actual perceived value and the expected value is almost between (-0.6) and (-0.2).

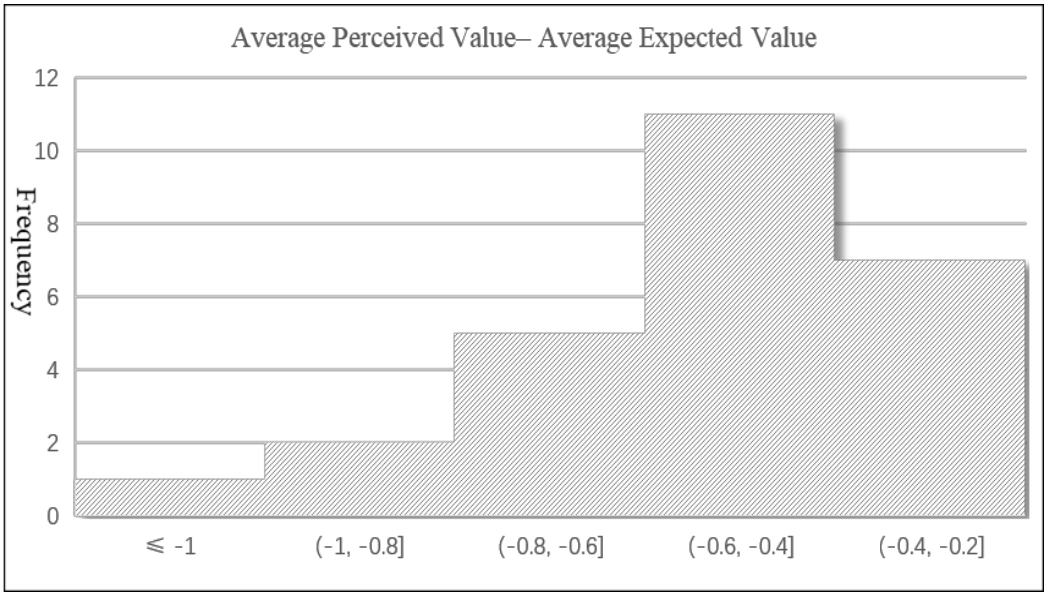

Figure 4.1 Histogram of the gap between the average perceived value and the average expected value

Source: elaborated by the author

By mapping the specific network service quality index values to the six service quality dimensions, the following sample scoring characteristics can be seen more clearly in Table 4.11:

1) In terms of network service quality expectations, reliability has the highest expected

value, followed by tangibility and assurance, while remediation, responsiveness and empathy have relatively lower expectations, but the overall expectation is above 3.9 points;

2) Regarding the actual perception of network service quality, assurance and remediation, received a high evaluation, followed by tangibility, reliability and responsiveness. Empathy received a low evaluation of fewer than 3.5 points, but the general actual perception level can be maintained overall;

3) After subtracting the average value of perception from the average value of the expected value of the index, and performing simple statistics on the gaps obtained, it is found that the gap in remediation is the smallest, followed by assurance, tangibility, reliability and responsiveness, while empathy produces greater perception gap.

Table 4.11 Sample network service quality dimension mean statistics

Dimension of service quality	Average expected value	Average perceived value	Average expected value-average perceived value
Y1 Tangibility	4.144	3.667	0.477
Y2 Reliability	4.176	3.663	0.513
Y3 Responsiveness	4.090	3.533	0.557
Y4 Assurance	4.144	3.698	0.446
Y5 Empathy	4.036	3.222	0.814
Y6 Remediation	4.139	3.694	0.445
Total score	4.122	3.581	0.542

Source: elaborated by the author

4.2.1.2 Test of the difference between the expected value and perceived value

The comparison of the average expected value and the average perceived value of the above six dimensions and 26 indicators of network service quality directly shows the gap between the expected value and perceived value. Since the average may be influenced by individual extreme values and cannot indicate the true level of the whole, it is necessary to statistically verify the difference between the expected value and the perceived value of network service quality with a difference test. The paired T-test can be applied to verify the disparity between the expected value and perceived value.

The total score of network service quality evaluation, scores of six dimensions and 26 indicators were tested with paired samples T-test, and the following Table 4.12 and Table 4.13 were obtained. It can be seen from Table 4.12 that the P values of the total score of network service quality evaluation and the six dimensions are all less than 0.05, manifesting that there are significant differences between the expected value and the perceived value of six dimensions. Table 4.13 shows that the P values of all indicators of network service quality evaluation are also less than 0.05, making clear that there are major differences between the expected value and the perceived value of each indicator of network service quality evaluation.

Table 4.12 Results of paired t-test for total score and six dimensions of network service quality

	Average expected value	Average perceived value	dif	St Err	t value	p value
Total	4.123	3.581	0.541	0.023	23.700	0.000
Y1	4.144	3.667	0.478	0.039	12.200	0.000
Y2	4.176	3.663	0.514	0.037	13.750	0.000
Y3	4.090	3.534	0.557	0.039	14.400	0.000
Y4	4.144	3.699	0.445	0.040	11.250	0.000
Y5	4.036	3.222	0.814	0.045	17.850	0.000
Y6	4.139	3.694	0.445	0.040	11.300	0.000

Source: elaborated by the author

Table 4.13 Results of paired t-test for specific indicators of network service quality

Indicators	dif	p value	Indicators	dif	p value
Y11	0.563	0.000	Y35	0.681	0.000
Y12	0.489	0.000	Y41	0.690	0.000
Y13	0.463	0.000	Y42	0.460	0.000
Y14	0.397	0.000	Y43	0.204	0.002
Y21	0.523	0.000	Y44	0.428	0.000
Y22	0.468	0.000	Y51	0.655	0.000
Y23	0.790	0.000	Y52	0.718	0.000
Y24	0.279	0.000	Y53	0.856	0.000
Y25	0.509	0.000	Y54	1.026	0.000
Y31	0.529	0.000	Y61	0.397	0.000
Y32	0.391	0.000	Y62	0.391	0.000
Y33	0.279	0.000	Y63	0.563	0.000
Y34	0.905	0.000	Y64	0.428	0.000

Source: elaborated by the author

The results of the paired samples T-test verify statistically the significant difference between the perceived value and expected value of network service quality. The network service quality perceived by the customer is lower than expected, which leads to the gap between perceived value and expected value. It can be inferred from the basic statistical analysis that whether from the total score of the network service quality evaluation system based on SERVQUAL scale, the total score of each dimension, or each network service evaluation indicator, the network service quality perceived by the customers is lower than the network service quality expected by the customers. According to the remarkable effects of the test of the difference between the expected value and the perceived value of the network service quality evaluation, the network service quality perceived by customers is not as good as expected quality, which answers the second research question raised in the thesis, that is, the opinions of network service quality are poor, and the network service quality the customer actually has is lower than the quality expected by the customer.

In the validity analysis, the author shows that it is statistically significant to divide the network service quality into tangibility, reliability, responsiveness, assurance, empathy and remediation. In the statistical analysis and difference test in this chapter, the customer's

perceived value of tangibility, reliability, responsiveness, assurance, empathy and remediation is lower than the customer's expected value, which is consistent with the overall evaluation of network service quality. This may also further answer the first research question of the thesis, that is, network service quality is composed of six dimensions: tangibility, reliability, responsiveness, assurance, empathy and remediation.

4.2.2 Weighting evaluation dimensions and specific indicators

In real life, the importance of the six dimensions of network service quality to customers is usually various. Hence, when evaluating the network service quality, we can give different weights to different dimensions by weighting, so as to illustrate the benchmark for customers to evaluate the network service quality, and then calculate the quantitative value of network service quality. The calculation formula is:

$$Q=\sum_{j=1}^{n} W_j \frac{1}{m} \sum_{i=1}^{m} (\overline{P}_i - \overline{E}_i) \quad (4.1)$$

Among them, Q is the customer's evaluation of the overall service quality; $\overline{P}_i$ is the average customer's actual perception of the i-th item, $\overline{E}_i$ is the customer's expected average value for the i-th item, and m is the number of items in the table, n is the number of dimensions of service quality, and W_j is the weight of the j-th dimension of service quality.

Aiming at the weighting of the six major service quality evaluation dimensions, this study adopts the product scaling method which is commonly used in scale processing. It can be considered that the higher the expectations of the individuals for network service quality of a certain dimension are, the higher their attention to the network service quality of this dimension is. Therefore, the importance of the six dimensions can be ranked according to the average expected value of each dimension in the evaluation scale. The scale of dimension K with the lowest importance is set to 1, and then each dimension is compared in pairs. The scale of dimensions with the same importance as dimension K is set to 1; the scale of dimensions with "slightly greater" importance than dimension K is set to 1.354 (J. L. Zhang & Wu, 2003); the scale of dimensions with slightly greater importance than those dimensions with "slightly greater" importance is set to 1.354×1.354, and by analogy, the weights of the six dimensions of network service quality evaluation can be obtained as shown in the table below. The dimensions with weights from high to low are reliability, tangibility, assurance, remediation, responsiveness, and empathy, with weights of 26.86%, 19.84%, 19.84%, 14.65%, 10.82% and 7.99% respectively, as shown in Table 4.14.

From the weights of these six dimensions of network service quality, it can be seen that

customers are most concerned about reliability, namely, “the network services provided are reliable”, “customer problems are solved in a timely and proactive manner”, and “the actual service provided is consistent with the description of the advertisement or service personnel”, “Effective and unblocked manual customer call service is provided”, “Service personnel can answer and solve customer problems accurately”.

Table 4.14 The weights of six dimensions of network service quality of sample

Service quality dimension	Average expected value	Product scale	Weight
Y2 reliability	4.176	1×1.354×1.354×1.354×1.354	26.86%
Y1 tangibility	4.144	1×1.354×1.354×1.354	19.84%
Y4 assurance	4.144	1×1.354×1.354×1.354	19.84%
Y6 remediation	4.139	1×1.354×1.354	14.65%
Y3 responsiveness	4.09	1×1.354	10.82%
Y5 empathy	4.036	1	7.99%

Source: elaborated by the author

From the six major network service quality evaluation dimensions, the weighting granularity is relatively coarse. The difference within the dimension will affect the significance ranking of this dimension, thereby affecting the weighting. Thus, each indicator in the evaluation scale needs to be weighted. In order to obtain the most accurate scores, this study makes use of the product scaling method to gain the weights in each network service quality dimension. The method is the same as above, and will not be repeated. The expected values in each dimension that are different but very similar are treated as the same importance. Finally, Table 4.15 is obtained for the weighting of the network service quality scale indicators:

Table 4.15 Indicator weights of the sample network service quality evaluation scale

Service quality dimensions	Specific indicators	Average expected value	Product scale	Weight
Y1 tangibility	Y12	4.184	1×1.354×1.354	30.45%
	Y14	4.161	1×1.354×1.354	30.45%
	Y13	4.135	1×1.354	22.49%
	Y11	4.098	1.000	16.61%
Y2 reliability	Y23	4.319	1×1.354×1.354×1.354	27.12%
	Y25	4.279	1×1.354×1.354×1.354	27.12%
	Y24	4.181	1×1.354×1.354	20.03%
	Y22	4.092	1×1.354	14.79%
	Y21	4.011	1.000	10.93%
Y3 responsiveness	Y32	4.181	1×1.354×1.354	24.86%
	Y35	4.175	1×1.354×1.354	24.86%
	Y31	4.078	1×1.354	18.36%
	Y34	4.066	1×1.354	18.36%
	Y33	3.951	1.000	13.56%
Y4 assurance	Y41	4.218	1×1.354×1.354×1.354	37.22%
	Y43	4.175	1×1.354×1.354	27.49%
	Y44	4.115	1×1.354	20.30%
	Y42	4.066	1.000	14.99%

Service quality dimensions	Specific indicators	Average expected value	Product scale	Weight
Y5 empathy	Y51	4.101	1×1.354×1.354	33.08%
	Y54	4.026	1×1.354	24.43%
	Y53	4.017	1×1.354	24.43%
	Y52	4.000	1.000	18.05%
Y6 remediation	Y62	4.181	1×1.354×1.354	30.45%
	Y61	4.161	1×1.354×1.354	30.45%
	Y64	4.115	1×1.354	22.49%
	Y63	4.098	1.000	16.61%

Source: elaborated by the author

4.2.3 Analysis of gaps in service quality indicators based on SERVQUAL

After weighting the dimensions and specific indicators of network service quality, the SERVQUAL model is introduced to analyze the gap between actual perception and expectation, and the actual perception value, expected value, and perception expectation gap of each dimension after weighting are calculated as follows in Table 4.16. The author draws a more intuitive line chart (see Figure 4.2) founded on the content of Table 4.16.

Table 4.16 The weighted average perceived and expected values of sample network service quality evaluation

Service quality dimensions	Weighted average perceived value	Weighted average expected value	Gap
Y4 assurance	3.694	4.156	-0.462
Y1 tangibility	3.687	4.232	-0.545
Y3 responsiveness	3.560	4.122	-0.562
Y2 reliability	3.692	4.173	-0.481
Y5 empathy	3.266	4.052	-0.786
Y6 remediation	3.730	4.152	-0.422
Total score	3.634	4.160	-0.526

Source: elaborated by the author

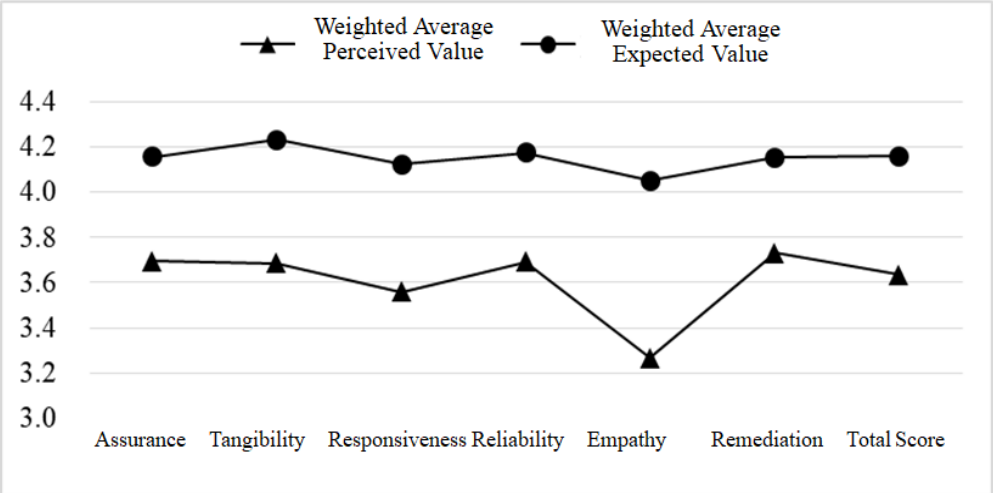

Figure 4.2 Comparison of the gap between the weighted average perceived and expected values

Source: elaborated by the author

On the basis of the weighted average of the indicators, the six quality evaluation weighting dimensions are utilized to calculate the total score of the perceived value and the expected value, and thus the overall gap between the perceived value and the expected value in this investigation and research is obtained.

In line with Table 4.16 and Figure 4.2, the following conclusions on network service quality evaluation can be drawn. The author also speculates on certain reasons here:

1) There is the smallest gap between the weighted average perceived value and that of the expected value for remediation, only 0.422. The specific indicators are "service personnel can actively solve the customers' complaints" (perceived value 3.764), "service personnel can take appropriate and timely measures to remedy their service" (perceived value 3.79), "customers know the response of the complaint and its handling process" (perceived value 3.534), "customers accept the results of complaint settlement" (perceived value 3.687). It can be concluded that mobile network operators have been recognized by customers for their solving of complaints about the quality of their network services, especially in terms of attitude. The indicator of "service personnel can actively solve customers' complaints" has the highest perceived value of network service quality evaluation. Taking the responsibility for service errors and effective measures can reduce the adverse impact of network service errors on customers and the loss of customers.

2) There is a relatively small gap between the weighted average perceived value and that of expected value for assurance, only 0.462. The specific indicators are "service personnel are skilled at solving the problems consulted by customers" (perceived value 3.529), "service personnel are competent and professional in solving various problems" (perceived value 3.606), "service personnel treat customers well" (perceived value 3.791), "service personnel can provide reliable solutions" (perceived value 3.687). It can be concluded that the service attitudes and business capabilities of mobile network service personnel have been recognized by customers. The efforts of mobile network operators in training service personnel's vocational skills and enhancing their professionalism and professional knowledge have provided a sound guarantee for customers to use network services.

3) There is a moderate gap between the weighted average perceived value and that of the expected value for reliability, which is 0.481. The specific indicators are "the network service provided is reliable" (perceived value 3.489) and "customer network experience problems are solved promptly and actively" (perceived value 3.624), "the actual service provided is consistent with the description of the advertisement or service personnel" (perceived value 3.529), "Effective and unblocked manual customer call service is provided" (perceived value

3.902), “service personnel can answer and solve customer problems accurately” (perceived value 3.77). It can be seen that the mobile network operators have won the trust of customers, especially in the effectiveness and smoothness of the manual service calls, which has been highly recognized by customers. However, there is still room to improve network service experience, advertising and marketing, such as improving unstable mobile network signals, and accelerating the slow network speed. Concurrently, the crooked promotion that misleads customers is also reducing the favorable impression of customers.

4) There is a moderate gap between the weighted average perceived value and that of the expected value for tangibility, which is 0.545. The specific indicators are “the business hall has modern supporting equipment” (perceived value 3.534), “service personnel are neat and tidy” (perceived value 3.695), “the overall environment of the business hall is comfortable and attractive” (perceived value 3.672), “the intelligent voice of customer service call is intelligent and efficient to answer questions” (perceived value 3.764). It can be seen from this that the externally visible service characteristics of mobile network services have been affirmed by consumers, especially the intelligent customer service call, which has a high perceived value. This is closely related to the trend that the operators have put much investment in science and technology of intelligent services to facilitate the life of people. Business outlets still need to increase investment in modern equipment.

5) There is a relatively large gap between the weighted average perceived value and that of the expected value for responsiveness, which is 0.562. The specific indicators are “service personnel can provide timely service” (perceived value 3.549), “manual customer service calls can be quickly connected” (perceived value 3.79), “customer problems can be solved within the promised time” (perceived value 3.672), “for complex problems, service personnel can actively seek solutions for customers” (perceived value 3.161), “the service personnel can determine the time to solve the problem” (perceived value 3.494). The customers give a low evaluation on the responsiveness dimension, making known that the mobile network service personnel do not solve the customer’s problems in time. Especially, there is a low perceived value for the indicator that service personnel can actively seek solutions for customers, indicating that the network service personnel should improve their service awareness.

6) There is the largest gap between the weighted average perceived value and that of the expected value for empathy, which is up to 0.786. The specific indicators are “operators can actively take into account network experience of customers” (perceived value 3.445), “operators provide customers with personalized services” (perceived value 3.282), “Operators take measures to actively understand customer needs” (perceived value 3.161), “operators put

customers' interests first" (perceived value 3.000). It can be seen that there is the largest gap for empathy, because mobile network operators do not adequately maintain customer interests. In the premise of two indicators with the lowest scores, they do not consider customer interests well, nor do they understand the customer needs actively, which has dissatisfied the customers.

7) Finally, in line with the weighted total score, it can be seen that the actual evaluation of the quality of the network service by the customer is at a general level, but the customer actually has a higher expectation for this, which leads to a relatively large perceived expectation gap. It can further answer the second question raised in the thesis, that is, the perceived network service quality is not good.

4.3 IPA analysis of network service quality evaluation

After conducting an empirical analysis of network service quality based on the SERVQUAL model, this research will continue to use Importance-Performance Analysis, namely, the IPA analysis method, to further analyze the satisfaction of each network service quality dimension and each specific indicator, in order to obtain more obvious elements of network service quality, and provide a useful reference for mobile operators to improve network service quality.

In this study, the average expected value in the SERVQUAL model is taken as the "importance degree", and it is the horizontal axis; the average value of the customer's actual perception value is regarded as the "performance level", and it is the vertical axis. After the weighting of service quality dimensions and specific indicators, the total score of the weighted average expected and perceived values are used as the origin, and a rectangular coordinate system is drawn. The rectangular coordinate system divides the plane area into four quadrants. Starting from the upper right quadrant, the four quadrants were clockwise named quadrant I, quadrant II, quadrant III, and quadrant IV successively. According to the features of the IPA analysis method, the coordinate points formed by the differences between the weighted average of the six major network quality dimensions as well as the value of each specific indicator and the total score of the expected value and the perceived value (origin) are drawn into the rectangular coordinate system for positioning analysis.

4.3.1 IPA analysis of the six dimensions of network service quality

The IPA analysis positioning map of the six major network service quality dimensions is shown in Figure 4.3 below.

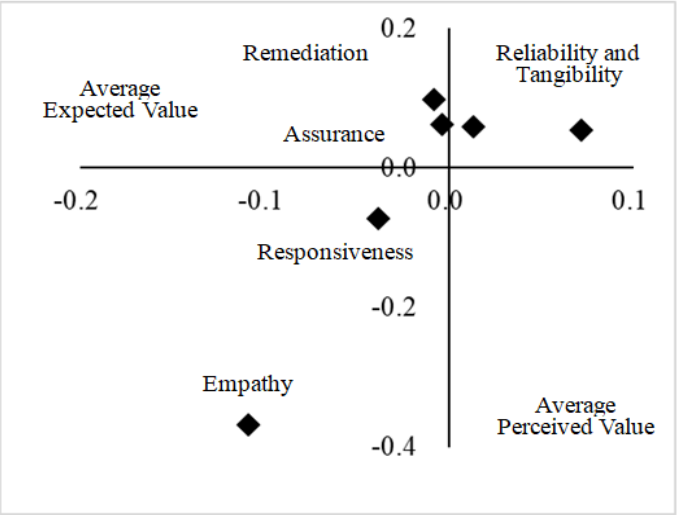

Figure 4.3 IPA analysis of the six major network quality dimensions

Source: elaborated by the author

The dimensions of each quadrant can be analyzed as follows:

1) Analysis of IPA positioning in quadrant I: reliability and tangibility

Quadrant I belongs to the dominant area. Reliability and tangibility dimensions fall in this quadrant, indicating that reliability and tangibility are value-added factors with high customer expectations. Compared with other dimensions, these two dimensions of network quality service have a higher degree of contribution to the overall evaluation of network service quality, and should continue to maintain their advantages. And the weights of these two dimensions are also very large, 26.86% and 19.84% respectively, which are the highest weights, which fully demonstrate their importance. This result can make the following recommendations for the mobile operator: the company should continue to invest available resources on the reliability and tangibility of network service quality and maintain their advantages.

2) Analysis of IPA positioning in quadrant II

Quadrant II belongs to the repair area. Factors falling into this quadrant indicate that their network service quality is of high significance, but their actual service quality level is low, which belong to the priority improvement factors. At present, no dimension falls into this quadrant, which proves that mobile operators can perceive customer needs in general, and there is no major error in the dimension of network service quality that customers value.

3) Analysis of IPA positioning in quadrant III: responsiveness and empathy

The third quadrant belongs to the area of opportunity, and the responsiveness and the empathy dimensions fall into this quadrant, which shows that customers do not value these service quality dimensions very much, and their actual service quality level is relatively low, which belong to the improvement factors. It is worth noting that although the empathy factor

has achieved the lowest expected value, it also achieved the lowest average value of perception. Hence, empathy should have a greater negative impact on the overall evaluation of service quality, and the mobile operator should pay enough attention to and focus on it, after the priority factors for improvement are resolved.

4) Analysis of IPA positioning in quadrant IV: remediation and assurance

Quadrant IV belongs to the maintenance area. The remediation dimension and the assurance dimension fall into this quadrant, which demonstrates that their importance is relatively low, but their actual service level is high and they are basic factors with a low contribution rate to the overall evaluation of network service quality. For the mobile operator, these factors can be ignored temporarily and it is unnecessary to pay too much attention to them. Hence, it is only necessary to continue to keep the advantages of the assurance dimension as well as the remediation dimension and maintain customer demand.

4.3.2 IPA analysis of network quality evaluation scale indicators

Aiming at the specific indicators under the six major network service quality dimensions, the IPA analysis positioning map is drawn as shown in Figure 4.4 below.

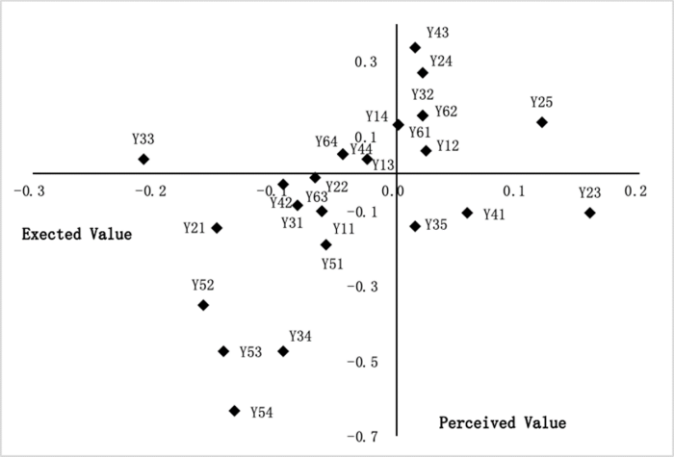

Figure 4.4 IPA analysis of specific indicators

Source: elaborated by the author

The following analysis can be made for the indicators of each quadrant:

1) IPA positioning analysis of quadrant I

Quadrant I belongs to the advantage area, in which fall the following indicators: “Y12 service personnel are neat and tidy”, “Y14 the intelligent voice of customer service call is intelligent and efficient to answer questions”, “Y24 effective and unblocked manual customer call service is provided”, “Y25 service personnel can answer and solve customer problems accurately”, “Y32 manual customer service calls can be quickly connected”, “Y43 service

personnel treat customers well", "Y61 service personnel can actively solve the customers' complaints", "Y62 service personnel can take appropriate and timely measures to remedy their services". These indicators are all related to the attitudes of network service personnel, indicating that the mobile network operator has trained service personnel in professional attitudes to maintain their momentum. It is also necessary to maintain technological advances, for example, intelligent customer service, which can bring a good experience to customers.

2) IPA positioning analysis of quadrant II

Quadrant II pertains to the repair area, in which fall the following indicators: "Y23 the actual service provided is consistent with the description of the advertisement or service personnel", "Y35 the service personnel can determine the time to solve the problem", "Y41 service personnel are skilled at solving the problems consulted by customers". There are a few indicators in quadrant II, but most of them are related to the effect of network service personnel in communicating with customers, which indicates that the actual effect of the communication of information by the network service personnel has not been able to meet the expectations of customers and that the operator needs to improve corresponding ability to improve the network service quality.

3) IPA positioning analysis of quadrant III

Quadrant III is part of the opportunity area, in which fall the following indicators: "Y11 the business hall has modern supporting equipment", "Y21 the network service provided is reliable", "Y22 customer network experience problems are solved promptly and actively", and "Y31 service personnel can provide timely service", "Y34 for complex problems, service personnel can actively seek solutions for customers", "Y42 service personnel are competent and professional in solving various problems", "Y51 operators can actively take into account network experience of customers", "Y52 operators provide customers with personalized services", "Y53 Operators take measures to actively understand customer needs", "Y54 operators put customers' interests first", "Y63 customers know the response of the complaint and its handling process". There are myriads of indicators in quadrant III. It shows that the actual service (resource input) of the mobile operator is appropriate, and the actual demand of customers has been predicted. However, such a large number of network service quality indicators indicate that the operator shall make full efforts to better network service quality in many aspects. The operator should focus on several indicators (Y52, Y53, Y21 and Y54) with particularly low perceived values, which are closely related to the interests of customers.

4) IPA positioning analysis of quadrant IV

Quadrant IV belongs to the maintenance area, in which fall the following indicators: "Y13

the overall environment of the business hall is comfortable and attractive", "Y33 customer problems can be solved within the promised time", "Y44 service personnel can provide reliable solutions", "Y64 customers accept the results of complaint settlement".Some indicators fall in quadrant IV, indicating that the mobile operator has better maintenance for these basic factors with low importance but high actual service level. The suggestion is to continue to meet the current needs of customers, without excessive input.

4.4 Exploration on the influencing factors of network service quality evaluation based on the results of empirical data analysis

In the gap analysis of service quality indicator based on SERVQUAL, the gap between customer's perceived value and expected value of remediation and assurance is the smallest. In other words, the customers praise the assurance and remediation of network service quality, so the factors implied by these two dimensions should be the factors which have a positive effect on the network service quality evaluation in empirical analysis. From the meaning of remediation and the ratings of specific indicators (refer to Table 3.3 and Table 4.10), it is thus clear that the remedial measures and the attitude of service personnel in service remediation improve the evaluation of network services by customers. They are the factors influencing network service quality. It can be seen from the meaning of assurance and the concrete score (refer to Table 3.3 and Table 4.10) that the customers accept the service attitude and business ability of the network service personnel, and speak highly of the attitude and ability. Consequently, the service attitude and service ability of the network service personnel are also the influencing factors of the network service quality. For good measure, in that IPA analysis, both the assurance and the remediation are located in the quadrant of the maintenance region, which shows that service remedial measures, service remedial attitude, service personnel's attitude and business ability play a positive role in the evaluation of network service quality. It is necessary to keep the advantage.

In the gap analysis of the SERVQUAL-based network service quality indicators, the evaluation of reliability and tangibility is at a medium level, and the gap between the customer's perceived value and expected value of reliability and tangibility is moderate, showing that the factors behind reliability and tangibility have both positive and negative effects on the evaluation of network service quality in empirical analysis. The analysis on the meaning of reliability and the ratings of specific indicators (see Table 3.3 and Table 4.10) show that efficiency and smooth operation of manual service calls and active resolution of network

problems are highly recognized. The service personnel should have a positive service attitude and professional ability to back up the efficiency and smooth operation of manual service calls as well as active resolution of network problems. It also proves that this factor may influence the network service quality evaluation. The reliability has a low rating in terms of the reliability of network service and the authenticity of the network service advertisement, which are related to the operator's understanding of customer demand and the management of customer service experience. It can be seen that in the empirical analysis, the understanding of customer demand and the management of customer service experience have a negative effect on the network service quality evaluation.

The analysis on the meaning of tangibility and the ratings of indicators (see Table 3.3 and Table 4.10) show the high ratings for the intelligence and efficiency of intelligent voice interaction of customer service calls. Behind the intelligent voice interaction of customer service calls is the improvement of the network service information system. It can be seen that the network service information system is a positive factor affecting the network service quality evaluation; however, the ratings for tangibility are poor in terms of environment and equipment modernization of business hall. In fact, the comfortable environment and modern equipment are important for the network service experience. The improper management of network service experiences has a negative effect on the network service quality evaluation. In the IPA analysis, both the reliability and tangibility are located in the quadrant of the dominant region, which are the value-added factors. Consequently, it is necessary to optimize indicators behind the reliability and tangibility (such as the understanding of customer demand and the management of customer service experience). Meanwhile, the factors (such as the positive service attitude and professional competence of service personnel, and the use of network service information systems) that play a positive role are maintained.

In the end, in the gap analysis of service quality indicators based on SERVQUAL, the responsiveness and empathy obtain the lowest network service quality evaluation, indicating that the factors implied by the two dimensions play a negative role in the network service quality evaluation in empirical analysis. From the meaning of responsiveness and the ratings of specific indicators (see Table 3.3 and Table 4.10), it can be seen that the customer's network service experience and service awareness of the network service personnel lower the customer's ratings on network service quality, customer network service experience and service awareness of network service personnel are the negative factors that affect the network service quality evaluation. From the meaning of empathy and the ratings of the indicators (see Table 3.3 and Table 4.10), the operator's active care for customer experience and understanding of customer

demand are not recognized by customers. The active care of customer experience and the understanding of customer demand are important embodiments of the customer interaction management of the operator; meanwhile, the operator's personalized service for the customer also gets a low evaluation, which indicates that standardization and personalization of services play a negative role in network service quality evaluation in the empirical analysis; In addition, customers believe that operators do not put the interests of customers first, which reflects the impact of operators' strategic concept factor on their service quality. How much importance is attached to the interests of customers is a very important concept and policy of service-oriented enterprises. In the IPA analysis, it can be seen that the responsiveness and empathy fall in the quadrant of the opportunity region, which indicates that these two dimensions can be perfected. The factors such as customer interaction management, standardization and personalization of services, and operator's strategic concept need to be paid attention to and improved continuously.

In the light of the results of gap analysis and IPA analysis of network service quality founded on SERVQUAL, there are some important factors influencing the network service quality evaluation, including service remedy measures, service remedy attitude, service personnel attitude and business ability, customer demand understanding, customer service experience management, network service information system support, customer interaction management, service standardization and personalization, and operator's strategic concept. Simultaneously, it also answers the third research question (what factors may influence the network service quality evaluation results?) at the beginning of the thesis. These factors will be an important basis for the improvement of network service quality in the future. The operators should continue to maintain the factors that play a positive role in network service quality evaluation, and improve the factors that play a negative role.

4.5 Empirical analysis conclusion

In the empirical analysis of this research, the sample characteristics of the 348 effective samples collected were first analyzed. The sample characteristics such as balanced male and female ratio, youthful age, high education, and frequent use of the Internet proved the accuracy and reliability of the sample. Secondly, the validity and reliability of the sample were analyzed. The KMO valued as high as 0.892, the larger Bartlett test chi-square distribution value, and the significance of Bartlett test less than 0.05 all proved the authenticity, accuracy, stability and reliability of the sample from a statistical point of view. In view of this, the author believes that

the network service quality evaluation system based on accurate and reliable samples is applicable to network service quality evaluation and has the reference for the network service quality management of mobile operators.

This empirical study can draw the following conclusions:

1. Customers have high expectations for network service quality, but the actual perception of network service quality is relatively ordinary. The average expected value of all network service quality indicators is higher than the actual perceived average, which does not meet the expected needs of customers.

2. There are dimensional differences in customer evaluation of network service quality. The gap between the weighted average network service quality perception value and the expected value calculated based on the weighted SERVQUAL model shows that the remediation dimension has achieved good results in meeting customer expectations, followed by the assurance, tangibility, responsiveness and reliability, while empathy creates a large gap between perception and expectation.

3. From the perspective of specific indicators, it is necessary to focus on the four indicators with the largest actual perception value, the smallest actual perception value, the largest perceived expectation gap, and the smallest perceived expectation gap. These indicators are: “Y43 service personnel treat customers well” “Y54 operators put customers’ interests first” “Y43 service personnel treat customers well” “Y54 operators put customers’ interests first”. The good attitudes of network service personnel have gained good reviews from customers. Operators should continue to strengthen the training of their professional attitudes and maintain their advantages. Operators’ non-caring about customer interests has become the worst factor affecting the evaluation of network service quality, which should be highly valued by the operators.

4. On the basis of the SERVQUAL scale score, an IPA analysis was carried out, and the matching degree between the customer’s emphasis on network service quality or specific indicators and the actual network service quality level was obtained. The analysis results found that:

1) The dimensions of reliability and tangibility fall into the advantage area, for which customers have higher expectations and where the network service quality is relatively high. Hence, resources should be invested to maintain the advantage of this area. The dimensions of responsiveness and empathy fall into the area of opportunity, which are not valued by customers, and in which the actual network service quality is not high. Enough attention should be paid to empathy with very low perceived value. The assurance and remediation dimension falls into

the maintenance area, where customers do not have high expectations, but the actual service level is relatively high. As a result, these factors can be ignored for the time being, and customer demands should be maintained.

2) Some indicators related to the subjective attitude of network service personnel fall into advantage areas, manifesting that the mobile network operator has achieved good results in training service personnel in professional attitudes and need to continue to maintain their advantages. A few indicators related to the interaction ability of network service personnel are in the repair area, indicating that customers value the interaction ability of network service personnel, but in reality, they have not met the requirements of customers, so the operator needs to prioritize this problem. Many indicators fall into the opportunity area, indicating that on the one hand, there is no misalignment in the actual service level (resources) of the mobile operator, and on the other hand, there are many areas for the operator to perfect. Among them, there are several indicators with extremely low actual perception values, which are closely related to customer interests and need to be focused on. Indicators that fall into the maintenance area can be temporarily ignored, and there is no need to pay too much attention to it, as long as the advantages are maintained.

5. According to gap analysis of service quality indicators based on SERVQUAL and the results of IPA analysis, some important factors influencing the quality of network service evaluation are inferred, some of which have a positive impact on the network service quality evaluation in the empirical analysis, including service remedy, service remedy attitude, service personnel attitude and business ability, support of network service information system. And some factors have a negative impact on the network service quality evaluation in the empirical analysis, such as customer demand understanding, customer service experience management, customer interaction management, service standardization and personalization, and the strategic concept of the operator.

These factors will be the important basis of improving the network service quality in the future.

After conducting empirical analysis, the first three research questions raised at the beginning of this study have been basically solved: first, what constitutes the quality of network service? second, what is the current status of network service quality evaluation? third, what factors may influence the network service quality evaluation results? The solution to the first three research questions will also provide the basis and direction for solving the fourth research question. The fourth research question, “how can the management level of network service quality be improved based on the influencing factors?” will be answered in the next chapter.

Chapter 5: Optimization for Network Service Quality Management

5.1 Process design for network service quality management optimization

5.1.1 Contents to be improved for network service quality management

In the empirical analysis of the previous chapter, this thesis conducted a layer-by-layer in-depth analysis on the operator's network service quality questionnaire data which is deliberately designed and based on the SERVQUAL, including the basic statistical analysis of the network service quality evaluation indicators, the gap analysis of network service quality evaluation indicators which is based on unweighted and weighted SERVQUAL method, and the IPA analysis which is based on network service quality dimensions and indicators, and reveals the current status of operators' network service quality, as well as the main influencing factors.

The current situation of network service quality is not satisfying, and the average expected values of customer network service quality indicators are higher than the average perceived values. Among them, the empathy dimension has the largest gap between perceived value and expected value, that is, the operator's care for customers and demand insights are far from the customer expectations.

In the IPA analysis, it is found that the low communication and interaction ability of network service personnel, false marketing advertisements, subjective neglect of customer interests, and the mismatch between some resource input and actual customer needs are significantly out-of-control links of the operator in the process of network service quality management. Concurrently, according to the results of gap analysis and IPA analysis of network service quality which are based on SERVQUAL, the author has summarized some important factors influencing the network service quality evaluation, including service remedy, service remedy attitude, service personnel attitude and business ability, network service information system support, customer demand understanding, customer service experience management, customer interaction management, service standardization and personalization, and operator's strategic concept.

In this chapter, the key point is to solve the fourth research question raised at the beginning

of the thesis: how can the management level of network service quality be improved based on the influencing factors? From the data and conclusions of the empirical analysis in the previous chapter, the contents that the MC operator needs to modify and continue to maintain in the network service quality management can be obtained.

Firstly, from some specific indicators of the network service quality evaluation dimensions of remediation, assurance and reliability, the indicators related to network service personnel have been well evaluated, such as "service personnel can actively solve customer complaints", "service personnel have a good attitude towards users", "the service personnel have the high problem-solving ability", "the solutions provided by the service personnel are trustworthy", "provide effective and smooth manual service calls", "the accuracy of the service personnel in answering and solving user problems", most of these indicators fall in the advantage area in IPA analysis, and the improvement of network service personnel is the content that needs to be maintained and paid attention to. Secondly, the network service quality evaluation dimension and specific indicators related to service recovery have been highly evaluated, and fall in the maintenance area in IPA analysis, reflecting that service recovery also needs to be maintained; over and above, advanced network service information system has also been highly praised, for example, the specific index score of "the intelligent voice of customer service telephone appears to be intelligent and efficient in interactive problems" is high, and falls in the advantage area of IPA analysis, indicating that the improvement of network service information system also needs to continue to maintain its advantages.

However, from the perspective of some specific indicators in the network service quality evaluation of reliability and tangibility, the customer service experience had not been well managed, such as "the business hall has modern supporting equipment", "timely and actively solve the problems of network experience of the users" and "the network service provided by operators is reliable" and other indicators didn't achieve high scores. From the perspective of some specific indicators of reliability and empathy evaluation dimensions, the MC operator also didn't actively interact with customers and did not well grasp customer needs, such as "the actual network services provided are consistent with the descriptions of advertisements or service personnel", "operators actively care about user network experience" and "operators take measures to proactively understand user needs" got a very low score. For good measure, the MC operator also failed to achieve good results in providing personalized services for customers, and the index of "operators provide tailored services for customers" in the evaluation of empathy obtained a very low score. Combined with the above analysis contents and the low scores of "operators take measures to actively understand user needs" and "operators put

customer problems first" in the evaluation of empathy, it can be seen that the MC operator is difficult for customers to feel operators' concern for customers' interests at the level of service concept and strategic planning.

The internal and external shocks confronted by operators' network services mentioned in the background research at the beginning of this thesis, including inter-operator competitions, the digital layout of mobile communications by giant technology companies, the "number portability" policy, and the development of 5G technology, which will bring many variables to the industry structure. Actively improving the quality of network services is an important focus for operators to seize opportunities and take the lead in the far from the rosy current situation of network service quality and the industry pattern of internal and external difficulties.

5.1.2 The optimization process design of network service quality management based on PDCA

After analyzing the contents that the MC operator needs to improve in network service quality management, it is necessary to put forward specific optimization suggestions and measures for these contents to be optimized and maintained. The above has summarized the contents that need to be improved, including the advantages of maintaining the improvement of network service personnel, service recovery and network service information system, as well as the disadvantages of customer service experience management, interaction with customers, providing personalized services and putting customer interests into the service concept. However, if only specific improvement measures are put forward for each problem, it is easy to ignore the overall situation and lose sight of each other. So the author thinks that to improve the quality management level of network service, it is necessary to use a set of practical quality management methods as a guide and combine the problems found in the empirical study of this thesis to give specific measures and suggestions.

In the literature review, four classic quality management theories are introduced, which are ISO9001 quality management system and process, PDCA cycle and process method, total quality management method, fishbone diagram method.

The ISO9001 quality management system and process have strong standardized attributes. MC and most companies will follow this basic and standardized quality management system, so this standardized management method is not recommended for the network operators in this thesis; although the total quality management method stipulates the concept of total quality, the management objects of TQM are broad and comprehensive, and it is not the precise theory for the "network service quality" sought in the thesis; fishbone diagram emphasizes more analysis

and forms targeted measures for the end factors that cause negative effects, which is not suitable for process management guidance. On the whole, founded on the attributes of intangibility, simultaneity of production and consumption, non-storability and heterogeneity of services, and the large customer group, this thesis adopts the PDCA cycle and process method for the optimization of network service quality management. The pattern of the PDCA is (1) P (Plan), to make plans, goals, and concurrently determine the activity plan at this stage; (2) D (Do), to implement the plan, do it on the spot; (3) C (Check), to check the effect of the activities based on the goals; (4) A (Action), to analyze the check results, get the effect and unresolved problems, confirm, promote and standardize successful experience and start the next PDCA. Established on this method and the research results of scholars (Fang, 2003), and the characteristics of network service quality and actual interviews, this thesis summarizes the following network service quality management system in Figure 5.1.

The general idea in this chapter will be established on the network service quality management system flow chart, and will be adjusted according to its importance. Here is a description of the relationship between the contents of this chapter and the contents that need to be furthered by the MC operator obtained from the empirical analysis: most of the contents that need to be elevated in the above analysis are improvement measures for service quality management. Among them, the MC operator fails to provide personalized services, which corresponds to the contents of service standardization and personalization sections. The network service information system corresponds to the content of the service information system support section. The network service personnel corresponds to the content of the service personnel improvement section in the service quality management. Failure to well manage the customer experience and failure to actively interact with customers correspond to the content of the service delivery process section, and the service recovery corresponds to the content of the service recovery and continuous optimization section. In terms of service quality management, the guidance of a comprehensive and scientific service system is needed, which section corresponds to the above analysis that the MC operator does not have done enough to grasp customer needs and establish service concepts. For the purpose of completing the design of the network service system and implementing the measures of network service quality management, the guidance of strategic concept and the guarantee of the organizational system is needed.

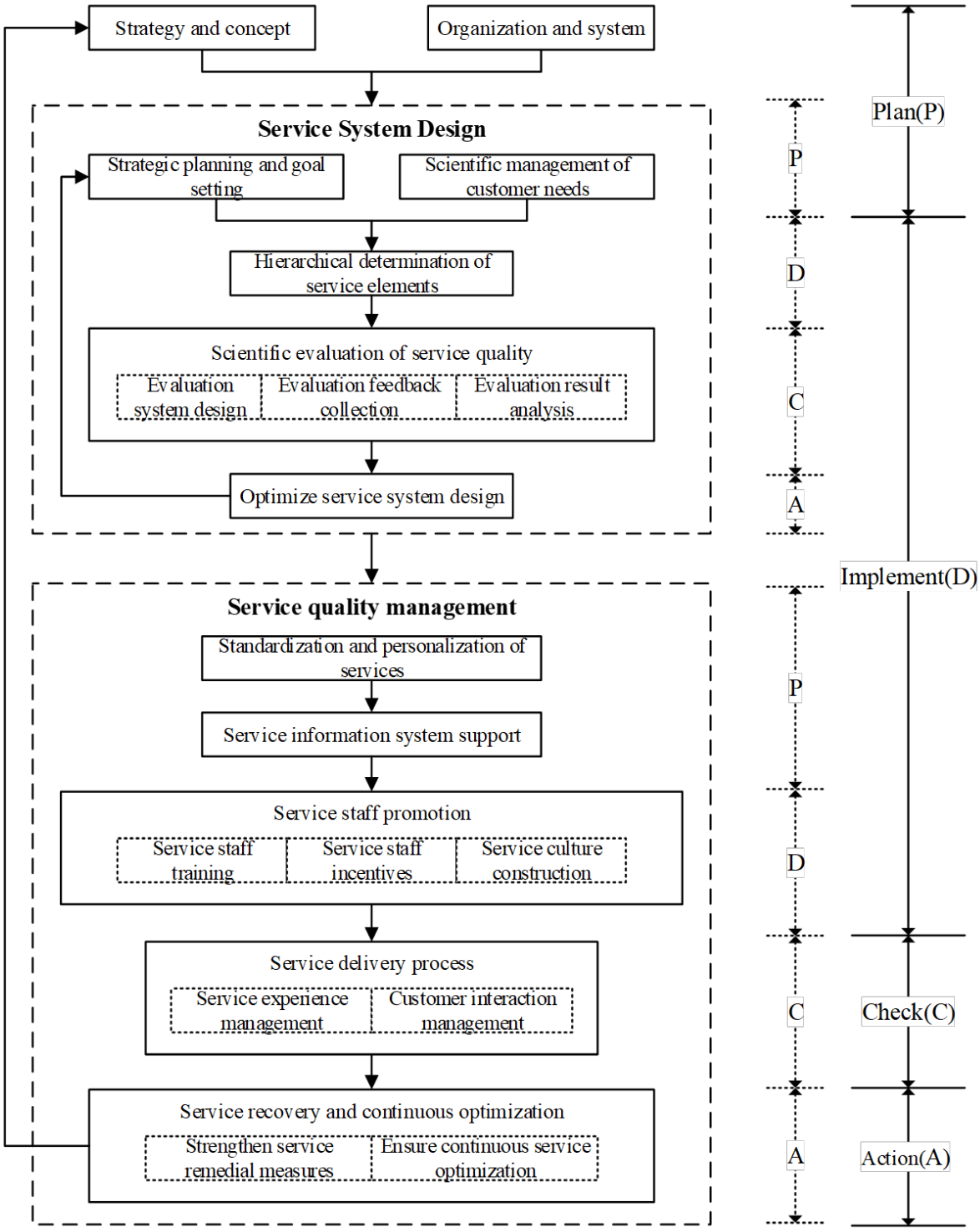

Figure 5.1 Flow chart of network service quality management system

Source: elaborated by the author

All in all, this chapter will first design the operator's network service system, successively discuss strategic planning and target establishment, scientific management of customer needs, hierarchical determination of service elements, scientific service quality evaluation (containing the design of evaluation system, collection of evaluation feedback, analysis of evaluation results), and optimization of service system design. As the network service system is designed

for network service quality management, and the network service quality management can, in turn, promote the optimization of the network service system, this chapter will discuss the management of the network service quality of operators after the network service quality system is put forward. In line with PDCA method, combing the important factors found in the empirical analysis which influence the network service quality evaluation, including service remedy, service remedy attitude, service personnel attitude and business ability, customer demand understanding, customer service experience management, network service information system support, customer interaction management, service standardization and personalization, and operator's strategic concept, the following will be discussed in order: the standardization and personalization of service, the support of service information system, the improvement of service personnel's capabilities through training, incentives, and cultural construction, and standardizing the delivery of service processes with service experience management and customer interaction management, as well as service remediation and continuous optimization. Subsequently, in order to ensure the smooth implementation of network service quality management, two safeguard measures are raised, which are a clear strategy and concept, and the establishment of an organization and a system. At the end of this chapter, the contents of this chapter are summarized.

5.2 Design of operator network service system

High-quality service begins with a clear, efficient and executable service system, which is the cornerstone of customer service quality. For operators, the design of the network service system is placed in front of the network service quality management process. It is actually the foundation of the network service quality management process. In the network service quality management process, the system will continue to optimize and iterate to be more beneficial to the network service quality management procedure. The design of the service system includes strategic planning and goal establishment, scientific management of customer needs, hierarchical determination of service elements, scientific evaluation of service quality, and optimization of service system design.

5.2.1 Strategic planning and goal establishment

The service system design is based on the company's strategic planning and the goals of each stage established therefrom, which usually needs to be formulated according to various factors such as industry development trends, market competition patterns, corporate values, and

customer needs. At present, network service operators are faced with the harsh background of the digital layout of mobile communications of giant technology companies brought by 5g technology, the homogenization competition within operators intensified by the "number portability" policy, and customers' increasingly high requirements for network service quality under the background of consumption upgrading, network service operators need to formulate reasonable strategic plans, clear and executable goals based on the corporate values.

In the empirical research part, regarding the evaluation of network service quality, the empathy dimension received the lowest evaluation, including that customers think operators do not give enough care to them and do not put customers' interests in the first place. Therefore, when establishing strategic planning, operators need to put the interests of customers first and take customer care as an important strategic direction.

5.2.2 Scientific management of customer needs

Customers are the demanders of network services, and they are the direct and final evaluators of network service quality. Since the evaluation of network service quality depends on the gap between expected values and perceived values of customers, it is necessary to understand the real network service needs and expected values of network services of customers.

In the empirical analysis part, regarding the evaluation of network service quality, indicators such as "operators take measures to actively understand user needs" and "network services provided by operators are reliable" received low customer evaluation, indicating that there is still a long way to go for improvement in communication with customers on demand. Nevertheless, not all customer needs to require to be met, especially unreasonable desires and technically unreachable demands. Hence, a certain degree of reasonable guidance to customer needs is required.

1. Providing options

If customers are asked to give their own standards of service quality expectations, the standards are usually endless and vary from person to person. Thus, service-oriented enterprises often regulate customer expectations by providing options or allowing customers to reset expectations. The "package" launched by operators, which focuses on Internet traffic services and combines other services, is the use of this method. In this way, customer expectations are relatively fixed.

2. Value-graded service

Product-oriented companies usually provide products at different prices for customers with different value perceptions and economic conditions. Although various customers have

different price requirements, this is indeed consistent with the values they perceive. Practices have proven that this method is also suitable for service-oriented enterprises. For operators, the concept of value classification can be applied to network services to create value graded services, that is, to provide ordinary network services for customers with low demand or tight budgets, and a higher level of network service and support for customers with higher willingness and payment.

3. Communicating the standards of effective service

Network service operators should establish reasonable network service standards for customers to evaluate service quality. If they lead customers in a credible way, they will have an advantage in the evaluation process. Face-to-face interviews and telephone follow-ups are the most effective way to communicate with customers. Through interviews, reasonable network service standards are provided to customers, which can provide customers with accurate network service standards and get customer feedback in time. Customers who accept these standards will use these standards to measure other companies. In addition to the evaluation criteria, the same method can be adopted for service levels.

4. Negotiating unrealistic expectations

Customers sometimes express that they are willing to obtain a general level of network service at the lowest price, and the price usually has a certain positive relationship with the quality. It is usually unrealistic to obtain high-quality network service quality at the lowest or lower service price. In this case, operators must learn not only to show the price of network services but also the value of network services.

5. Effectively managing and controlling customer needs and service quality expectations

The satisfaction of customer network service needs and the improvement of network service quality are endless, but customer quality needs and expectations can be controlled. Through the control and management of customer network service requirements and network service quality expectations, the goal of improving customer network service quality evaluation can also be achieved. The telecommunications service industry should be a typical industry that conforms to the economic law of "supply determines demand". Operators have a strong guiding role in customer demand, so operators should try to avoid promoting sales and giving promises beyond their own capacity and technical constraints.

5.2.3 Hierarchical determination of service elements

First, it is necessary to determine the service elements that can meet customer expectations and that operators can effectively manage. For example, the five dimensions (tangibility, reliability,

responsiveness, assurance, and empathy) of the concrete SERVQUAL method can be used as service elements. Or the six dimensions of tangibility, reliability, responsiveness, assurance, empathy and remediation designed in this thesis based on the SERVQUAL model and network service quality characteristics can be used as service elements. According to the House of Quality matrix proposed by American scholars J. R. Hauser and D. C1ausing, training, attitude, ability, information, equipment and other service elements that managers can manipulate could be used as the service elements (Hauser & Clausing, 1988). After confirming the basic service elements, it is necessary to mark the correlation strength between the service elements. The quality improvement of the service elements with strong correlation can affect each other, so it can provide a certain foundation for improving service quality and reducing resource mismatch and waste. The next step is to weigh service elements, and operators need to determine resource input based on the importance of service elements. The basis for the weights of service elements is the correlation between the service elements and the corresponding customer expectations, the degree to which customers attach importance to the service elements. The closer the relationship with customers is, the more important the service elements are, and the increase in the perceived value of the customers brought by improving the quality of network services will be even greater. When operators balance the investment in various service elements, they should also favor these service elements that are strongly connected to and valued by customers.

5.2.4 Scientific evaluation of service quality

Scientific evaluation of service quality is the premise of testing the results of network service quality and the basis for making reasonable decisions in the future. Hence, designing a reasonable network service quality evaluation system, collecting a wide range of objective network service quality evaluation feedback, and performing accurate and in-depth analysis of the network service quality evaluation results are important in the design of the network service quality service system and network service quality management.

5.2.4.1 Network service quality evaluation system

The network service quality evaluation system is the foundation for scientific service quality evaluation. Established on the SERVQUAL method in this thesis and the operator’s practice in customer service quality evaluation, the following recommendations regarding network service quality evaluation systems are proposed:

1. SERVQUAL service evaluation model

The SERVQUAL model method is the service quality evaluation method used in the

questionnaire design and empirical analysis of the network service quality evaluation system in this thesis. Compared with the Gronroos customer perception model, the PZB gap model, and the SERVPERF method, it is believed that the SERVQUAL method is more suitable for the research of network service quality in terms of representativeness, generality, measurability and interpretability. In the empirical analysis, the sample data collected by the study also passed the verification of reliability and validity. From the perspective of academic comparison and empirical analysis, the SERVQUAL method has certain advantages. In fact, the SERVQUAL method has been widely used in developed countries. The SERVQUAL method applied by the economy in which the service industry accounts for more than 70% of GDP is worth learning from by domestic service companies.

In the design of the actual SERVQUAL network service quality evaluation system, operators can refer to the revised network service quality evaluation system (see Table 3.3) and the revised network service quality questionnaire (see Annex B) based on the features of network services in this thesis. That is, the remediation dimension and corresponding indicators are added based on traditional SERVQUAL method. Operators can also adjust and optimize the evaluation dimensions of network service quality founded on tangibility, reliability, responsiveness, assurance, empathy and remediation, combined with the actual situation of enterprise management and customer feedback.

2. Telecommunication Customer Satisfaction Index (TCSI)

In the practice of evaluating the service quality of operators, TCSI is a widely used evaluation system, which is mainly composed of brand image, expected quality, perceived quality, perceived value, customer satisfaction, customer complaints, and customer loyalty. Brand image can be subdivided into “corporate image” and “integrity” indicators, and perceived quality can be subdivided into “communication quality”, “complaint handling”, “business hall service”, “customer service hotline”, “billing service” and other indicators, and loyalty can be divided into “probability of continuing to use the business” and “probability of recommending service to others” indicators. Normally, service quality evaluation dimensions and indicators involved in the TCSI will be combined with specific services of the operator. The network service business will be evaluated from mobile Internet and fixed broadband Internet services.

From TCSI evaluation system put into use by operators, it can be found that the concept of customer perception of service quality gaps has been introduced, but seen from specific indicators of TCSI, it is still not scientifically rigorous enough. It is recommended that operators integrate the service quality evaluation scale of SERVQUAL method with TCSI evaluation system to design a practical and scientific network service quality evaluation system.

5.2.4.2 Collection of feedback on network service quality evaluation

1. Evaluation methods, evaluation forms and sampling requirements

The evaluation methods of network service quality mainly include outbound calls, immediate evaluation, on-site visits, unannounced visits by mysterious customers. The evaluation methods should comprehensively consider the characteristics of the business, product and service, evaluation efficiency, and customer habits. In principle, it is necessary to gradually reduce the proportion of outbound calls, on-site visits, and unannounced visits by mysterious customers, and increase the application of immediate evaluation. The evaluation form of network service quality is generally carried out in the form of questionnaires. In the light of business, product and service traits, evaluation efficiency, and customer habits, the questionnaire of the evaluation system are adjusted adaptively. Under different circumstances, full survey or sampling survey can be used. The sampling survey should meet the random principle, the sample size should meet the reasonable confidence interval requirements, and the sampling process should be founded on the established conditions to ensure fairness, objectivity, and reasonableness. The sample data shall be passed through the system, and a person independent of the sampling operators must review the sampling process.

2. Evaluation execution and execution support

In the process of evaluation and execution, reasonable planning and division of labor are required to control the cycle, timing and frequency of evaluation. During execution, process management needs to be strengthened. On-site inspections and post-sampling inspections are combined. The completed evaluation results must be aggregated and stored in real time, and evaluation execution must be independent and not interfered by other factors to ensure that the evaluation results are objective and true. In the evaluation process, for outbound calls, on-site visits, unannounced visits by mysterious customers, and other evaluations that require hosts of personnel and have a concentrated workload, support parties can be introduced to assist in the evaluation. For supporters, operators need to introduce supervision and verification mechanisms, establish support work evaluation mechanisms, prevent related cooperation, strengthen risk management, confidentiality management, and intellectual property management. They shall require supporters to comply with other compliance requirements and ensure evaluation goes smoothly.

5.2.4.3 Analysis of network service quality evaluation results

The basis of the analysis of network service quality evaluation results is the recovery, audit, cleaning, and storage of questionnaire data. On the basis of the data, data analysis methods and

tools are used to analyze the evaluation results. Besides, evaluation results need to be reported and fed back to help the management hierarchy make decisions.

1. Data Management

In principle, data information related to network service quality evaluation is stored, transferred, and processed through the system. The service quality evaluation samples should be tested in critical links such as effectiveness evaluation, data transmission and data calculation, and a specialized audit process should be established for results of service quality evaluation involving the assessment, and the evaluation result data can be applied after the audit.

2. Evaluation and Analysis

The analysis of evaluation data needs to introduce big data analysis methods and data analysis tools when necessary, professional data science experts and data analysis professionals can be hired to analyze the evaluation results according to the attributes of network services. Evaluation and analysis results will be used in reports, notifications and assessments to provide a basis for managers to make decisions, and at the same time expose problems in network services to promote the improvement of network service quality.

5.2.5 Optimizing service system design

The design of the service system is not accomplished overnight. Its completion and optimization process should also follow the PDCA method, namely plan, do, check, and action; the strategic planning and target determination mentioned above pertain to P (plan). Scientific management of customer needs and hierarchical determination of service elements belong to D (do), and scientific evaluation of service quality is step C (check). The optimization of service system design based on the above steps is A (stop errors/improve process) step. As a result, it is necessary to carry out continuous design optimization established on the difficulties encountered and the feedback received in the design of the service system. Simultaneously, it is necessary to fully absorb the feedback obtained in practice when the network service quality system is applied to network service quality management. The PDCA method is also constantly repeating the steps of planning, doing, checking, and acting to achieve better optimization and improvement of service system design.

5.3 Operators' network service quality management

Strengthening the management of network service quality is the most direct way to improve network service quality. However, network service quality management is a very difficult and

complex process. On the basis of designing an efficient, clear and executable network service system, it is necessary to establish standardized and personalized network services, strengthen network service information system support, improve the professional level of network service personnel, better network service delivery processes, perfect network service remediation and continuous optimization.

5.3.1 Standardization and personalization of services

Service quality standards should be the standards to be achieved for service quality. Standardization of service quality is a momentous assurance for stable service quality. The prerequisite for service quality standardization is service standardization, which refers to the entire process of the establishment, release and full implementation of the service standards provided by the enterprise. Operators need to have a mature management system and content requirements for network service standards, and have basic codes of conduct for guiding and managing service activities. At the same time, the personalization of services can better satisfy customers' differentiated network service needs and allow customers a better service experience. In the part of empirical analysis, regarding the evaluation of network service quality, the indicator of "operators provide personalized service to customers" received a low customer evaluation, indicating that customers have expectations for tailored service. The standardization and personalization of network services should complement each other and jointly promote the improvement of network service quality.

1. Standardization of network services

Network operators should systematically establish a set of refined, quantitative, standardized, and effective network service standards, and use network service standards to guide, standardize, and restrict the relevant work of network service, including detailed and quantitative data indicators for network services, guidance and education on the mentality and behavior of network service personnel.

To reduce the instability of service quality and control the service deviations in a small scope, it is needed to minimize the impact of human factors, ensure that the network-related services provided by different regions, environments, and network service personnel are as consistent as possible, and that network-related services provided by the same network service personnel in the same region, environment, and under different conditions are also as consistent as possible. MC's service hotline "big front desk" adopts such a standardized method. The standardization of services can not only rapidly expand the scope of network services in the horizontal direction, but also facilitate the continuous provision of stable services in the vertical

direction, thereby enabling the standardization of service quality to be rapidly expanded, as well as continuously and steadily improved.

With the development of science and technology, unmanned service and self-service have become important methods to promote the standardization of network services. The trend of machines replacing service personnel and customer self-service reduces manual intervention and provides the most standardized system-executed services to ensure the consistency of the services, as well as the consistency and stability of the service quality.

2. Personalization of network services

Standardized services can live up to the common needs of customers, but with the development of the economy and the improvement of people's living standards, the individual needs of customers are becoming more and more prominent, and the details of needs are extremely differentiated, which requires operators to grasp the individualization of customer needs, provide sufficient flexibility when designing and customizing network services, and retain manual services and manual operation channels.

Differing from the big front desk, the "Internet special seat" that solves intractable problems is the personalized service setting. In the training of network service personnel, operators should strengthen the training of network service personnel's ability to respond to changes. According to the tailored needs of customers, they can deal with it flexibly, to improve customer perception and service quality. Besides, for personalized services, operators need to have a certain degree of foresight. Instead of responding to the customer needs, they can learn the personalized characteristics of customers through early customer demand research and make service plans in advance. In the case of sufficient resources, they can provide personalized services, give customers a variety of network service supply experiences, and increase customers' trust and loyalty to network services.

Between personalized services and standardized services, graded services can also be offered, that is, providing different levels of standardized network services for corresponding customer groups, such as one to five stars, diamond, gold and silver and other value divisions. The customers can choose the services based on their own demand and budget level, which can achieve the relative unity of personalized and standardized services. Customers choosing different levels of services will also have different service quality expectations. Under the condition of understanding their own needs and budget levels, there will be a smaller gap between this expected value and the perceived value, so as to reduce the gap between customer perception and expectations, and improve the score of the evaluation service quality.

5.3.2 Service information system support

With the development of the economy and the advancement of technology, the management of enterprises has also moved towards informationization. In order to adapt to the fast pace of the market economy and the rapid iteration of market competition, enterprises have used corporate information service systems to assist corporate management, instead of the old management models and methods. The emergence of enterprise information systems has changed the way enterprises operate, improved their internal and external resource integration capabilities, and improved organization and production efficiency.

In the empirical analysis, regarding the "customer service telephone intelligent voice in interaction is smart and reflects high efficiency", the network service quality evaluation index got a higher score, customer service telephone intelligent voice interaction as part of the network information service system can bring positive role for the network service quality evaluation, which needs to continuously work well. For network operators, a strong service information system is needed for the entire network service provision and network service quality management process.

Taking customer complaints about the quality of network service handled by front-line customer service personnel as an example, customer complaints about the quality of network service are faced with the core contradiction of the limitation of the front-line customer service personnel and the pre-position of professional capabilities. The front-line staff of online customer service are limited by their professional skills. The poor quality of online complaint response leads to the inability to solve the problems of the customer, the lack of good complaint support means leading to a long complaint processing time, and the limited interception of complaint work orders leads to the intensity of the backstage processing staff. These issues are affecting the experience of the customers and aggravating customer dissatisfaction. By studying customer service support systems, network service operators can provide front-line customer service personnel with the ability to handle complaints and delimitation search engines, and provide second-line customer service personnel with more in-depth verification and quality analysis tools than front-line customer service personnel. For network quality complaints, it is required to accurately judge the quality problems of users of the network. The judgment part of some users' service quality is advanced to the front desk through two-level forward movement, and the average handle time (AHT) of a customer is optimized while reducing the misjudgment of quality problems. For example, for traffic disputes, the front desk can see the details of the service provider visited by the customers at a specific point in time, and solve the complaint

accurately. Through the above methods, the efficiency of the entire customer complaint handling process is perfected.

5.3.3 Service personnel promotion

Due to the intangible nature of services, service personnel have become one of the most important ways for customers to perceive service quality. Hence improving the service level of network service personnel is a direct and effective way to improve customers' perception of network service quality. The main ways to improve network service personnel include training the concepts and skills of network service personnel; rewarding network service personnel with salary, spirit, promotion and authorization; and strengthening the cultural construction of network service.

In the empirical analysis, regarding the index system constructed on SERVQUAL method and network service quality characteristics, there are multiple dimensions and specific indicators related to service personnel. For instance, in the assurance dimension, "service personnel are skilled at solving the problems consulted by customers", "service personnel have the high problem-solving ability", 'service personnel have a good attitude towards users", "service personnel provide reliable solutions" and other indicators; in reliability, indicators such as "timely and actively solve problems of users' network experience", "accuracy of service personnel's answers and solutions to users' problems"; in tangibility, indicators, for example, "service personnel's appearance is clean", and in responsiveness, indicators, for example, " manual customer service calls can be quickly connected". Most of these indicators related to network service personnel have obtained good customer evaluation in the empirical analysis, indicating that the MC operator has achieved good results in this initiative and need to continue to maintain. However, some indicators related to service personnel received a low evaluation, such as "service personnel can actively seek solutions for users to complex problems". The problems reflected in these indicators need to be focused on solving.

5.3.3.1 Service personnel training

Training can enable network service personnel to establish a unified and standardized service concept, and can give network service personnel sufficient service skills. Under the guidance of a unified network service concept, network service personnel use excellent service skills to provide network services, which not only can provide customers with more standardized and professional network services, improve customer satisfaction, but also enable network service personnel to have the sense of achievement and accomplishment in work, and understand the

meaning and practical value of their work. Consequently, in terms of service personnel training, it is necessary to strengthen concept training and skill training simultaneously.

1. Concept training

In addition to imparting relevant skills to service personnel, education and training are more important to instill in service personnel the core values, service concepts, professional ethics, and work standards advocated by operators in network services. Regarding service as a profession or a career determines the excellence of service work. Concept training can enable network service personnel to fully understand the operator's network service strategy, the relationship between high-quality network service and customer loyalty, the significance of customer loyalty to the continuous operation of operators, and the close relationship between the level of network service quality and personal development, thereby regulating the mentality and behavior of network service personnel. The advanced service concept (T. Liu, 2011) requires network service personnel to provide the service founded on the needs of customers, and the service should be "customer-oriented", that is, network service personnel must understand, care for, and respect customers, fully understand and try to meet the reasonable needs of customers, forming a "customer-centric" business environment.

2. Skill training

Network operators should strengthen skill training for service personnel, including soft skills, for example, communication skills with customers, and professional skills, for example, business handling. Cultivating the communication skills of network service personnel is actually to improve the network service personnel's interpersonal skills. It includes a sincere service attitude, good mental outlook, respect, trust, and understanding of customers.

Through training, network service personnel are always polite and friendly when communicating with customers, showing understanding and respect for customers, so as to improve customers' perception of network service quality, satisfaction and loyalty to operators' network services. In the training of business processing professional skills, it is necessary to provide meticulous lectures, repeated training, and strict assessment, so that network service personnel can master the operation and process of business processing proficiently, and reduce the time waste caused by nonproficiency, thereby shortening response time, improving the speed of solving network service problems, and leaving customers with an impression of efficient and professional services, which improves customers' trust and satisfaction with network service personnel and operators.

5.3.3.2 Service personnel incentives

Network service personnel are the direct contacts of customers in network service experience, and the high-quality and stable services provided by network service personnel have the most direct impact on customer evaluation.

In order to ensure that network service personnel can provide high-quality and stable services, in addition to concept and skill training, it is also necessary to establish an incentive mechanism to strengthen the positive motivations of all network service personnel, including material incentives, spiritual incentives, promotion incentives, and authorization incentives to stimulate the subjective initiative of network service personnel and mobilize their enthusiasm and determination to improve network service quality.

1. Salary incentive

Salary incentive is a basic measure to motivate network service personnel to improve network service quality. Operators should appropriately improve the salary and welfare plan, give full play to the role of assessment and reward, and ensure the competitiveness and attractiveness of the salary system. Meanwhile, it is also necessary to continuously adjust the salary level according to the industry's salary situation to ensure that the income level of network service personnel is at the upper-middle level of the industry, so as to attract excellent network service personnel.

2. Spiritual motivation

The main ways of spiritual motivation are praise, award of honorary titles, evaluation of professional titles, commendation and rewards, and respect and care. Operators can enhance the professional honor and sense of belonging of network service personnel by establishing a unified, standardized and efficient employee honor system. Concurrently, they should give adequate respect and care to network service personnel, guide and encourage individuals to grow together with the company, which is also helpful to enhance the cohesion of the enterprise, the network service personnel will be transformed into the endogenous motivation of network service quality improvement.

3. Promotion incentive

Operators should establish a fair, reasonable and stimulating promotion mechanism for network service personnel. The service level can be taken as the basic promotion criterion to fully mobilize the enthusiasm and creativity of network service personnel, and to cultivate the sense of belonging and loyalty of network service personnel, so as to bind the personal interests of network service personnel more closely with the enterprise interests of operators.

4. Authorization incentive

Authorization refers to the process of giving network service personnel certain power and autonomy so that they can make appropriate decisions within the scope of the services. This means that service personnel at different levels have different decision-making powers and assume corresponding responsibilities. Authorizing network service personnel allows them to quickly respond to customer needs. Authorized network service personnel can respond more quickly and directly to customer needs in the service process and service recovery process. First of all, high-quality service should be accessible and convenient, which is not compatible with the lengthy reaction chain (Y. Zhou, 2011). Hence, reasonable authorization is also the need for service optimization, as it can improve the satisfaction and loyalty of customers, and enhance the network service personnel's sense of accomplishment and pride in work, thereby furthering the satisfaction and loyalty of network service personnel to operators.

5.3.3.3 Service culture construction

Culture has a subtle but profound and lasting influence, and the service culture has a similar effect on network service personnel. The construction of network service culture can be carried out from several aspects: the cultural content of network service, the concept of network service, and the framework of network service.

1. In-depth study of the cultural content of the service environment

Service environment culture refers to the cultural factors infiltrated in various internal and external environments that affect and restrict service activities. The key to the construction of the culture of service environment is to highlight the cultural characteristics. In the construction of the network service culture, we must also pay attention to the coordination of the micro and macro environments. Because it takes a long time to transform the macro environment, we can first achieve excellence in the microenvironment.

2. Creating internal customer satisfaction and cultivating a unified service concept

The core value of service culture should be customer satisfaction. Customers are satisfied with the good attitude and behavior of network service personnel, and such attitudes and behaviors originate from the service personnel's heart. Only when the service personnel accept the values of service culture from their heart, can they do their best to maintain the image of operators and spread the network service culture of operators. Operators need to give network service personnel due return, support and encouragement. In the process of creating a network service culture, satisfied network service personnel will play many positive roles.

3. Building the framework of service culture and shaping high-grade service culture

Clear and strict network service specifications and systems are the operating standards for network service behavior and the framework guarantee for the construction of service culture. It is not enough for network service personnel to have a conceptual understanding of norms and systems. If they do not implement them and break away from constraints, shaping service culture will only be a castle in the sky. Each industry has its own industry norms and systems, and the service activities of the telecommunications service industry are no exception. Complying with industry norms and systems is crucial for a telecommunications company that takes service as the carrier to create a high-quality cultural atmosphere.

5.3.4 Service delivery process

Operators should manage the delivery process of network services. The management of the network service delivery process mainly embodies paying attention to the customer's network service experience in the network service delivery process, and strengthening the interaction with customers in the network service delivery process. In the empirical analysis, there are some problems in the process of service delivery, for instance, "the actual service provided is consistent with the description of the advertisement or service personnel" achieved a lower score showing that the user perception and the original meaning of operators have a great discrepancy, and "the business hall has modern supporting equipment", "the service personnel can determine the time to solve the problem" received a lower score. It indicates that some service experiences affect customers' evaluation of network service quality in the process of service delivery.

5.3.4.1 Network service experience management

The improvement of customer service experience needs to be designed from the aspects of customer's feelings, emotions, thinking and actions, and planned to create positive experiences that are compatible with mobile communication brands for customers. Specifically, it includes enhancing the reliability of network services, improving the responsiveness of network services, and strengthening the empathy of network services.

1. Enhancing service reliability

Reliability refers to a certain ability in network service quality, which enables service providers to reliably and accurately fulfill their commitments in the service link. Reliability actually requires operators to avoid errors in the process of network services and ensure the stability and quality of network services. They should also emphasize the reliability and speed of the network, and create a service positioning superior to the competitors.

2. Improving service responsiveness

Responsiveness refers to a certain quality that operators need to possess. This quality enables operators to provide customers with fast and convenient network services, improve network services and enhance network service levels in the shortest time. Keeping customers waiting, especially waiting without good cause, will adversely affect the experience of network service quality (Luo & Shen, 2006). When there are accidents in network services, timely and effective solutions will bring a positive impact on the perception of network quality. Service responsiveness is one of the significant comparison indicators of service providers. In the future of fierce competition among operators, response efficiency will become a strategic key to network service competition.

3. Strengthening the empathy of service

Empathy mainly refers to the delicate and personalized concerns to customers, thinking about what customers think and paying special attention to them. Empathy actually refers to the "customer-oriented" service concept and service process. Its characteristics include sensitivity to customer needs, the ability to provide personalized services, and the ability to gain customer trust. Empathy requires "people-oriented" services to maintain the degree of satisfaction of customers' individual needs and the degree of confidentiality of customers' personal information, so that customers can enjoy the services and be respected.

5.3.4.2 Customer interaction management

1. Increasing customer willingness to interact

First of all, operators need to maintain interaction with customers in a timely and proactive manner through various channels to make interaction simple and easy. Secondly, operators should actively establish a customer interaction system, and clearly and plainly inform customers of the departments where the operator accepts feedback and their contact information and working procedures. Third, it is necessary to lower the "threshold" of customer interaction, make it convenient for customers to perform their roles in terms of systems and facilities, and keep the channels open, making customer interaction simple.

2. Improving the interaction ability and willingness of service personnel

Operators can enhance their ability and willingness to interact with customers by training and motivating network service personnel, and fully interacting with customers in the network service delivery process to satisfy customers. Operators can also optimize the content and process of the "performance" (Pan, 2007) to maximize the ability of network service personnel, so that they can provide tailored services according to the preferences of different customers.

Network service personnel should take the initiative to interact and communicate with customers. They should also watch every mood of the customers during the communication process, understand customers' feelings timely, change topics in time or attract customers' attention, maintain good interaction with customers. Excellent service personnel can guide customers to transfer to high-value services, such as upgrading 4G services to 5G.

3. Improving customer motivation to participate in interaction

When designing interactions, operators should avoid role ambiguity or role conflicts, maintain comfortable and reasonable role boundaries, and make customers feel that they are fit to play a role in the interaction, so that they will be willing to participate in the interaction. In addition, in order to stimulate customers' positive attitudes towards interaction, operators must let customers know what benefits the interaction can bring to them (Zeng, 2007) to increase the enthusiasm of customers to participate in the interaction. Operators can introduce measures to encourage customer interaction, for instance, rewarding customers for their positive interactions, so that customers are willing and doing their best to take on their roles in the service process.

4. Improving the ability of customers to participate in the interaction

For some more complex network service products or new network service projects, customers may not know their roles and required investment. Operators need to provide the customer with education and training, to let them gain knowledge and capabilities required for the interaction, and help customers understand the interaction process and their role in the interaction process. The operators must provide necessary technical support, while on-site help and guidance are necessary.

5.3.5 Service recovery and continuous optimization

5.3.5.1 Strengthening service remedial measures

In order to minimize the adverse impact of network service errors on operators, especially the loss of customers, operators should pay attention to the construction of service remedial mechanisms, actively assume responsibility for service errors, and take effective measures. Related research (Jiang, 2005) believed that if service errors can be handled properly, they may become the second opportunity for service providers to improve customer service experience. Hence, once a service error occurs, an active service remediation mechanism can enhance the corporate image. In the empirical analysis, the remedial dimension of the evaluation of network service quality received a high score on the whole. For example, "service personnel can actively

solve customers' complaints", "service personnel can take appropriate and timely measures to remedy their service", "customers know the response of the complaint and its handling process" and "customers accept the results of complaint settlement" all had a gap of high perceived value and low perceived expectation. Operators had achieved good results in the level of remedied service. The remedial measures of network service and the attitude of service personnel in service remedied have improved customers' evaluation of network service, so it needs to be maintained.

Service remediation measures can be taken in the following process:

1. Establishing a service recovery early warning system

Operators need to establish a network service remedial early warning system to discover customer complaints, so as to determine the shortcomings of network services, and actively look for potential network service problems. In some cases, operators also need to predict the remediation needs, that is, to foresee the problem before it occurs and avoid it. Anomalies can be found in increments based on historical reference values, or they can analyze customer behavior before complaints with big data and intervene early.

2. Paying attention to customer issues

Customers usually think that the most effective remedy is for network service personnel to proactively acknowledge the problems, for example, failures that occur during network operation and negative effects during maintenance, and apologize to customers with care and sincere words and relevant explanation, and solve the problem in a timely, efficient and reasonable manner. If the customers feel that the network service personnel really want to solve customer problems, their dissatisfaction caused by network service errors will be mitigated.

3. Solving the problems timely and quickly

Once a service error occurs, the network service personnel must quickly resolve the error, even if it is caused by the customer, otherwise, the network service error that has not been properly resolved will quickly expand and worsen, giving customers a second bad impression, greatly reducing the customer's perception of service quality. In some cases, operators need to foresee the problem before it occurs and eliminate it. For example, technical means can be used to detect and judge that the network traffic is not being used properly, and send SMS prompts in time to let customers know that operators are protecting their interests.

4. Bold authorization for service personnel

In addition to targeted training on network service remediation for network service personnel, operators should also grant necessary authorization to network service personnel so that they have certain authority to solve problems independently. Authorization can increase

the sense of responsibility of network service personnel, improve their initiative, enthusiasm and creativity in their work, and quickly and timely solve customer problems.

5. Encouraging customers to submit their complaints

Customer complaints are an important source of discovering network service errors. The survey shows that the main reason for most dissatisfied customers not to submit their complaints is that they do not know how to accurately express their intentions or to "whom" they can submit complaints. Thus, operators as network service providers must first establish network service standards. For customers, the service standards of operators are service commitments. Clear and specific network service standards can remove customers' vague expectations and make network services measurable. Secondly, it is necessary to design a procedure to facilitate complaints, and publicize them widely to encourage and guide customers to report their complaints.

6. Learning from the remedy

Service remediation is not only to make up for the insufficiency of network services and strengthen the connection with customers, it is also an extremely valuable but often overlooked or underutilized, diagnostic information resource that can help operators improve service quality. By tracking the entire process of network service remediation, operators can discover a series of urgent problems in the network service system, and timely correct some links in the network service system, so that the network service remediation phenomenon will not occur.

5.3.5.2 Ensuring continuous service optimization

The continuous optimization of network services also follows the PDCA method. The design of the network service system mentioned above follows a small PDCA method, while the continuous optimization of network services is part of a larger PDCA cycle that constitutes the outer layer. In the PDCA method, the design of the network service system belongs to the P (plan) step, the network service quality management pertains to the D (do) step, and the service quality evaluation and performance evaluation is C (check) step, while service recovery and continuous optimization of services is part of step A (stop errors/improve process). Hence, continuous network service optimization needs to be carried out based on the difficulties encountered in each link of network service quality management and the feedback received, so as to promote the continuous optimization of network service quality management and provide strong assurance for the improvement of network service quality.

Continuous optimization should focus on improving the accuracy and scientificity of network service management methods and processes to ensure that they are operable and

executable; minimizing the occurrence of remedial phenomena and reducing the impact of temporary and personalized services on the normal service process; strengthening execution tracking and correcting service deviations in the first time; shortening the communication chain between the management department and the front-line service personnel, while reducing links and improving process efficiency.

5.4 Quality assurance measures for the implementation of network service quality management

Clear, efficient and executable network service system design and effective, controllable and sustainable network service quality management both need strong measures to guarantee them. Therefore, it is necessary to establish a strong supporting service quality assurance, including the establishment of strategies and concepts, and organizations and systems.

5.4.1 Strategy and philosophy

The main reason affecting service quality in the service industry is not only technology and products, but more importantly, service personnel and the service itself. For the service industry, the key to long-term profits of enterprises lies in the service quality perceived by customers. For operators, the network services provided and the service level of network service personnel directly determine the quality of network services perceived by customers. In empirical research part, regarding the evaluation of network service quality, the dimension of empathy received the lowest evaluation, including customers think that operators do not give enough care to them and do not put the interests of customers in the first place, which has a relatively negative impact on the evaluation of customer service quality and needs to be focused on the correction. Hence, operators should establish a service-oriented market strategy.

1. Service strategy orientation

The service strategy is to provide a series of services to promote customer relationships. The core of this strategy is to integrate and internalize services into the product. Compared with competitors, the competitiveness of network operators is reflected in the level of customer network services. The higher the quality of network services is, the easier it is to achieve market differentiation.

Emphasizing service strategy is not to belittle technology strategy, price strategy, and image strategy, but to put the key point of strategic thinking and management decision-making on

service. In other words, the core capability of network operators is network services. In fact, the network service strategy includes the core strategic content of technology strategy, price strategy, image strategy, and it also needs to combine factors that have an important impact on customer needs such as regional environment, social culture, and consumption habits to create a service-oriented business strategy. Competitive advantages are established by various elements of network services and customer relationships. Operators can rely on the differences in network services to achieve differentiation.

2. Correcting the relationship between operation and service

The so-called correcting the relationship between operation and service is to answer the overall positioning of the service in the company and what it can bring to the company. Employees of all levels, especially front-line network service personnel, should form a unified understanding of this.

With the promotion of the number portability policy in China, market competition will expose various shortcomings in network service quality management, bring new and advanced management concepts, and enable the entire network service industry to adapt to competition and integrate into the world's development trend, and the network service industry will be transformed from an extensive development model that pursues scale and quantity to an intensive development model that focuses on stock customers, market share, and pays attention to benefits and efficiency. As a result, the one-sided understanding that operators and network service personnel believe that operation with benefit is a hard indicator, while network service without benefit is a soft indicator can be changed. The one-sided approach of focusing on operation and neglecting service can be changed, and a mechanism of the virtuous circle of mutual promotion and integrated development of operation and service can be formed.

3. Establishing a full service concept

The idea is the precursor of action. To behave well in network service, the traditional service concept must be transformed, and a big service concept that customers are the core and all forces shall be mobilized must be established. Service culture is an integral part of corporate culture, with service values as the core, customer satisfaction as the goal, and with common service value cognition and behavior norms as the contents. Network operators should first have a correct understanding of the importance of network services, establish a service strategy, and correct the relationship between operation and service. Simultaneously, they should guide all the employees to implement the service concept within the enterprise group to form a top-down instillation of the service concept.

5.4.2 Organization and system

1. Updating service specifications

Operators should further standardize rules based on the network service system, truly pay attention to the differences in their own network service types and the diversity of customer needs, and provide precise services for the customers with different needs. Operators can manage customers in groups in line with their preferences, industry and other characteristic information. For example, they can push different contents according to the different needs of each type of customer to minimize harassment and provide precise services.

2. Optimizing the organization system

In network service quality management, operators should realize the overall linkage from headquarters to branch offices, front-line grids and business halls to enhance the core competitiveness of operators' overall business. For the purpose of improving the network service system, the branches, grids, and business halls of operators should implement "customer stratification, functional division, and service diversion" based on the scale, structure and distribution of medium and high-value customers to provide comprehensive service solutions for customers. And a high-quality, competitive personal service center can be established to provide customers with personalized products and differentiated services (Du, 2015).

5.5 Summary of this chapter

This chapter is established on background research, literature research, and empirical analysis, with PDCA as the research method, and proposes recommendations for network service quality management optimization. The first is to analyze the content that needs to be improved in the MC operator network service quality management and clarify the process of network service quality management optimization, lay the foundation for the writing ideas of this chapter, then based on the PDCA method, the recommendations for the design of the operator's network service system, the operator's network service quality management, and the implementation of guarantees for network service quality management are put forward. These suggestions may effectively answer the fourth research question (how can the management level of network service quality be improved based on the influencing factors?).

In the part of the operator's network service system design, the author first suggests that operators need to combine corporate values to formulate reasonable strategic plans, clear and executable goals under the background of internal and external shocks; secondly, they can

scientifically manage customers' needs by providing choices, creating value graded services, and communicating effective service standards, negotiating unrealistic expectations; then by confirming basic service elements, marking the relevance of service elements, and empowering service elements, the service elements are determined by levels. More important is the scientific evaluation of service quality, including establishing a service quality evaluation system, collecting evaluation feedback, and analyzing evaluation results; the author provides two commonly used service quality evaluation methods: SERVQUAL model and TCSI, which provide suggestions on collecting evaluation feedback from the perspectives of evaluation methods, forms, sampling requirements, execution and execution support, and provide effective evaluation results analysis measures such as data management and talent tool introduction. At the end of the design of the operator's network service system, it emphasizes the need to continuously optimize the design of the operator's network service system.

In the part of operator's network service quality management, this thesis first puts forward suggestions on network service standardization and individualization, discusses the importance of a set of refined, quantitative, standardized, and effective network service standards, and also points out that individualization and hierarchical network services can meet the increasingly diverse needs of customers; then, taking the front-line customer service personnel to handle customer complaints about network service quality as an example, it illustrates that how the service information system can effectively improve service level. Next, this thesis puts forward suggestions for the improvement of service personnel from three aspects of training, motivation and cultural construction. Among them, service personnel training embodies concept training and skills training, and service personnel incentives include salary incentives, spiritual incentives, promotion incentives, and authorization incentives. The construction of service culture can be carried out from the cultural content of network services, the concept of network services, and the framework of network services. In the next step, the thesis proposes relevant measures for service delivery process management, including enhancing service reliability, responsiveness, and empathy to improve network service experience management, and improving the willingness, ability and motivation of service personnel and customers to carry out customer interaction management. In the last part of the suggestions on the operator's network service quality management, this thesis emphasizes the importance of service remediation and continuous optimization. Strengthening service remediation measures include establishing a service remediation early warning system, paying attention to customer problems, solving problems quickly and timely, empowering service personnel, and encouraging customers to submit their complaints; focusing on improving the accuracy and scientificity of

network service management methods and processes is to ensure continuous optimization of services.

Finally, in the part of the assurance measures for the implementation of network service quality management, the author puts forward suggestions on strategy and concept, organization and system. The suggestions for strategies and concepts include service strategic orientation, correcting the relationship between operation and service, and establishing a full-service concept; organization and system construction includes updating service specifications and optimizing the organization system.

[This page is deliberately left blank.]

Chapter 6: Conclusion

6.1 Research conclusion

In the context of the research on the internal and external impacts confronted by operators' network services, by sorting out the literature related to network service quality, the author has obtained ideas for network service quality evaluation and network service quality management. By comparison, this thesis uses the SERVQUAL method to design the network service quality evaluation system. Established on the SERVQUAL scale and the characteristics of network service quality, a questionnaire is designed, and sample collection, data recovery, and data cleaning are carried out. Through the characteristic analysis, reliability and validity test of the sample data, the reliability and accuracy of the sample data have been proved. Subsequently, the unweighted and weighted SERVQUAL method of network service quality index gap analysis, and IPA analysis founded on network service quality dimensions and indicators are carried out. These in-depth empirical analyses reveal the current status of operators' network service quality, as well as the main influencing factors. In the end, based on the status quo of network service quality, the guidance of PDCA research method, and the reference to relevant literature, recommendations on the optimization of network service quality management are put forward from the design of operator network service system, network service quality management at the operator level and guarantee measures of management implementation.

This thesis is dedicated to answering the four research questions raised at the beginning. Firstly, what constitutes the quality of network service? Secondly, what the current status of network service quality evaluation is? Thirdly, what factors may influence the network service quality evaluation results? Fourthly, how can the management level of network service quality be improved based on the influencing factors? In the empirical analysis part of the research, the first three questions raised at the beginning are solved. Namely, the current situation of network service quality is not rosy. The average expected values of customers for all network service quality indicators are higher than the average perceived values. Network service quality consists of six dimensions: tangibility, reliability, responsiveness, assurance, empathy and remediation. Among them, the empathy dimension has the largest gap between perceived value and expected value. Operators' customer care, demand insights, service provision and quality management

are far below customer expectations. In line with the results of gap analysis and IPA analysis of network service quality based on SERVQUAL, there are some important factors influencing the network service quality evaluation, including service remedy, service remedy attitude, service personnel attitude and business ability, customer demand understanding, customer service experience management, network service information system support, customer interaction management, service standardization and personalization, and operator's strategic concept. In the optimization suggestions part of the study, the fourth question raised at the beginning is answered, that is, the network service quality management process of the operator has not been effectively controlled. The operators first need to design the network service system from aspects such as the strategic planning, goal establishment, scientific management of customer needs and levels, determining the service elements by levels, scientifically evaluating the service quality, and optimizing the design of the service system. Second, they should manage the network service quality from aspects such as the standardization and personalization of the services, the support of the service information system, the promotion of service personnel, the standardization of the service delivery process, service remediation and continuous optimization, and finally provide guarantee for the implementation of network service quality management from the aspects of strategy and concept, organization and system.

There are two main innovations in this research, which may make a little contribution to the development of related fields. First, although the SERVQUAL model is widely accepted and adopted by the academic community, the introduction of the SERVQUAL model into the research of network service quality is a relatively new topic. Especially in recent years, the rapid development of mobile network communication technology has brought tremendous changes to people's lives, the topic selection of this research appears to be particularly practical, and it can also provide some ideas for operators in the actual network service practice. Second, in the part of network service quality management optimization suggestions, this thesis uses the PDCA method from the inside to the outside. This nested analysis method enables the research to self-consistently embed small logic into large logic in the optimization suggestions, thereby giving clear and feasible recommendations.

6.2 Research limitations

Due to many factors such as the limited literature available in related fields and the objective conditions in the research implementation process, this thesis still has the following limitations:

1. Sample structure needs to be optimized

In this thesis, a total of 500 questionnaires were sent out through online social platforms and on-site collection methods. After they were sorted out and checked, 348 valid questionnaires were obtained. Although the characteristics of the questionnaire sample were well distributed in terms of gender, age group, education level, and frequency of Internet use, and the sample reliability and validity test results were also very significant, the number of 348 questionnaires relatively small, compared to tens of millions of research object. Due to the objective and realistic difficulty of issuing the questionnaire, some factors that may affect the reliability and effectiveness of the sample are not reflected in the questionnaires, such as sample industry distribution and sample preference distribution. Especially, the respondents were mainly from Sichuan, China, and the possibility of regional deviation could not be ruled out. The reliability and accuracy of the sample data directly determine the reliability and accuracy of the empirical analysis conclusions, so the empirical analysis conclusions in this thesis may also have certain limitations.

2. Model expansion

On the basis of the SERVQUAL model, this thesis expands the evaluation dimension of network service quality and adds the remediation dimension and its four indicators. As the remediation dimension and its four indicators are proposed based on the author's relevant work practice and life cognition, there are a few references. Although the validity and rationality of the remediation dimension and its indicators have been verified by the data in this study, more empirical studies are required to prove the validity and rationality of the remediation dimension. Over and above, other network service characteristics such as extensiveness, scalability and substitution are not taken into account in this study. Therefore, some uniqueness of network services may be neglected for the influence of network service quality evaluation, and the design of network service quality evaluation system studied may have certain limitations.

3. No main part research

Although a host of questionnaires and opinions on network service quality objects (customers of network services) have been collected, and interviews have been made, the main actors of network service quality management are operators. In the "Optimization for Network Service Quality Management" section, the optimization suggestions are all made for operators. If the operators are surveyed, the optimization suggestions put forward in this thesis will be more targeted. However, due to the limitations of objective conditions, the author can only explore the practical problems that operators have in the management of network service quality and the measures they have taken and the effectiveness of these measures, combined with third-party materials such as online news, newspapers and magazines, media interviews, social

platforms, and professional literature. Therefore, the optimization suggestions given in this thesis have a strong universality and are not enough to visualize the detailed measures that operators should take. Operators are required to adopt these suggestions put forward based on their own business conditions.

6.3 Research outlook

The outlook of this research is mainly to make up for the limitations of the research and draw more accurate and reliable conclusions and recommendations. For good measure, due to the rapid progress of science and technology in recent years and changes in macro policies, the author is very interested in new measures taken by operators under internal and external shocks.

1. Optimizing sample structure

The first is to greatly increase the size of samples, conduct more extensive data collection, and collect more different voices to make the survey and analysis results more representative. The second is to fully consider the influence of the samples' region, industry, and preference on the survey results, try to achieve a more uniform region distribution, industry distribution, and preference distribution of respondents to reduce the possibility of systematic deviation of sample data. Besides, more scientific questionnaire survey methods can be introduced, such as periodic or irregular surveys on the same batch of samples, or replacing the same type of questions in the questionnaire, as well as other commonly used questionnaire survey methods, so as to improve the accuracy and reliability of data.

2. Expanding model dimensions

In the premise of the six dimensions of empathy, responsiveness, tangibility, assurance, reliability and remediation of this thesis, dimensions and specific indicators of the SERVQUAL scale can be expended from other features of network service like extensiveness, scalability, substitution, demand diversity, a combination of online and offline services, so that the network service quality evaluation system can better reflect the gap between perceived value and expected value of customers, and get better network service quality evaluation results.

3. The impact of the new environment

From the traditional basic phone and short message services, to the slow Internet era of 3G, and to the era of 4G smart mobile Internet, operators have been constantly improving the level of network services. The advent of the 5G era will also bring about tremendous changes in network communications. In the 5G era, how will operators meet the higher requirements of customers for network service quality, and what are the expectations of customers for network

services in the 5G era? These questions will affect the network service quality management of operators, and can be perceived as the direction of future extension of this research. In addition, due to the particularity of Chinese telecom operators, the policy has a significant impact on operators. Will the “number portability” policy introduced in 2019 greatly promote the improvement of the operator’s network service quality? What is the path to improve network service quality? These related questions can also be adopted as an extension of this research.

[This page is deliberately left blank.]

Bibliography

Ahluwalia, P., & Varshney, U. (2009). Composite quality of service and decision making perspectives in wireless networks. *Decision Support Systems*, *46*(2), 542-551.

Alnsour, M. S., Tayeh, B. A., & Alzyadat, M. A. (2014). Using SERVQUAL to assess the quality of service provided by Jordanian telecommunications sector. *International Journal of Commerce and Management*, *24*(3), 209-218.

American Marketing Association. (1960). *Marketing definitions: A glossary of marketing terms.* American Marketing Association Committee.

American Educational Research Association., American Psychological Association., & National Council on Measurement in Education. (2003). *Standards for educational and psychological testing.* American Educational Research Association.

Angelova, B., & Zekiri, J. (2011). Measuring customer satisfaction with service quality using American Customer Satisfaction Model (ACSI Model). *International Journal of Academic Research in Business and Social Sciences*, *1*(3), 232.

Ashill, N. J., Rod, M., & Carruthers, J. (2008). The effect of management commitment to service quality on frontline employees' job attitudes, turnover intentions and service recovery performance in a new public management context. *Journal of Strategic Marketing*, *16*(5), 437-462.

Atack, J. (1984). *From the American system to mass production, 1800-1932*. Johns Hopkins University Press.

Aydin, S., & Özer, G. (2005). The analysis of antecedents of customer loyalty in the Turkish mobile telecommunication market. *European Journal of Marketing*, *39*(7), 910-925.

Badri, M. A., Abdulla, M., & Al-Madani, A. (2005). Information technology center service quality: Assessment and application of SERVQUAL. *International Journal of Quality and Reliability Management*, *22*(8), 819-848.

Beaumont, N. B., Sohal, A. S., & Terziovski, M. (1997). Comparing quality management practices in the Australian service and manufacturing industries. *International Journal of Quality and Reliability Management*, *47*(8), 141-142.

Berry, L. T., Sostack, G. L., & Upah, G. D. (1983). *Emerging perspectives on services marketing*. American Marketing Association.

Bessom, R. M. (1973). Unique aspects of marketing of services. *Arizona Business Bulletin*, *9*(November), 8-15.

Besterfield, D. H., Besterfield-Michna, C., Besterfield-Sacre, M., Besterfield, G. H., & Urdhwareshe, H. (2011). *Total quality management: For Anna university*. Pearson Education.

Blois, K. J. (1974). The marketing of services: An approach. *European Journal of Marketing*, *8*(2), 137-145.

Boshoff, C., & Leong, J. (1998). Empowerment, attribution and apologising as dimensions of service recovery. An experimental study. *International Journal of Service Industry Management*, *9*(1), 24-47.

Box, J. F. (1987). Guinness, Gosset, Fisher, and small samples. *Statistical Science*, *2*(1), 45-52.

Brady, M. K., & Cronin, J. J. (2001). Some new thoughts on conceptualizing perceived service quality: A hierarchical approach. *Journal of Marketing*, *65*(3), 34-49.

Brogowicz, A. A., Delene, L. M., & Lyth, D. M. (1989). A synthesised service quality model with managerial implications. *International Journal of Service Industry Management*, *1*(1),

27-45.
Cao, L. (2012). *Research on mobile operation service quality management based on value chain* [Doctoral dissertation]. Wuhan University of Technology.
Cao, S. M., & Du, Q. L. (2008). PDCA 循环在企业绩效管理系统中的运用 [The application of PDCA cycle in enterprise performance management system]. *Value Engineering*, *6*, 109-112.
Cardoso, J., Sheth, A., Miller, J., Arnold, J., & Kochut, K. (2004). Quality of service for workflows and web service processes. *Journal of Web Semantics*, *1*(3), 281-308.
Cardozo, R. N. (1965). An experimental study of customer effort, expectation, and satisfaction. *Journal of Marketing Research*, *2*(3), 244-249.
Carrillat, F. A., Jaramillo, F., & Mulki, J. P. (2009). Examining the impact of service quality: A meta-analysis of empirical evidence. *Journal of Marketing Theory and Practice*, *17*(2), 95-110.
Chau, V. S., & Kao, Y. Y. (2009). Bridge over troubled water or long and winding road?: Gap-5 in airline service quality performance measures. *Journal of Service Theory and Practice*, *19*(1), 106-134.
Chen, L. (2014). *BC Research on BC's service quality management system improvement* [Master's thesis]. China University of Geosciences.
Chen, W. P. (2014). *Research on quality management of Guangxi Telecom IMS network construction project* [Master's thesis]. Guangxi University.
Chen, X. Z. (2016). *现代统计分析方法的理论和应用 [Theory and applications of modern statistical analysis method]*. National Defense Industry Press.
Chen, Z. P. (2001). *服务市场营销 [Service marketing]*. Dongbei Finance University Press.
Cheng, P. C., & Long, X.Y. (2015). 基于 SERVQUAL 模型的电信企业服务质量研究 [Research on service quality of telecom enterprises based on SERVQUAL model]. *Modern Business*, (3), 148-149.
Chinese University Dictionary Editing Committee. (2000). *汉语大词典普及本 [Popularization of Chinese dictionary]*. Chinese Dictionary Publishing House.
Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297-334.
Cronin Jr, J. J., & Taylor, S. A. (1992). Measuring service quality: A reexamination and extension. *Journal of Marketing*, *56*(3), 55-68.
Crosby, P. B. (1980). *Quality is free: The art of making quality certain*. Signet Publishing House.
Cua, K. O., McKone, K. E., & Schroeder, R. G. (2001). Relationships between implementation of TQM, JIT, and TPM and manufacturing performance. *Journal of Operations Management, 19*(6), 675-694.
Dabholkar, P. A. (1996). Consumer evaluations of new technology-based self-service options: an investigation of alternative models of service quality. *International Journal of Research in Marketing*, *13*(1), 29-51.
Dahlgaard-Park, S. M. (2009). Decoding the code of excellence–for achieving sustainable excellence. *International Journal of Quality and Service Sciences*, *1*(1), 5-28.
Davis, J. R., & Davis, A. B. (1998). *Effective training strategies: A comprehensive guide to maximizing learning in organizations*. Berrett-Koehler Publication.
Deming, W. E. (1967). Walter A. Shewhart, 1891-1967. *American Statistician, 21*(2), 39-40.
Deming, W. E. (1950). *Elementary principles of the statistical control of quality*, Nippon Kagaku Gijutsu Remmei.
Deming, W. E. (2000). *Out of the crisis*. Massachusetts Institute of Technology Press.
Deng, F. M. (2004). 基于服务质量差距模型的服务质量特性构成分析 [Analysis of the composition of service quality characteristics based on the service quality gap model].

Journal of Sichuan University (Philosophy and Social Sciences Edition), (05), 27-30.
Dong, R. Y. (2003). *Research on the evaluation and improvement of service quality* [Master's thesis]. Shenyang University of Technology.
Droge, C. (1998). Know your customer: New approaches to understanding customer value and satisfaction. *Journal of the Academy of Marketing Science*, *26*(4), 351.
Du, S. Y. (2015). 我国电信行业垄断改革问题研究 [Research on monopoly reform of Chinese telecom industry]. *Brand Research*, (04), 50.
Dutka, A. (1994). *Handbook of customer satisfaction*. Lincolnwood.
Elcan, L. A. (1996). Simulation modeling for process reengineering in the telecommunications industry. *Interfaces*, *26*(3), 1-9.
Ennaciri, A., Erritali, M., & Bengourram, J. (2019). Load balancing protocol (eesaa) to improve quality of service in wireless sensor network. *Procedia Computer Science*, *151*, 1140-1145.
Erevelles, S., Srinivasan, S., & Rangel, S. (2003). Consumer satisfaction of internet service providers: A process based approach. *Journal of Information Technology and Management*, *4*(2), 69-89.
Eylon, D., & Bamberger, P. (2000). Empowerment cognitions and empowerment acts. *Group & Organization Management*, *25*(4), 354-372.
Fan, X. C. (1999). 服务质量管理：交互过程与交互质量 [Service quality management: Interaction process and interaction quality]. *Nankai Business Review*, (01), 8-12, 23.
Fang, Z. G. (2003). *Research on service quality evaluation and management system based on service gap model* [Master's thesis]. Tianjin University.
Feigenbaum, A. V. (2002). *Total quality management*. John Wiley and Sons.
Feigenbaum, A. V. (1983). *Total quality control*. McGraw-Hill Book.
Ferguson, R. J., Paulin, M., Pigeassou, C., & Gauduchon, R. (1999). Assessing service management effectiveness in a health resort: implications of technical and functional quality. *Managing Service Quality an International Journal, 9*(1), 58-65.
Fornell, C. (1992). A national customer satisfaction barometer: The Swedish experience. *Journal of Marketing*, *56*(1), 6-21.
Gao, X., Zhang, J. M., & Yang, T. (2019). 全视角携号转网政策研究与市场对策分析 [Full-perspective number portability policy research and market countermeasure analysis]. *Communication Enterprise Management*, *389*(09), 72-75.
Gao, Y. (2009). *Research on the evaluation of mobile communication service quality based on SERVQUAL model* [Doctoral dissertation]. Beijing University of Posts and Telecommunications.
Gao, Y. R., & Li, Y. (2003). 论服务补救对顾客忠诚度的影响 [On the impact of service remediation on customer loyalty]. *Commercial Research,* (18), 30-31.
Garvin, D. A. (1983). Quality on the line. *Harvard Business Reviews*, *61*(5), 65-75.
Ghobadian, A., Speller, S., & Jones, M. (1994). Service quality: Concepts and models. *International Journal of Quality and Reliability Management*, *11*(9), 43-66.
Goldstein, S. M. (2010). Employee development: An examination of service strategy in a high-contact service environment. *Production and Operations Management*, *12*(2), 186-203.
Gronroos, C. (1982). An applied service marketing theory. *European Journal of Marketing*, *16*(7), 30-41.
Gronroos, C. (1983). *Strategic marketing and management in the service sector*. Marketing Science Institute.
Gronroos, C. (1984). A service quality model and its marketing implications. *European Journal of Marketing*, *18*(4), 36-44.
Gronroos, C. (1988). Service quality: The six criteria of good perceived service. *Review of Business*, *9*(3), 10.
Gronroos, C. (1990). *Service management and marketing*. Lexington Books.

Gronroos, C. (2000). *Service management and marketing: A customer relationship management approach.* John Wiley and Sons.

Gronroos, C. (2001). The perceived service quality concept: A mistake?. *Managing Service Quality,*, *11*(3), 150-152.

Han, J. L., & Dong, J. (2006). *顾客感知服务质量的评价方法和管理 [Customer perceived service quality evaluation method and management]*. Nankai University Press.

Han, Z. J., Xu, Q., & Zhong, X. F. (2008). *质量管理 [Quality management]*. Science Press.

Hansen, T. (2010). Consumer values, the theory of planned behaviour and online grocery shopping. *International Journal of Consumer Studies*, *32*(2), 128-137.

Hao, D. H. (2005). *社会调查研究方法 [Social research methods]*. China Renmin University Press.

Hauser, J. R., & Clausing, D. (1988). The house of quality. *Harvard Business Review*, *66*(3), 63-73.

Hong, Z. S., Su, Q., & Huo, J. Z. (2012). 服务质量管理研究的回顾与现状探析 [Review and current analysis of service quality management research]. *Management Review*, (07), 154-165.

Horvat, G., Žagar, D., & Vlaović, J. (2017). Evaluation of quality of service provisioning in large-scale pervasive and smart collaborative wireless sensor and actor networks. *Advanced Engineering Informatics*, *33*(Aguest), 258-273.

Hsu, C., & Su, C. (2002). Quality management practices in Taiwan's telecommunication industry. *Measuring Business Excellence*, *6*(3), 42-46.

International Organization for Standardization. (1986). *ISO 8402: 1986: Quality-vocabulary*. International Organization for Standardization.

International Organization for Standardization. (1987). *ISO 9000: 1987: Quality management and quality assurance standards-guidelines for selection and use*. International Organization for Standardization.

International Organization for Standardization. (1994). *ISO 8402: 1994: Quality management and quality assurance-vocabulary*. International Organization for Standardization.

International Organization for Standardization. (1994). *ISO 9002: 1994: Quality systems-model for quality assurance in production, installation and servicing*. International Organization for Standardization.

International Organization for Standardization. (2000). *ISO 9000: 2000: Quality management systems-fundamentals and vocabulary*. International Organization for Standardization.

Ishikawa, K. (1990). *Introduction to quality control*. Productivity Press.

Jadayil, W. A., Shakoor, M., Bashir, A., Selmi, H., & Qureshi, M. (2020). Using serviqual to investigate the quality of provided wireless communication services in UAE. *International Journal of Quality and Service Sciences*, *12*(1), 109-132.

Jia, D. H., Lu, H. W., & Wang, R. R. (2010). 网上营业厅服务质量评价实证研究 [An empirical study on the service quality evaluation of online business halls]. *Journal of Beijing University of Posts and Telecommunications (Social Science Edition)*, *012*(003), 56-64.

Jiang, G. P. (2005). 服务补救流程以及运作策略 [Service recovery process and operation strategy]. *China Quality*, (007), 29-32.

Joudeh, J. (2017). The impact of service quality dimensions upon customers' satisfaction: An empirical study applied in the jordanian mobile telecommunication sector. *International Review of Management & Business Research*, *6*(1), 184.

Judd, R. C. (1964). The case for redefining services. *Journal of Marketing*, *28*(1), 58-59.

Juran, J. M., Gryna, F. M., & Bingham, R. S. (1974). *Quality control handbook*. McGraw Hill.

Kang, G. D., Jame, J., & Alexandris, K. (2002). Measurement of internal service quality:

Application of the servqual battery to internal service quality. *Journal of Service Theory and Practice*, *12*(5), 278-291.

Kano, N. (2002, September 15–17). *Attractive quality creation under globalization.* The 8th Asia Pacific Quality Organization Conference, Beijing, China.

Kozainski, H., & Kneevi, P. (2014). Configuration of quality of service parameters in communication networks. *Procedia Engineering*, *69*(1), 655-664.

Kumar, A., & Telang, R. (2011). Product customization and customer service costs: An empirical analysis. *Manufacturing and Service Operations Management*, *13*(3), 347-360.

Lai, F., Griffin, M., & Babin, B. J. (2009). How quality, value, image, and satisfaction create loyalty at a chinese telecom. *Journal of Business Research*, *62*(10), 980-986.

Lapierre, J., Filiatrault, P., & Perrien, J. (1996). Research on service quality evaluation: Evolution and methodological issues. *Journal of Retailing and Consumer Services*, *3*(2), 91-98.

Lee, D., Shin, J., & Lee, S. (2015). Network management in the era of convergence: Focusing on application-based quality assessment of Internet access service. *Telecommunications Policy*, *39*(8), 705-716.

Lehtinen, U., & Lehtinen, J. R. (1982). Service quality: A study of quality dimensions. *Service Management Institute*, *5*, 25-32.

Lester, A. (2014). *Project management, planning, and control: Managing engineering, construction and manufacturing projects to PMI, APMand BSI standards*. Elsevier.

Lewis, & Barbara, R. (1989). Quality in the service sector: A review. *International Journal of Bank Marketing*, *7*(5), 4-12.

Li, R. (2016). *Research on service quality evaluation and improvement of HZ Unicom business hall based on SERVQUAL* [Master's thesis]. Xi'an University of Science and Technology.

Li, X. G. (2011). 质量经理知识大纲系列讲座 [Quality manager knowledge outline series lecture]. *China Quality*, (003), 41-42.

Li, X. Q. (2012). 谈以 PDCA 循环为视角的图书馆服务质量管理 [Research on library service quality management from the perspective of PDCA cycle]. *Library Work and Research*, (05),45-48.

Liu, M. (2019). *Research on the transformation of all-service e-commerce of telecom operators in the context of cross-border integration* [Doctoral dissertation]. Beijing University of Posts and Telecommunications.

Liu, S., Jiang, Y., & Liang, X. J. (2010). 全业务运营时代的电信服务质量管制 [Telecommunication service quality control in the era of full-service operation]. *Journal of Beijing University of Posts and Telecommunications (Social Science Edition)*, (01), 90-96.

Liu, T. (2011). 基于 SERVQUAL 模型的乡村旅游服务质量提升研究 [Research on the improvement of rural tourism service quality based on the SERVQUAL model]. *Resource Development and Market*, (06), 569-571.

Liu, X., Wang, Y., & Guo, J. M. (2012). 企业应用 PDCA 循环进行质量改进研究 [Enterprises apply the PDCA cycle for quality improvement research]. *Modern Commercial Industry*, *24*(014), 12-13.

Li, Y. N. (1995). ISO 8402:1994 质量管理和质量保证——术语 [ISO8402-1994 Quality management and quality assurance-vocabulary]. *Project Quality Management and Monitoring 02*(02), 38-41.

Lovelock, C. H. (1980). Towards a classification of services. *Theoretical Developments in Marketing*, *72*(6), 72-76.

Luan, S. (2016). *An empirical study on the service quality of railway general-speed trains based on customer perception* [Master's thesis]. Henan University.

Luo, X. G., & Shen, J. (2006). SERVQUAL 模型在服务型政府绩效评价中的应用研究

[Research on the application of SERVQUAL model in service-oriented government performance evaluation]. *Economic Review*, (11), 23-26.

Ma, G. C. (2013). *Research on network service optimization and innovation of telecom operators based on PPDIOO* [Master's thesis]. Beijing University of Posts and Telecommunications.

Ma, H. J. (2017). *Research on the evaluation and improvement measures of service quality of XM Telecom call center based on SERVQUAL model* [Master's thesis]. University of South China.

Ma, X. C. (2019). 基于通讯工程的网络服务质量监测和控制研究 [Research on network service quality monitoring and control based on communication engineering]. *Science and Technology Economy Guide*, (021), 13.

Mao, B. H., & Yang, Z. M. (2010). 客户可感知的电信服务质量指标体系模型的研究与实践 [Research and practice on customer-perceivable telecommunication service quality indicator system models]. *Telecommunications Science*, (07), 128-132.

Mardani, A., Jusoh, A., & Zavadskas, E. K. (2015). Fuzzy multiple criteria decision-making techniques and applications: Two decades review from 1994 to 2014. *Expert Systems with Application*, *42*(8), 4126-4148.

Martilla, J. A., & James, J. C. (1977). Importance-performance analysis. *Journal of Marketing*, *41*(1), 77-79.

Miranda, S., Tavares, P., & Queiró, R. (2018). Perceived service quality and customer satisfaction: A fuzzy set QCA approach in the railway sector. *Journal of Business Research*, *89*, 371-377.

Naghshineh, M., & Acampora, A. S. (1996). Qos provisioning in micro-cellular networks supporting multimedia traffic. *Wireless Networks*, *2*(3), 195-203.

Newman, & Karin. (2001). Interrogating SREVQUAL: A critical assessment of service quality measurement in a high street retail bank. *International Journal of Bank Marketing*, *19*(3), 126-139.

Nitecki, D. A., & Hernon, P. (2000). Measuring service quality at Yale university's libraries. *Journal of Academic Librarianship*, *26*(4), 259-273.

O'Neill, M. A., & Palmer, A. (2004). Importance-performance analysis: a useful tool for directing continuous quality improvement in higher education. *Quality Assurance in Education*, *12*(1), 39-52.

Oakland, J. S. (1993). *Total quality management: The route to improving performance.* Butterworth Heinemann.

Pan, Y. F. (2007). 基于 SERVQUAL 模型的饭店服务质量测评——以浙江省星级饭店为例 [Hotel service quality evaluation based on the SERVQUAL model: Taking Zhejiang star-rated hotels as an example]. *Shopping Mall Modernization*, (03S), 129-130.

Parasuraman, A., Berry, L. L., & Zeithaml, V. A. (1991). Perceived service quality as a customer-based performance measure: An empirical examination of organizational barriers using an extended service quality model. *Human Resource Managemen*t, *30*(3), 335-364.

Parasuraman, A., Berry, L. L., & Zeithaml, V. A. (1993). More on improving service quality measurement. *Journal of Retailing*, *69*(1), 140-147.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing*, *49*(4), 41-50.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1988). SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality. *Journal of Retailing*, *64*(1), 12-40.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1994). Reassessment of expectations as a comparison standard in measuring service quality: Implications for further research. *Journal of Marketing*, *58*(1), 111-124.

Pearson, K. (1895). VII. Note on regression and inheritance in the case of two parents.

Proceedings of the Royal Society of London, *58*(347-352), 240-242.
Pinho, J. C., Macedo, I. M., & Monteiro, A. P. (2007). The impact of online SERVQUAL dimensions on certified accountant satisfaction: The case of taxation services. *Euromed Journal of Business*, *2*(2), 154-172.
Pirsig, R. (1992). *Lila: An inquiry into morals*. Bantam Books.
Popoola, S. I., Atayero, A. A., Faruk, N., & Badejo, J. A. (2018). Data on the key performance indicators for quality of service of GSM networks in Nigeria. *Data in Brief*, *16*(C), 914-928.
Qiao, Z. J. (2005). 从质量定义看本质 [See the essence from the definition of quality]. *Enterprise Standardization*, (005), 23-25.
Raghunathan, T. S., Rao, S. S., & Solis, L. E. (1997). A comparative study of quality practices: USA, China and India. *Industrial Management and Data Systems*, *97*(5), 192-200.
Rathmell, J. M. (1966). What is meant by services?. *Journal of Marketing*, *30*(4), 32-36.
Regan, W. J. (1963). The service revolution. *Journal of Marketing*, *27*(3), 57-62.
Rod, M., & Ashill, N. J. (2013). The impact of call centre stressors on inbound and outbound call-centre agent burnout. *Managing Service Quality*, *23*(3), 245-264.
Rosander, A. C. (1980). Service industry quality control: Is the challenge being met. *Quality Progress, 13*(9), 34-35.
Rosenbaum, M. S., & Wong, I. (2009). Modeling customer equity, SERVQUAL, and ethnocentrism: A Vietnamese case study. *Journal of Service Management*, *20*(5), 544-560.
Rust, R. T., & Oliver, R. L. (1993). *Service quality: New directions in theory and practice*. Sage Publications.
Salama, A., & Saatchi, R. (2018). Probabilistic classification of quality of service in wireless computer networks. *Information and Communications Technology Express*, *5*(3), 155-162.
Santouridis, I., & Trivellas, P. (2010). Investigating the impact of service quality and customer satisfaction on customer loyalty in mobile telephony in Greece. *Total Quality Management Journal*, *22*(3), 330-343.
Sasser, W. E., Olsen, R. P., & Wyckoff, D. D. (1978). *Management of service operations: Text, cases, and readings*. Allyn and Bacon.
Scheffe, H. (1999). *The analysis of variance*. John Wiley and Sons.
Schneider, B., White, S. S., Paul, M. C., Schneider, B., White, S. S., & Paul, M. C. (1998). Linking service climate and customer perceptions of service quality: test of a causal model. *Journal of Applied Psychology*, *83*(2), 150-63.
Seibert, S. E., Silver, S. R., & Randolph, W. A. (2004). Taking empowerment to the next level: A multiple-level model of empowerment, performance, and satisfaction. *The Academy of Management Journal*, *47*(3), 332-349.
Shewfelt, R. L. (1999). What is quality?. *Postharvest Biology and Technology*, *15*(3), 197-200.
Shewhart, W. A. (1931). *Economic control of quality of manufactured product*. Macmillan Pressing House.
Shewhart, W. A., & Deming, W. E. (1986). *Statistical method from the viewpoint of quality control*. Courier Corporation.
Slack, N., Chambers, S., & Johnston, R. (2010). *Operations management.* Pearson Education.
Solis, L. E., Rao, S., Raghu-Nathan, T.S., Chen, C., & Pan, S. (1998). Quality management practices and quality results: A comparison of manufacturing and service sectors in Taiwan. *Journal of Service Theory and Practice*, *8*(1), 46-54.
Sun, M. W., & Qi, Y. D. (2019). 基于云模型和改进灰色关联分析模型的网络服务质量综合评估 [Comprehensive evaluation of network service quality based on cloud model and improved grey relational analysis model]. *Computer Science*, *46*(05), 322-326.
Swan, J. E., & Combs, L. J. (1976). Product performance and consumer satisfaction: A new concept. *Journal of Marketing*, *40*(2), 25-33.

Taguchi, G. (1986). Introduction to quality engineering: Designing quality into products and processes. *Technometrics*, *31*(2), 198.

Tang, L. Y. (2010). 电信企业客户服务质量感知与客户满意度研究 [Research on customer service quality perception and customer satisfaction of telecom enterprises]. *Statistics and Decision,* (08), 100-102.

Thaichon, P., Lobo, A., & Mitsis, A. (2012, December 3–5). *Investigating the antecedents to loyalty of Internet service providers in Thailand: Developing a conceptual model*. Australian and New Zealand Marketing Academy Conference, Adelaide, Australia.

Thaichon, P., Lobo, A., Prentice, C., & Quach, T. N. (2014). The development of service quality dimensions for internet service providers: Retaining customers of different usage patterns. *Journal of Retailing and Consumer Services*, *21*(6), 1047-1058.

Tse, D. K., & Wilton, P. C. (1988). Models of consumer satisfaction: An extension. *Journal of Marketing Research*, *25*(5), 204-212.

Vlachos, P. A., & Vrechopoulos, A. P. (2008). Determinants of behavioral intentions in the mobile internet services market. *Social Science Electronic Publishing*, *22*(4), S213.

Wang, J., & Zheng, H. L. (2008). 构建基于客户感知的电信服务质量评价体系 [Building a telecommunications service quality evaluation system based on customer perception]. *Communication Enterprise Management,* (10), 70-71.

Wang, Q., Zhou, W., Wang, H., Liang, D. G., Chen, X. W., & Wang, X. (2019). 面向电力测试装置远程校准的网络服务质量可靠性建模与分析 [Modeling and analysis of network service quality reliability for power meter remote calibration]. *High-Voltage Electrical Appliances*, *55*(06), 117-122.

Wang, R. H. (2013). *Research on aviation service quality evaluation based on SERVQUAL method* [Master's thesis]. Dalian University of Technology.

Wang, W. J. (2014). *Research on the service value enhancement strategy of telecom operators* [Doctoral dissertation]. Beijing University of Posts and Telecommunications.

Wang, Y., Lo, H. P., & Yang, Y. (2004). An integrated framework for service quality, customer value, satisfaction: Evidence from China's telecommunication industry. *Information Systems Frontiers*, *6*(4), 325-340.

Watson, O. (1976). *Longman modern English dictionary.* Longman.

Wei, F. X. (2005). *服务质量评价与管理 [Service quality evaluation and management]*. Publishing of Civil Posts and Telecommunications.

Wei, F. X., & Han, J. L. (2003). 文化差异对顾客服务质量感知影响的实证研究 [An empirical study on the impact of cultural differences on customer service quality perception]. *Nankai Management Review*, *6*(003), 77-80.

Weiseke, J., Ahearne, M., Lam, S. K., & Dick, R. V. (2010). The role of leaders in internal marketing: A multilevel examination through the lens of social identity theory. *Social Science Electronic Publishing*, *53*(2), 87-93.

Westbrook, R. A., & Reilly, M. D. (1983). Value-percept disparity: An alternative to the disconfirmation of expectations theory of consumer satisfaction. In R. P. Bagozzi, & A. M. Tybout (Eds.), *Advances in consumer research* (pp. 256-261). Association for Consumer Research.

Wu, J. (2015). *Xi'an mobile communication network service quality evaluation* [Master's thesis]. Xi'an Polytechnic University.

Wu, X. Q. (1997). 服务质量特性与服务质量体系 [Service quality features and service quality system]. *World Standardization and Quality Management*, (007), 11-14.

Xiao, L., & Liu, L. (2010). 国内外质量管理研究现状比较 [Comparison of the status quo of domestic and foreign quality management research]. *Chinese Management Informatization*, *13*(023), 44-45.

Xiao, T. (2013). 浅谈企业如何有效运行 ISO 质量管理体系 [Talking about how an enterprise can effectively operate the ISO quality management system]. *Construction Technology*, (008), 76-77.

Xie, J. H. (2017). *Research on the corporate dilemma and transformation path of basic telecom operators in the mobile internet environment* [Doctoral dissertation]. Beijing University of Posts and Telecommunications.

Xie, L. J., Wang, H. X., & Zhou, Q. (2018). 面向服务质量的前摄式网络功能动态部署策略研究 [Research on QoS-oriented proactive virtual network functions dynamic placement strategy]. *Journal of the University of Information Engineering*, *19*(04), 17-23.

Xu, Z. Y. (2002). *顾客服务：供应链一体化的营销管理 [Customer service: Integrated marketing management of supply chain]*. China Materials Publishing House.

Yan, G. (2014). *我国商业银行服务管理问题研究 [Research on the service management of Chinese commercial banks]*. China Financial Publishing House.

Yan, X. M. (2015). *Research on the improvement of Qinhuangdao Unicom service quality based on customer satisfaction* [Master's thesis]. Yanshan University.

Yang, Y. (2019). *中国基础电信服务业与经济增长的关系研究 [Research on the relationship between China's basic telecommunications service industry and economic growth]* [Master's thesis]. Beijing University of Posts and Telecommunications.

Ye, W. C. (2001). *服务营销学 [Service marketing]*. Higher Education Press.

Yeo, G. T., Thai, V. V., & Roh, S. Y. (2015). An analysis of port service quality and customer satisfaction: The case of Korean container ports. *Asian Journal of Shipping and Logistics*, *31*(4), 437-447.

You, J. X., Zhou, W. Y., Wu, X. J., & Shao, N. N. (2014). *质量管理学 [Quality management]*. Science Press.

Yu, X. B. (2005). 高等教育质量概念：内涵与外延 [The concept of higher education quality: Connotation and extension]. *Higher Education Development and Evaluation,* (06), 46-49.

Zeithaml, & Valarie, A. (2008). *Services marketing: Integrating customer focus across the firm*. China Machine Press.

Zeithaml, V. A., Bitner, M. J., & Gremler, D. D. (2010). *Services marketing strategy*. John Wiley and Sons.

Zeithaml, V. A., Parasuraman, A., & Berry, L. L. (1985). Problems and strategies in service marketing. *Journal of Marketing*, *49*(2), 33-46.

Zeng, L. Q. (2007). 服务质量差距模型及差距弥合 [Service quality gap model and gap bridging]. *Coastal Enterprises and Technology*, (006), 71-73.

Zhang, J. L., & Wu, X. Z. (2003). SERVQUAL 模型在图书馆服务质量评价上的应用 [The application of SERVQUAL model in the evaluation of library service quality]. *Research in Library Science,* (5), 87-90.

Zhang, S. H. (2010). *Service quality analysis of YT communication service company based on SERVQUAL model* [Master's thesis]. Sun Yat-sen University.

Zhao, M., Ma, J., & Ma, H. (2010). 电信服务接触点分析及其应用建议 [Telecom service touch point analysis and application suggestions]. *Modern Telecom Technology*, *040*(001), 36-39.

Zhou, Y. (2011). 服务质量差距模型在酒店营销中的运用 [The application of service quality gap model in hotel marketing]. *China Market*, (026), 47-47.

Zhou, Z. S. (2012). *Construction and application research on service quality evaluation model of logistics enterprises* [Doctoral dissertation]. Jiangsu University.

Zhu, H., Wang, C. X., Cen, C. D., & Xie, L. S. (1999). 服务质量属性的实证研究 [An empirical study of service quality attributes]. *Business Research,* (06), 82-85.

[This page is deliberately left blank.]

Webliography

Baidu Baike. (2010, July 1). *Pearson correlation coefficient*. Baidu. Retrieved October 28, 2019, from https://baike.baidu.com/item/Pearson 相关系数/6243913?fr=aladdin

Ben, S. S. (2017, June 25). *移动、联通、电信三大运营商角力，破局制胜的关键是什么 [Mobile, Unicom, Telecom three operators wrestle, what is the key to win the game]*. Huxiu. Retrieved October 28, 2019, from https://www.huxiu.com/article/201411.html

Ben, S. S. (2019, March 27). *电信运营商的同质化竞争严重吗 [Is the homogenization competition of telecom operators serious]*. Huxiu. Retrieved October 28, 2019, from https://www.huxiu.com/article/291366.html

China Academy of Information and Communication Technology. (2017, June 13). *中国信通院发布《5G 经济社会影响白皮书》 [CAICT releases "5G white paper on economic and social impact"]*. China Academy of Information and Communication Technology. Retrieved October 28, 2019, from http://www.caict.ac.cn/xwdt/ynxw/201804/t20180426_157297.htm

Liu, Y. (2019, March 19). *莫让"携号转网"成花架子 [Don't let the "number portability" become frilly]*. China's Central Government. Retrieved October 28, 2019, from http://www.gov.cn/xinwen/2019-03/19/content_5374881.htm

Mu, M. (2019, January 10). *国内 5G：政策、运营商、设备商全部到位丨盘点 2018 [Chinese 5G: Policies, operators and device vendors 丨A summary in 2018]*. Ijiwei. Retrieved October 28, 2019, from https://baijiahao.baidu.com/s?id=1622246047845762067&wfr=spider&for=pc

Qiu, Y. (2019, October 26). *台前与幕后的 5G 战争 [5G battles in front of and behind the scenes]*. 36K. Retrieved October 28, 2019, from https://36kr.com/p/5259947

Securities Times. (2019, October 9). *三大运营商 5G 预约用户数突破 1000 万户 [The number of 5G reservation subscribers of the three major carriers exceeded 10 million]*. Interface News. Retrieved October 28, 2019, from https://www.jiemian.com/article/3559004.html

Sichuan Communications Administration. (2018, March 12). *四川省通信管理局关于发布全省电信服务质量用户满意度指数测评结果的公告 [Announcement of Sichuan communications administration on release of the results of evaluation on customer satisfaction index of telecommunication service quality of Sichuan Province]*. Sichuan Communications Administration. Retrieved October 28, 2019, from https://scca.miit.gov.cn/zwgk/dxhhlwgl/art/1970/art_9f2e1f4e958945ddaa5a23921f9a0de2.html.

Sina Sichuan. (2014, December 16). *四川移动全业务战略惠及全川百姓 [The whole business strategy of Sichuan Mobile benefits all the people in Sichuan]*. Sina. Retrieved October 28, 2019, from http://sc.sina.com.cn/news/finance/2014-12-16/detail-icczmvun2667925.shtml

Sichuan Mobile Service Work. (2017, March 14). *四川移动"网络强省"战略初显成效 [Sichuan Mobile's strategy of "enhancing network capacity in Sichuan Province" has effectiveness]*. West China City Daily. Retrieved October 28, 2019, from https://e.thecover.cn/shtml/hxdsb/20170314/34256.shtml

Tang, J. Y., & Zhang, J. C. (2019, October 19). *5G 破晓，三大运营商策略生变 [As 5G dawns,*

three major operators' strategies change]. Interface News. Retrieved October 28, 2019, from https://www.jiemian.com/article/3594490.html

The International Organization for Standardization. (2015, September 9). *ISO 9000:2015 Quality management systems — Fundamentals and vocabulary.* ISO. Retrieved October 18, 2020, from https://www.iso.org/obp/ui/#iso:std:iso:9000:ed-4:v1:en

Tencent Technology. (2015, November 27). *中国移动宣布向母公司收购铁通资产 [China Mobile announces acquisition of Tietong assets from its parent company]*. Tencent Technology. Retrieved October 28, 2019, from https://tech.qq.com/a/20151127/049237.htm

Ren, X. Y. (2018, December 9). *5G 频谱分配方案终落定 三大电信运营商"都不亏" [The three telecom operators profit from 5G spectrum allocation scheme].* Xinhuanet Client. Retrieved October 28, 2019, fromhttps://baijiahao.baidu.com/s?id=1619353454356607028&wfr=spider&for=pc

Xinhuanet. (2019, March 16).*政府工作报告 [Government work report].* China's Central Government. Retrieved October 28, 2019, from http://www.gov.cn/premier/2019-03/16/content_5374314.htm

Xu, H. (2013, December 18). *中国移动总裁李跃详细解读 4G"和"品牌 [President of China Mobile Li Yue interprets the 4G "AND" brand]*. CNMO. Retrieved October 28, 2019, from https://www.cnmo.com/4g/336811.html

Yang, J. (2019, February 2). *成都力促 5G 产业发展，产业化优势项目最高奖励 300 万 [Chengdu promotes the development of 5G industry, with a maximum award of 3 million yuan for projects with industrialization advantages]*. CS Net. Retrieved October 28, 2019, from http://www.cs.com.cn/cj/hyzx/201902/t20190202_5921829.html

Zhang, J. (2019, August 23). *三大运营商集体陷增长困境，5G 大潮前何去何从 [The three major operators are trapped in a growth dilemma, and what to do before the 5G wave]*. Interface News. Retrieved October 28, 2019, from https://www.jiemian.com/article/3435202.html

Zhen, Q. L. (2019, March 15). *工信部印发《关于 2019 年信息通信行业行风建设暨纠风工作的指导意见》 [MIIT issues "Guiding opinions on the construction and rectification of work style in the information and communication industry in 2019"]*. CWW Net. Retrieved October 28, 2019, from http://www.cww.net.cn/article?id=448767

Zhu, C. (2019, August 28). *五个常见客户满意度测评模型 [Five common customer satisfaction measurement models].* Jianshu. Retrieved October 28, 2019, from https://zoyi14.smartapps.cn/pages/note/index?slug=e5cf2e95bd4e&origin=share&hostname=baiduboxapp&_swebfr=1

Annex A: Pre-survey Questionnaire

Questionnaire for Operators' Network Service Quality

The purpose of this questionnaire is to explore the network service quality of operators. The results of the questionnaire are only made use of for academic research, and your privacy will be protected. Please feel free to answer in accroance with the actual situation.

1. Personal information

Question	Option
Are you the MC user?	A Yes B No
gender	A Male B Female
age	A Under 18 years old B 18～30 years old C 31～50 years old D Above 50 years old
education level	A Junior college or below B Undergraduate C Postgraduate or above
Area	A. First- and second-tier cities B. Non-first- and non-second-tier cities C. Towns D. Rural areas
Monthly income	A. 3,000 yuan and below B. 3,001-5,000 yuan C. 5,001-10,000 yuan D. 10,001-20,000 yuan E. More than 20,000 yuan
Network usage frequency	A High frequency users who rely on the Internet to work, study, leisure. B Intermediate frequency users who use Internet when necessary for work or study C Low frequency users who only use phone for communication
The year starting to use network services	A. 2002~2005 B. 2006~2010 C. 2011~2015 D. 2016~2020

2. Service quality evaluation

There are 22 questions in this part, and you have to answer your expected service and actual operator service quality in each question. Each service is scored on a 5-point scale, with 1-5 points representing very poor, poor, fair, good, and very good respectively.

Service	Your expectations of the service	Operator's actual service level
1. The business hall has modern supporting equipment	1 2 3 4 5	1 2 3 4 5
2. Service personnel are neat and tidy	1 2 3 4 5	1 2 3 4 5
3. The overall environment of the business hall is comfortable and attractive	1 2 3 4 5	1 2 3 4 5
4. The intelligent voice of customer service call is intelligent and efficient to answer questions	1 2 3 4 5	1 2 3 4 5
5. The network service provided is reliable	1 2 3 4 5	1 2 3 4 5
6. Customer network experience problems are solved promptly and actively	1 2 3 4 5	1 2 3 4 5
7. The actual service provided is consistent with the description of the advertisement or service personnel	1 2 3 4 5	1 2 3 4 5
8. Effective and unblocked manual customer call service is provided	1 2 3 4 5	1 2 3 4 5
9. Service personnel can answer and solve customer problems accurately	1 2 3 4 5	1 2 3 4 5
10. Service personnel can provide timely service	1 2 3 4 5	1 2 3 4 5
11. Manual customer service calls can be quickly connected	1 2 3 4 5	1 2 3 4 5
12. Customer problems can be solved within the promised time	1 2 3 4 5	1 2 3 4 5
13. For complex problems, service personnel can actively seek solutions for customers	1 2 3 4 5	1 2 3 4 5
14. The service personnel can determine the time to solve the problem	1 2 3 4 5	1 2 3 4 5
15. Service personnel are skilled at solving the problems consulted by customers	1 2 3 4 5	1 2 3 4 5
16. Service personnel are competent and professional in solving various problems	1 2 3 4 5	1 2 3 4 5
17. Service personnel treat customers well	1 2 3 4 5	1 2 3 4 5
18. Service personnel can provide reliable solutions	1 2 3 4 5	1 2 3 4 5
19. Operators can actively take into account network experience of customers	1 2 3 4 5	1 2 3 4 5
20. Operators provide customers with personalized services	1 2 3 4 5	1 2 3 4 5
21. Operators take measures to actively understand customer needs	1 2 3 4 5	1 2 3 4 5
22. Operators put customers' interests first	1 2 3 4 5	1 2 3 4 5

Annex B: Questionnaire

Questionnaire for Operators' Network Service Quality

The purpose of this questionnaire is to explore the network service quality of operators. The results of the questionnaire are only used for academic research, and your privacy will be protected. Please feel free to answer according to the actual situation.

1. Personal information

Question	Option
Are you the MC user?	A Yes B No
gender	A Male B Female
age	A Under 18 years old B 18～30 years old C 31～50 years old D Above 50 years old
education level	A Junior college or below B Undergraduate C Postgraduate or above
Area	A. First- and second-tier cities B. Non-first- and second-tier cities C. Towns D. Rural areas
Monthly income	A. 3,000 yuan and below B. 3,001-5,000 yuan C. 5,001-10,000 yuan D. 10,001-20,000 yuan E. More than 20,000 yuan
Network usage frequency	A High frequency users who rely on the Internet to work, study, leisure. B Intermediate frequency users who use Internet when necessary for work or study C Low frequency users who only use phone for communication
The year starting to use network services	A. 2002~2005 B. 2006~2010 C. 2011~2015 D. 2016~2020

2. Service quality evaluation

There are 26 questions in this part, and each question should answer your expected service situation and actual operator service quality. Each service is scored on a 5-point scale, with 1-5 points representing very poor, poor, fair, good, and very good.

Service	Your expectations of the service	Operator's actual service level
1. The business hall has modern supporting equipment	1 2 3 4 5	1 2 3 4 5
2. Service personnel are neat and tidy	1 2 3 4 5	1 2 3 4 5
3. The overall environment of the business hall is comfortable and attractive	1 2 3 4 5	1 2 3 4 5
4. The intelligent voice of customer service call is intelligent and efficient to answer questions	1 2 3 4 5	1 2 3 4 5
5. The network service provided is reliable	1 2 3 4 5	1 2 3 4 5
6. Customer network experience problems are solved promptly and actively	1 2 3 4 5	1 2 3 4 5
7. The actual service provided is consistent with the description of the advertisement or service personnel	1 2 3 4 5	1 2 3 4 5
8. Effective and unblocked manual customer call service is provided	1 2 3 4 5	1 2 3 4 5
9. Service personnel can answer and solve customer problems accurately	1 2 3 4 5	1 2 3 4 5
10. Service personnel can provide timely service	1 2 3 4 5	1 2 3 4 5
11. Manual customer service calls can be quickly connected	1 2 3 4 5	1 2 3 4 5
12. Customer problems can be solved within the promised time	1 2 3 4 5	1 2 3 4 5
13. For complex problems, service personnel can actively seek solutions for customers	1 2 3 4 5	1 2 3 4 5
14. The service personnel can determine the time to solve the problem	1 2 3 4 5	1 2 3 4 5
15. Service personnel are skilled at solving the problems consulted by customers	1 2 3 4 5	1 2 3 4 5
16. Service personnel are competent and professional in solving various problems	1 2 3 4 5	1 2 3 4 5
17. Service personnel treat customers well	1 2 3 4 5	1 2 3 4 5
18. Service personnel can provide reliable solutions	1 2 3 4 5	1 2 3 4 5
19. Operators can actively take into account network experience of customers	1 2 3 4 5	1 2 3 4 5
20. Operators provide customers with personalized services	1 2 3 4 5	1 2 3 4 5
21. Operators take measures to actively understand customer needs	1 2 3 4 5	1 2 3 4 5
22. Operators put customers' interests first	1 2 3 4 5	1 2 3 4 5
23. Service personnel can actively solve the customers' complaints	1 2 3 4 5	1 2 3 4 5
24. Service personnel can take appropriate and timely measures to remedy their service	1 2 3 4 5	1 2 3 4 5
25. Customers know the response of the complaint and its handling process	1 2 3 4 5	1 2 3 4 5
26. Customers accept the results of complaint settlement	1 2 3 4 5	1 2 3 4 5

Annex C: Additional Tables

Table C-1 Results of KMO test and Bartlett-Test of Sphericity of pre-survey data

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.927
Bartlett test of sphericity	Chi-square	2762.692
	Degrees of freedom	231
	p-value	0.000

Source: elaborated by the author

Table C-2 Cumulative Variance Contribution Rates

Factor	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Eigenvalue	Proportion	Cumulative	Variance	Proportion	Cumulative
Factor1	10.934	0.411	0.411	3.589	0.157	0.157
Factor2	2.561	0.053	0.464	2.957	0.130	0.287
Factor3	1.821	0.051	0.515	2.685	0.118	0.405
Factor4	1.441	0.047	0.562	2.313	0.101	0.506
Factor5	1.213	0.046	0.608	1.971	0.086	0.593
Factor6	1.002	0.045	0.653	1.646	0.072	0.665

Source: elaborated by the author

Table C-3 Rotated factor loading matrix

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6
Y11			0.537			
Y12			0.655			
Y13			0.543			
Y14			0.500			
Y21						
Y22				0.561		
Y23				0.485		
Y24				0.772		
Y25				0.463		
Y31					0.652	
Y32					0.505	
Y33					0.491	
Y34					0.489	
Y35					0.646	
Y41		0.534				
Y42		0.477				
Y43		0.649				
Y44		0.454				
Y51	0.666					
Y52	0.667					
Y53	0.481					
Y54	0.597					

Source: elaborated by the author

Table C-4 Expected values of different genders in independent sample t test

	obs-male	obs-female	Mean-male	Mean-female	dif	St Err	t value	p value
E(Y1)	167	181	4.142	4.147	-0.004	0.063	-0.05	0.947
E(Y2)	167	181	4.215	4.141	0.073	0.064	1.15	0.257
E(Y3)	167	181	4.096	4.085	0.011	0.063	0.15	0.866
E(Y4)	167	181	4.176	4.114	0.064	0.066	0.95	0.332
E(Y5)	167	181	4.048	4.025	0.023	0.066	0.35	0.727
E(Y6)	167	181	4.128	4.148	-0.019	0.066	-0.3	0.773

Source: elaborated by the author

Table C-5 Perceived values of different genders in independent sample t test

	obs-male	obs-female	Mean-male	Mean-female	dif	St Err	t value	p value
Y1	167	181	3.623	3.707	-0.085	0.074	-1.15	0.259
Y2	167	181	3.641	3.683	-0.042	0.068	-0.6	0.533
Y3	167	181	3.518	3.548	-0.03	0.079	-0.4	0.699
Y4	167	181	3.644	3.748	-0.105	0.079	-1.35	0.183
Y5	167	181	3.152	3.286	-0.133	0.092	-1.45	0.149
Y6	167	181	3.662	3.724	-0.062	0.074	-0.85	0.406

Source: elaborated by the author

Table C-6 One-way analysis of variance for the age

expected value test	f value	p value	perceived value test	f value	p value
E(Y1)	5.58	0.001	Y1	2.07	0.104
E(Y2)	2.79	0.041	Y2	2.75	0.043
E(Y3)	2.30	0.077	Y3	3.13	0.026
E(Y4)	3.53	0.015	Y4	0.69	0.046
E(Y5)	2.17	0.091	Y5	2.94	0.033
E(Y6)	1.14	0.335	Y6	1.02	0.382

Source: elaborated by the author

Table C-7 Comparison between groups

Expected value	Below 18	18~30	31~50	Perceived value	Below 18	18~30	31~50
18~30	0.336			18~30	0.359		
	0.082				0.154		
31~50	0.403	0.067		31~50	0.461	0.102	
	0.020	0.915			0.028	0.405	
Above 51	0.418	0.082	0.015	Above 51	0.335	-0.024	-0.126
	0.097	1.000	1.000		0.613	1.000	1.000

Source: elaborated by the author

Table C-8 One-way analysis of variance for the education level

expected value test	f value	p value	perceived value test	f value	p value
E(Y1)	0.68	0.507	Y1	0.25	0.779
E(Y2)	1.24	0.292	Y2	0.15	0.857
E(Y3)	0.14	0.869	Y3	2.08	0.127
E(Y4)	0.02	0.980	Y4	0.26	0.768
E(Y5)	0.99	0.374	Y5	3.26	0.340
E(Y6)	2.02	0.134	Y6	0.61	0.544

Source: elaborated by the author

Table C- 9 One-way analysis of variance for the area

expected value test	f value	p value	perceived value test	f value	p value
E(Y1)	0.82	0.481	Y1	0.39	0.763
E(Y2)	0.15	0.932	Y2	0.30	0.823
E(Y3)	1.39	0.246	Y3	0.88	0.450
E(Y4)	0.40	0.754	Y4	0.61	0.610
E(Y5)	0.58	0.628	Y5	0.56	0.639
E(Y6)	0.22	0.880	Y6	0.06	0.979

Source: elaborated by the author

Table C- 10 One-way analysis of variance for the monthly income

expected value test	f value	p value	perceived value test	f value	p value
E(Y1)	1.12	0.346	Y1	1.22	0.301
E(Y2)	1.42	0.226	Y2	0.77	0.546
E(Y3)	1.85	0.120	Y3	1.20	0.309
E(Y4)	3.03	0.018	Y4	0.89	0.472
E(Y5)	2.16	0.043	Y5	1.66	0.159
E(Y6)	1.72	0.145	Y6	1.32	0.262

Source: elaborated by the author

Table C-11 Comparison of assurance's expected values between groups

	3,000 yuan and below	3,001-5,000 yuan	5,001-10,000 yuan	10,001-20,000 yuan
3,001-5,000 yuan	-0.043 1.000			
5,001-10,000 yuan	-0.027 1.000	0.016 1.000		
10,001-20,000 yuan	-0.208 1.000	-0.165 0.970	-0.181 0.189	
More than 20,000 yuan	-0.402 0.897	-0.359 0.159	-0.375 0.045	-0.194 1.000

Source: elaborated by the author

Table C-12 Comparison of empathy's expected values between groups

	3,000 yuan and below	3,001-5,000 yuan	5,001-10,000 yuan	10,001-20,000 yuan
3,001-5,000 yuan	0.073 1.000			
5,001-10,000 yuan	0.154 1.000	0.081 1.000		
10,001-20,000 yuan	0.088 1.000	0.015 1.000	-0.067 1.000	
More than 20,000 yuan	-0.238 1.000	-0.311 0.392	-0.392 0.042	-0.326 0.213

Source: elaborated by the author

Table C- 13 One-way analysis of variance for the frequency of network use

expected value test	f value	p value	perceived value test	f value	p value
E(Y1)	0.60	0.548	Y1	1.31	0.272
E(Y2)	0.24	0.785	Y2	2.19	0.114
E(Y3)	0.65	0.524	Y3	2.05	0.130
E(Y4)	1.37	0.256	Y4	3.25	0.240
E(Y5)	1.40	0.247	Y5	6.20	0.202
E(Y6)	0.71	0.492	Y6	0.27	0.766

Source: elaborated by the author

Table C-14 One-way analysis of variance for the years of network use

expected value test	f value	p value	perceived value test	f value	p value
E(Y1)	4.41	0.105	Y1	1.39	0.245
E(Y2)	1.55	0.202	Y2	0.31	0.815
E(Y3)	0.49	0.688	Y3	1.75	0.156
E(Y4)	0.66	0.578	Y4	1.01	0.389
E(Y5)	1.12	0.339	Y5	1.25	0.292
E(Y6)	1.29	0.277	Y6	0.53	0.663

Source: elaborated by the author

Table C-15 Results of KMO test and Bartlett-Test of Sphericity

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.892
Bartlett test of sphericity	Chi-square	1740.755
	Degrees of freedom	325
	p-value	0.000

Source: elaborated by the author

Table C-16 Cumulative variance contribution rate

Factor	Initial eigenvalue			Rotation sums of squared loadings		
	Eigenvalue	Proportion	Cumulative	Variance	Proportion	Cumulative
Factor1	10.953	0.371	0.371	4.578	0.160	0.160
Factor2	2.720	0.092	0.463	3.963	0.139	0.299
Factor3	2.033	0.069	0.532	3.481	0.122	0.420
Factor4	1.711	0.058	0.590	2.679	0.094	0.514
Factor5	1.363	0.046	0.637	2.259	0.079	0.593
Factor6	1.035	0.035	0.672	1.955	0.068	0.661

Source: elaborated by the author

Table C-17 Rotated factor loading matrix

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Y11			0.471			
Y12			0.717			
Y13			0.511			
Y14			0.624			
Y21				0.467		
Y22				0.621		
Y23				0.549		
Y24				0.763		
Y25				0.545		
Y31					0.565	
Y32					0.626	
Y33					0.471	
Y34					0.483	
Y35					0.687	
Y41		0.469				
Y42		0.492				
Y43		0.732				
Y44		5.281				
Y51	0.632					
Y52	0.617					
Y53	0.544					
Y54	0.599					
Y61						0.678
Y62						0.549
Y63						0.673
Y64						0.589

Source: elaborated by the author

Table C-18 Analysis of reliability results of network service quality dimension

Service quality dimension	Expected value Cronbach's alpha	Perceptual value Cronbach's alpha	Items
Y1 Tangibility	0.8291	0.8194	4
Y2 reliability	0.7112	0.7244	5
Y3responsiveness	0.6972	0.6566	5
Y4 assurance	0.6807	0.7778	4
Y5 Empathy	0.7206	0.7687	4
Y6 Remediation	0.7068	0.7671	4

Source: elaborated by the author

Table C-19 The correlation between the dimensions' expected values and the total scores of quality evaluation on network service

	E(Y1)	E(Y2)	E(Y3)	E(Y4)	E(Y5)	E(Y6)
Pearson value	0.775	0.806	0.826	0.788	0.736	0.674
Sig.	0.000	0.000	0.000	0.000	0.000	0.000

Source: elaborated by the author

Table C-20 The correlation between the dimensions' perceived values and the total scores of quality evaluation on network service

	Y1	Y2	Y3	Y4	Y5	Y6
Pearson value	0.711	0.781	0.828	0.751	0.800	0.631
Sig.	0.000	0.000	0.000	0.000	0.000	0.001

Source: elaborated by the author

Annex D: Additional Figures

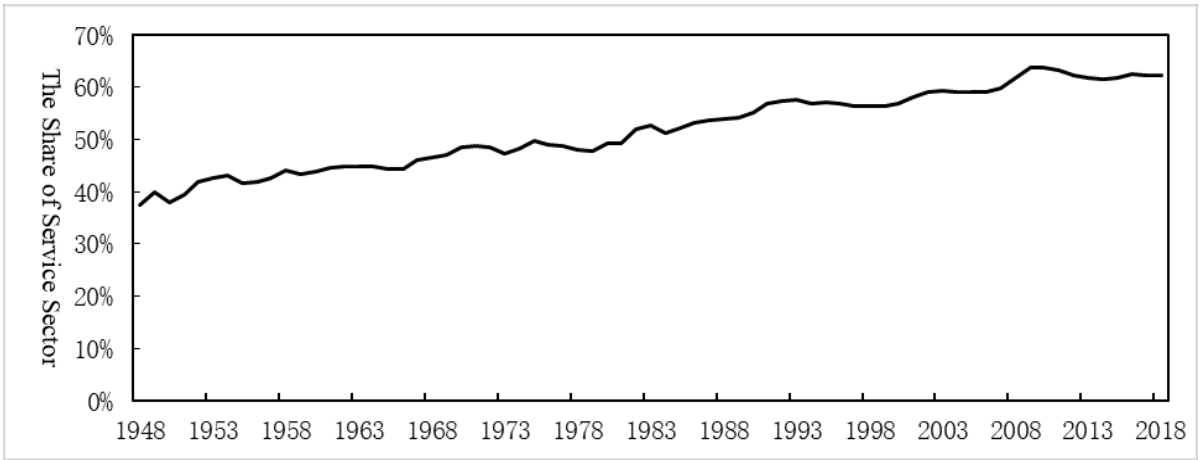

Figure D-1 The share of US services sector in GDP

Data Source: Federal Reserve Economic Data

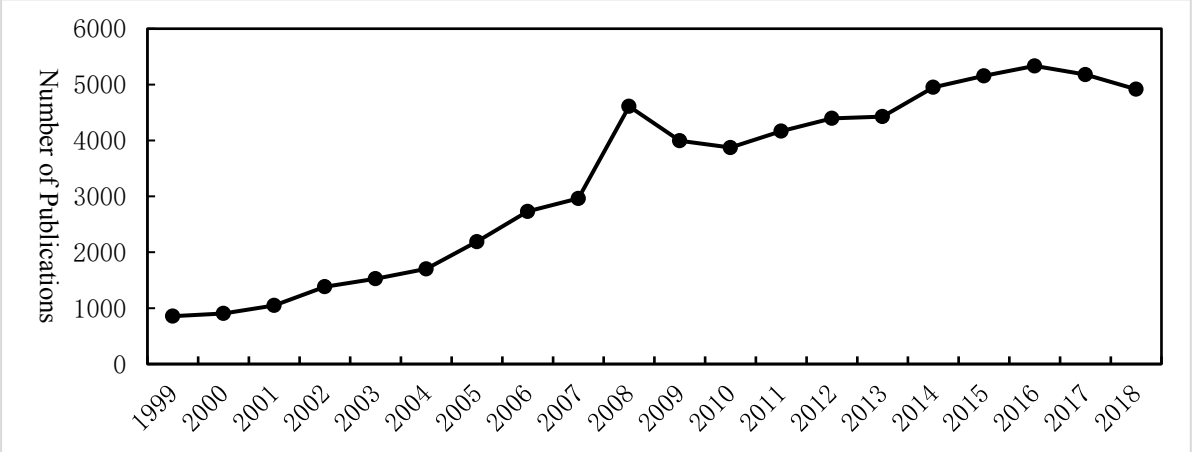

Figure D-2 CNKI's literature on "quality of service" changes from 1999 to 2018

Source: elaborated by the author

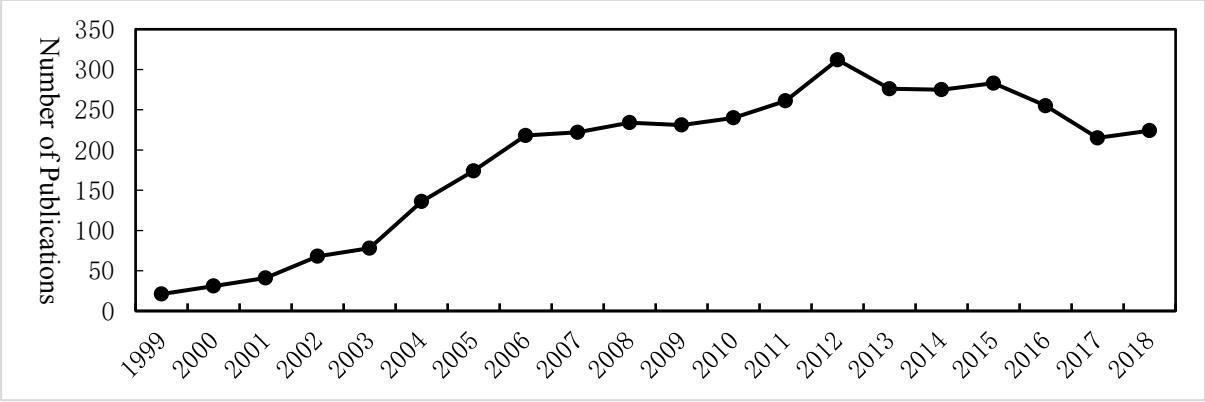

Figure D-3 Changing trend of quantity of CNKI's literature on the "quality of network services"

Source: elaborated by the author

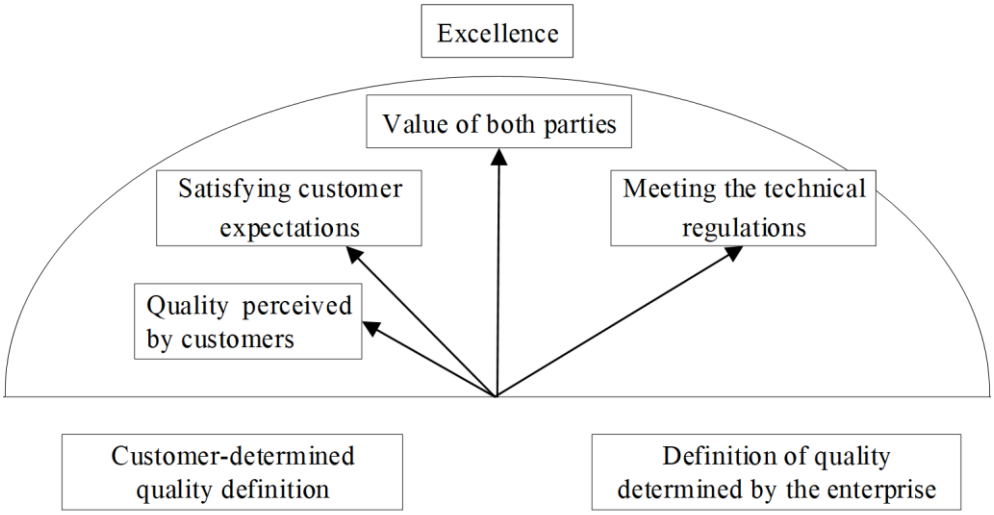

Figure D-4 Five types of quality definition

Source: Luan (2016)

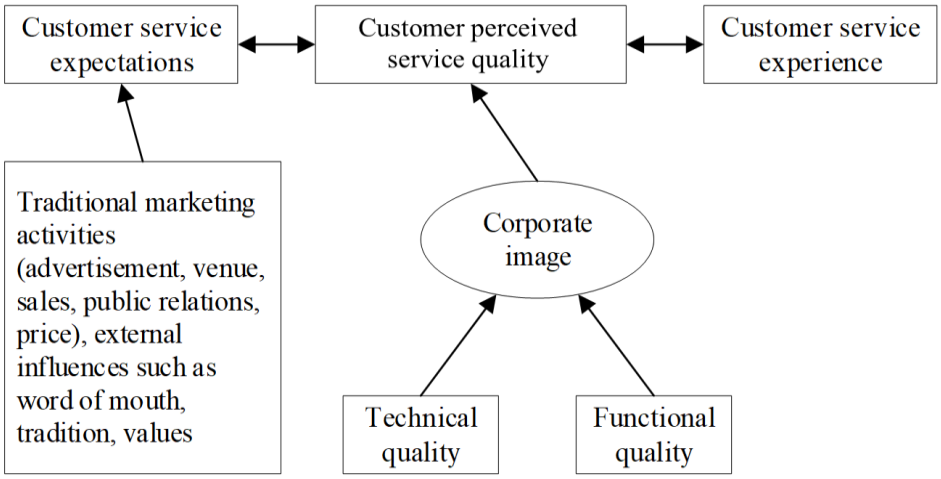

Figure D-5 Gronroos customer perception service quality model 1

Source: Gronroos (1984)

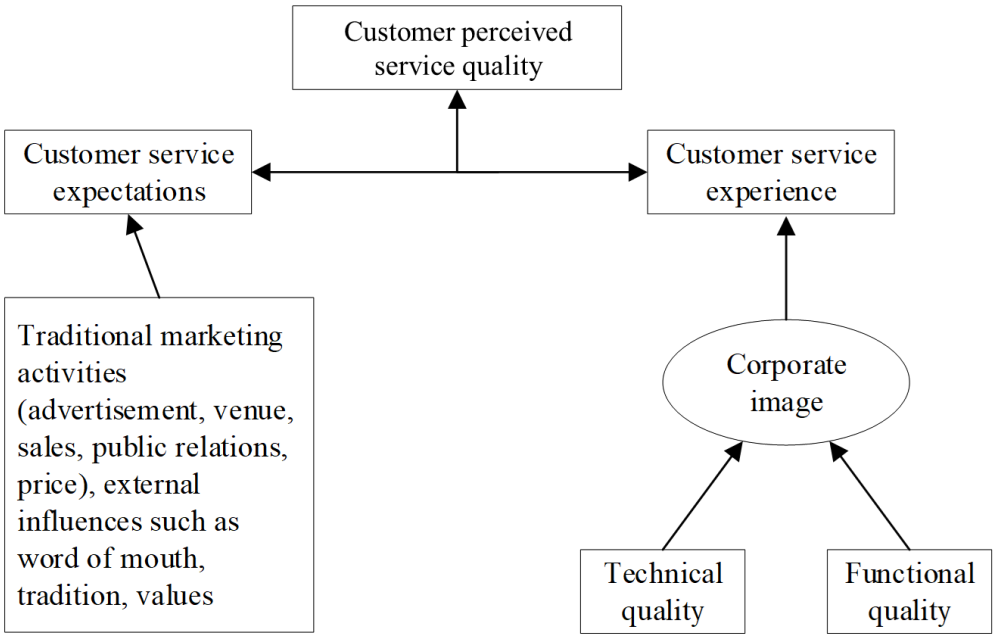

Figure D-6 Gronroos customer perception service quality model 2

Source: Gronroos (2000)

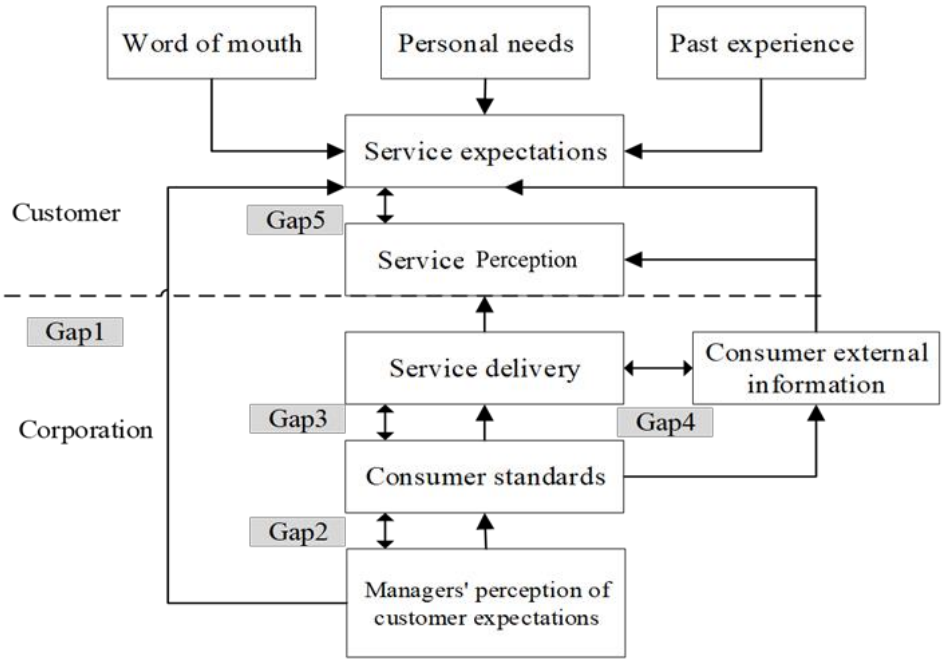

Figure D-7 The gap model of PZB quality of service

Source: Parasuraman et al. (1985)

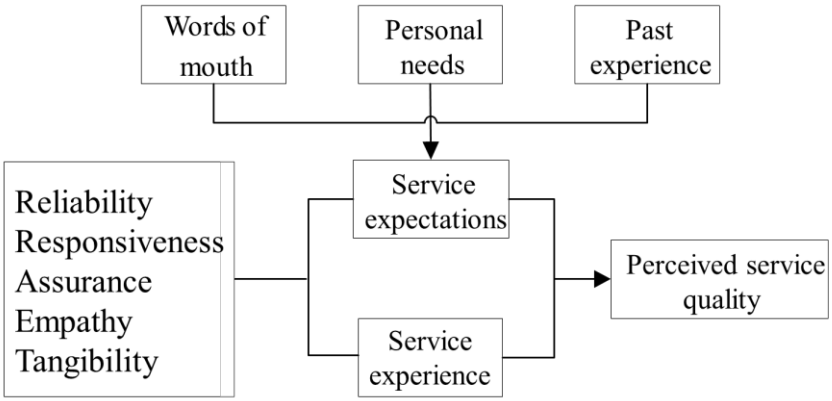

Figure D-8 The determinants of customer perception of service quality

Source: Parasuraman et al. (1985)

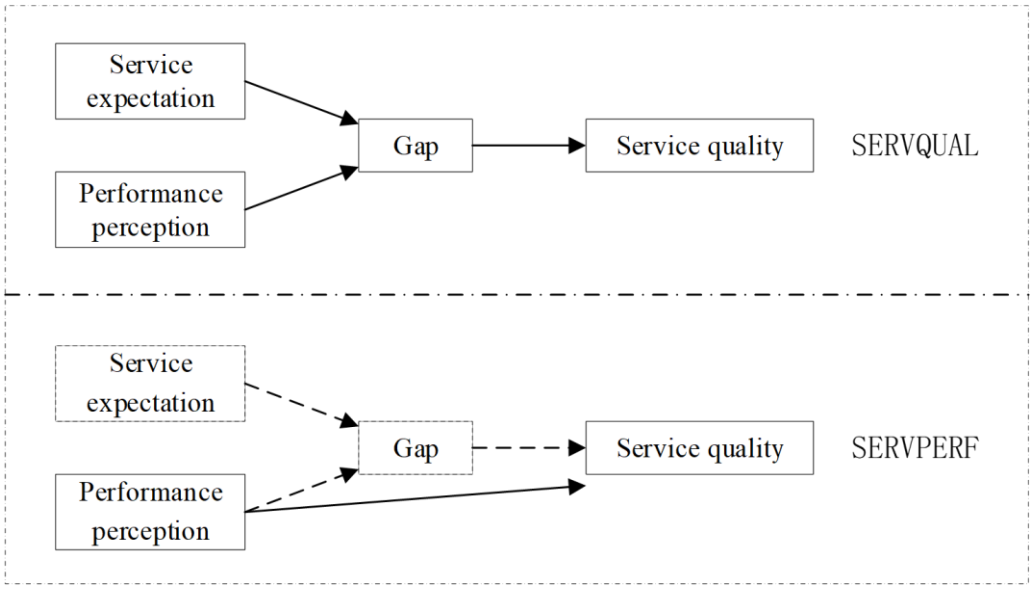

Figure D-9 Comparison of SERVQUAL and SERVPERF scales

Source: R. H. Wang (2013)

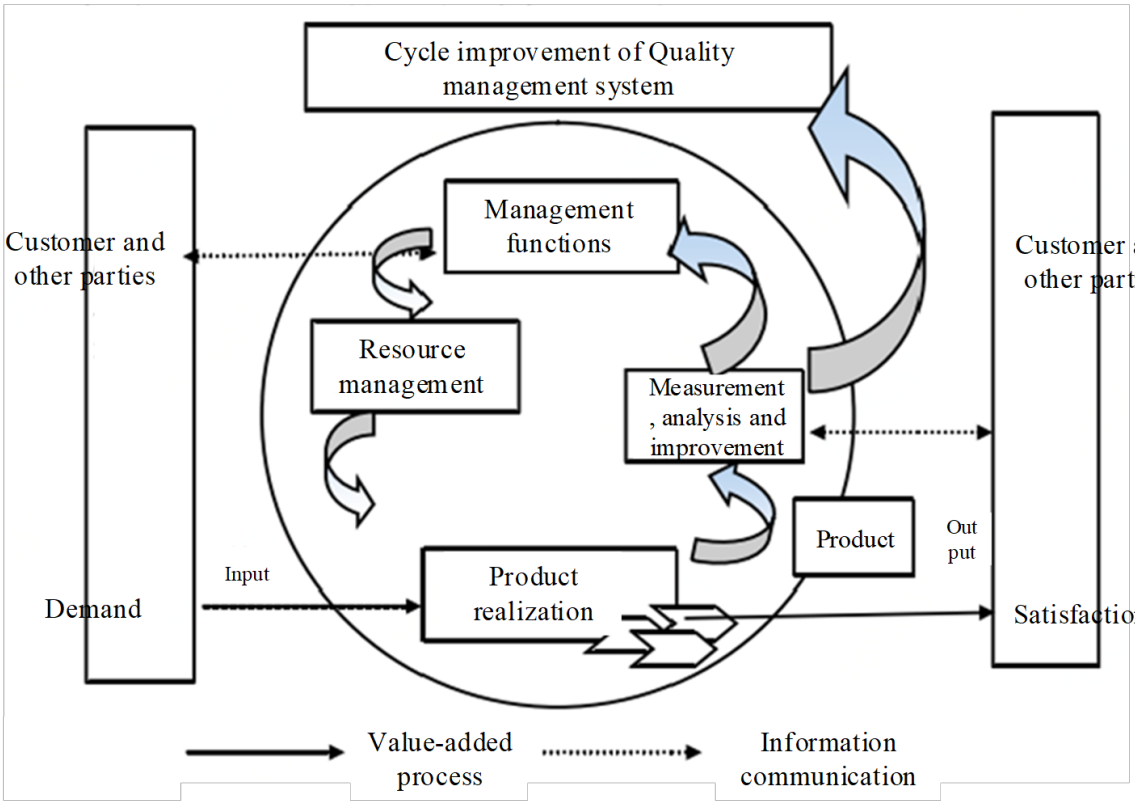

Figure D-10 Process-based quality management system operation and control

Source: L. Chen (2014)

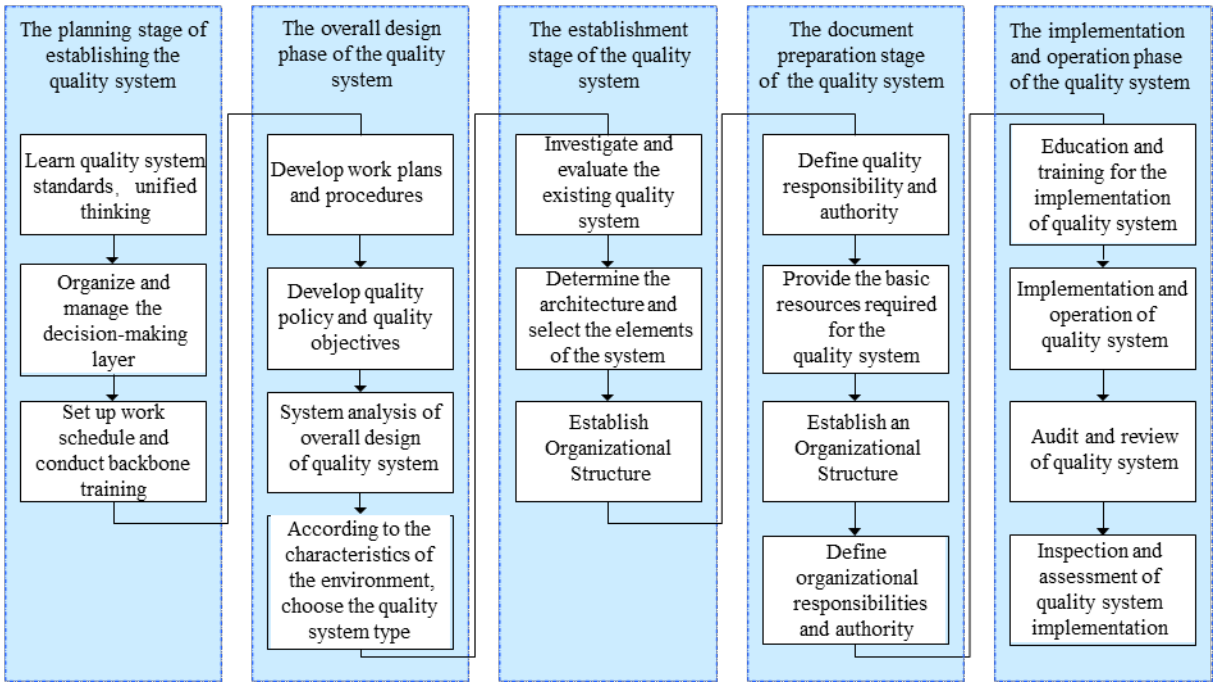

Figure D-11 Quality management system process

Source: elaborated by the author

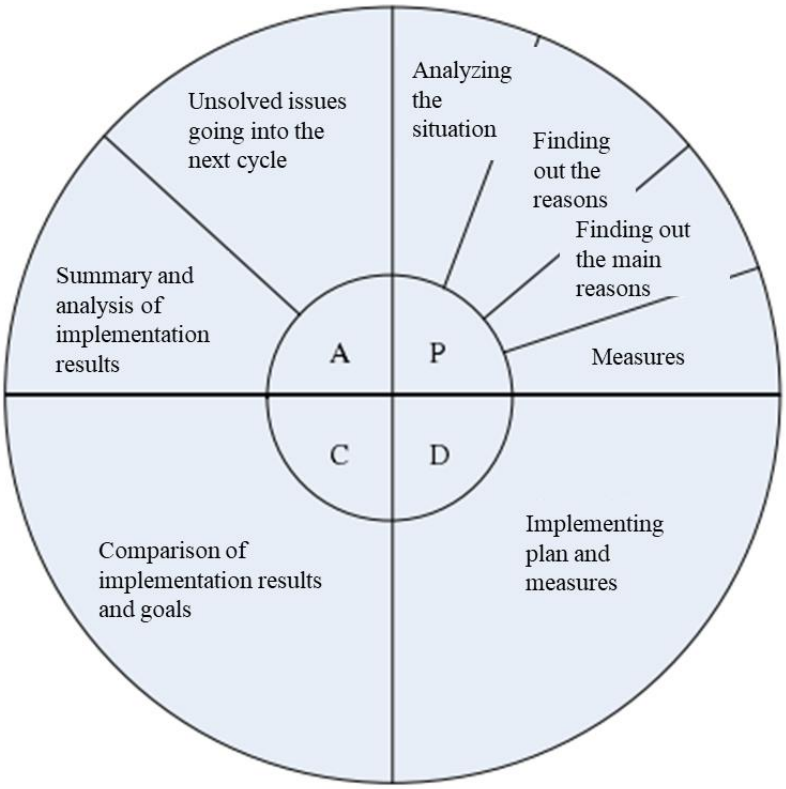

Figure D-12 Quality management cycle work procedures

Source: X. Q. Li (2012)

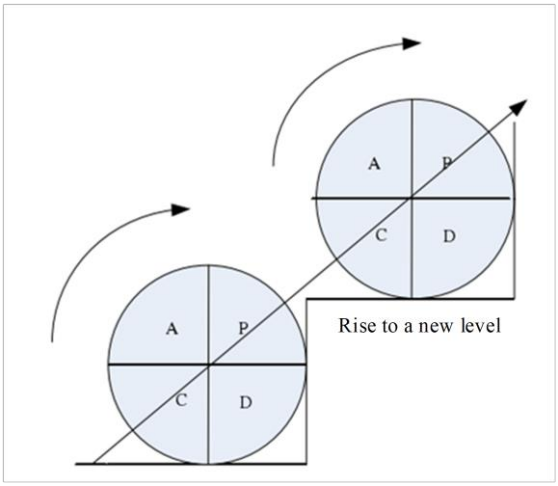

Figure D-13 PDCA cycle and method

Source: S. M. Cao and Du (2008)

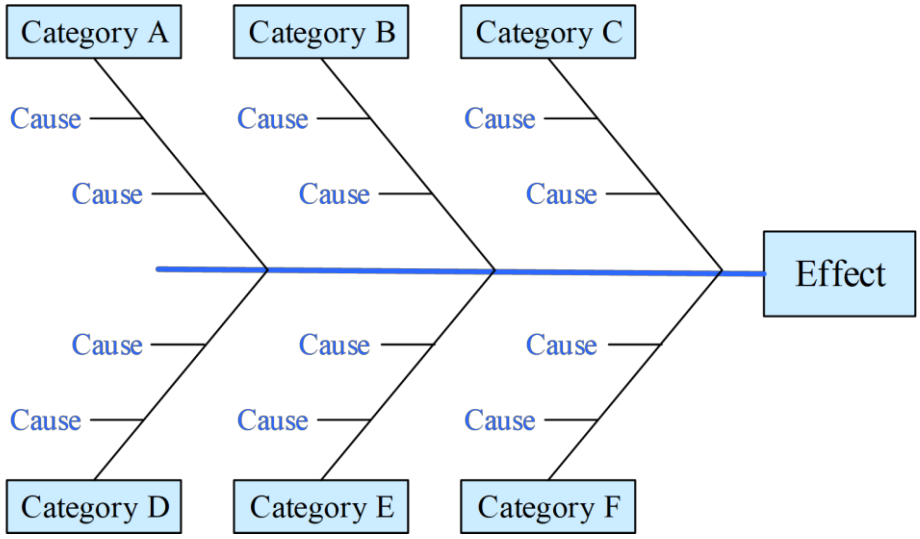

Figure D-14 Fishbone diagram model

Source: Ishikawa (1990)