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The PDCA(Plan-Do-Check-Act) Cycle's Roles in Food Quality Improvement

-- A case study of the Hangzhou Lele Food Factory in China

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Abstract: The rising occurrence of food quality incidents in China has greatly diminished consumer trust and endangered market stability, highlighting the urgent requirement for enhanced quality management systems in food firms. This article examines the use of the PDCA(Plan-Do-Check-Act) cycle as a strategic framework to improve food quality management at Hangzhou Lele Food Factory. The analysis identifies specific flaws in the factory's existing quality management methods and applies the PDCA(Plan-Do-Check-Act) cycle to develop focused interventions to rectify these deficiencies. Which also identified several problems in the factory's routine operations, including inadequate operation of the quality management system, poor traceability of company food products, a rough food production process, and insufficient investment in quality management resources. In addition, the article presents a systematic approach for incorporating the PDCA(Plan-Do-Check-Act) cycle into daily operations, with a focus on continuous improvement methods that seek to enhance regulatory compliance and restore consumer confidence. The utilization of this cycle has led to significant enhancements in procedural transparency and operational efficiency, setting a standard for the adoption of the PDCA(Plan-Do-Check-Act) cycle in comparable industrial environments.

Keywords: PDCA(Plan-Do-Check-Act) cycle, Food Quality, Quality Management.

1. Introduction

As society advances, people are becoming more conscious of the importance of food quality, safety, and health. (Aung et al.,2014) This has led to a growing demand for strict food safety standards, which are crucial for both public health and economic growth (Stuckler et al.,2009). The worries are exacerbated by increased market rivalry and repeated safety breaches, highlighting severe shortcomings in China's food quality control (Lu, Y et al., 2015). These issues require significant improvements in quality management practices to meet consumer expectations, protect public health, and cultivate a strong brand reputation.

In China's dynamic market economy, providing high-quality food is not only essential for the continued success of the food business, but also crucial for maintaining a competitive advantage and increasing market share. (Ryu, K et al., 2012). Top-notch, affordable, and dependable products are crucial for producing revenues, expanding market presence, and enhancing a company's competitive standing and financial results. Superior product and service quality is considered essential to the business strategies of successful global organizations.

The study specifically examines the quality management system of Hangzhou Lele Food Factory, identifying any existing deficiencies and proposing specific improvements. The study seeks to enhance Hangzhou Lele's market position by improving its quality management processes through thorough the PDCA(Plan-Do-Check-Act) cycle and the use of sophisticated quality management theories. To simplify the formatting as much as possible, this template provides a complete set of pre-modified styles. It is highly recommended that the authors directly apply these styles to format their manuscripts.

2. Literature Review

The Quality management is a comprehensive approach that encompasses all activities and tasks required to maintain a desired level of excellence (Anderson et al.,1994; Flynn et al.,1994; Hackman, & Wageman,1995; Kaynak, H. 2003). It involves the determination of a quality policy, creating and implementing quality planning and assurance, and quality control and quality improvement. It is aligned with the organization's strategic direction and integrates various functions to provide continuous improvement and customer satisfaction (Samson, D., & Terziovski, M. ,1999). The theoretical underpinnings of quality management have evolved internationally for several decades, marked by the emergence of significant scholars and groundbreaking theories (Dale, et al.,2007). Edwards Deming (Knouse et al.,2009), a trailblazer in this field, coined the transformative concept of "continuous improvement." He firmly believed in the perpetual pursuit of quality, which he structured into the Deming Cycle (PDCA): Plan-Do-Check-Act, a conceptual loop chart comprising planning, executing, inspecting, and acting. His doctrine, encapsulated in "Deming's Fourteen Points," (Walton, M. ,1988). has profoundly influenced quality management theories and methodologies worldwide.

Philip Crosby (Suarez, J. G. ,1992) introduced the notion of "maturity in quality management" and a focus on process management, advocating that quality should meet the set requirements rather than aspiring to beauty or excellence. He emphasized prevention over inspection and a zero-defect performance standard, suggesting that quality metrics are not merely indicators but represent costs of non-conformance to requirements. Armand Feigenbaum (Feigenbaum, A. V,1991), in his seminal work "Total Quality Management," elevated the idea that quality is the foremost consideration in customer

applications and marketing. He proposed that quality control should begin early in the product development process, involving all departments, rather than being a final step. Joseph M. Juran's (Juran, J. M. 1992;1993;1999;2003) research on identifying customer groups, recognizing varying customer needs, and translating these needs into product specifications led to a dedicated quality planning process aimed at achieving high-quality manufacturing outcomes without the necessity for inspections. His work (Godfrey, A. B., & Kenett, R. S. ,2007) on the costs associated with internal and external failures and assurance shaped the foundation of quality control practices that have helped Japan's quality management model thrive and support its industrial leadership. Kaoru Ishikawa (Ishikawa, K., & Loftus, J. H. 1990) contributed significantly with his cause-and-effect diagrams, allowing users to visually trace multiple potential causes of an outcome to identify process issues' roots. Furthermore, he established the concept of "quality circles," propagating a collective approach to quality management (Ishikawa, K. 1984; Kondo, Y. 1994). These pioneers have had a substantial impact on current quality management practices, with most modern methods grounded in their fundamental ideas.

From the 1970s onward, quality management systems have steadily progressed towards standardization. With the advancement of global economic integration, product quality and accountability have become pronounced concerns (Başaran, B. ,2016; Heras-Saizarbitoria, I., & Boiral, O. 2013; Keng, T. C., & Kamil, S. Z. 2016), prompting the ISO organization to release and update the ISO 9000 family of standards since 1982, with significant revisions in 1994 and 2000, which are now widely adopted across numerous countries.

Table 1. Literature on Total Quality Management (TQM) in China

Category	Author (s)	Scope of Study
Theoretical Framework	Zhang Gongxu (1998)	TQM Development
	Liu Yuanzhang (2019)	Comprehensive Quality Management
	Lee, C. Y., & Zhou, X. (2000) Lee, C. Y. (2004).	Integration with Technology
	Yang Haihong (2022)	great quality" concept
Quantitative Analysis	Wang, Y. (2017).	PDCA Process
	Lang Zhizheng (2014)	Quality Management Principles
	Yu, et.al (2019)	Integration with Technology

Table 1 summarizes the key studies categorized by "theoretical framework" and "quantitative analysis," presenting a detailed examination of Total Quality Management (TQM) as it has evolved in China since its inception in 1976. This review reflects on significant scholarly contributions that have defined the theoretical underpinnings of TQM and have driven its integration into the fabric of Chinese manufacturing and service industries, enhancing both the process and the outcome of quality management.

Scholars have laid a robust foundation for TQM in China. Zhang Gongxu (1998) developed the statistical process diagnosis theory, offering a comprehensive analysis of quality beyond manufacturing. Liu Yuanzhang (2019) broadened the scope of quality management to a more holistic, continuous process, inclusive of all organizational personnel. Lee, C. Y., & Zhou, X. (2000) and Lee, C. Y. (2004) emphasized the integration of technology into quality management, proposing a synergy between modern technological advancements and traditional quality control methods.

In terms of quantifying quality, Wang Y. (2017) advocated for the PDCA(Plan-Do-Check-Act) cycle as an essential tool for improving processes. Lang Zhizheng (2014) presented a detailed quantitative analysis of the principles underpinning quality management, advocating for a more expansive definition of quality that includes various dimensions of business operations. Additionally, Yu et al. (2019) emphasized the importance of integrating sophisticated technologies to achieve an efficient quality management system.

Yang Haihong (2022) brought forward the "great quality" concept, prompting organizations to embrace digital and intelligent technologies, leading to the modernization of quality management. Guo Xiao long and Yuan Mingli's research further provided insights into controlling quality processes and analyzing the benefits of a well-implemented TQM system, focusing on the significance of precise management of all elements involved in the production process to ensure premium quality output.

3. Introduction to the PDCA Cycle

3.1. Definition

The PDCA Cycle, occasionally referred to as The Deming Cycle, was developed in the 1960s by the American researcher W. Edwards Deming as a fundamental framework for Total Quality Management (TQM). The iterative four-stage model includes the fundamental processes of 'Plan,' 'Do,' 'Check,' and 'Act,' forming a continuous loop that is crucial for incremental quality improvement in a company. The cyclical and repeating character of the process enables continuous identification and resolution of issues, promoting an environment of ongoing development and improvement. When implementing comprehensive quality management, a business must efficiently incorporate these four elements to promote effective management practices. The Chinese researcher, B Li (Li, B et al, 2024), highlights the PDCA method for its diversity, ease of implementation, and remarkable effectiveness. It can be skillfully used in a wide range of managerial activities.

The 'Plan' phase encompasses the formulation of an organization's quality policies and objectives, which are then translated into specific actions and schedules. It is supported by meticulous study and analysis to detect deficiencies. To address these shortcomings, root cause investigations are performed, and actions are developed considering the circumstances. This phase establishes the groundwork for specific methods designed to improve quality standards.

The ' Check' phase is a methodical assessment of the execution of the plan. This entails the validation of actions in accordance with predetermined plans and the evaluation of the results to verify their efficacy. Any deviations or faults that occur throughout the execution are identified, which serves as a factual basis for further examination.

The 'Do' phase involves carrying out the measures that have been specified previously. It is distinguished by the efficient implementation of the plan, where the planned activities are put into practice. This phase converts the theoretical framework into concrete processes, ensuring that the plan is

put into action within the organizational structure.

The 'Act' phase focuses on implementing actions based on the findings from the 'Check' phase. It involves implementing necessary actions based on the evaluation results and incorporating previous experiences to extract relevant insights. Unresolved issues from the current cycle are gathered and readied for resolution in the next PDCA cycle. The last stage is vital for solidifying advancements and guaranteeing that the enhancement of quality is a continuous procedure.

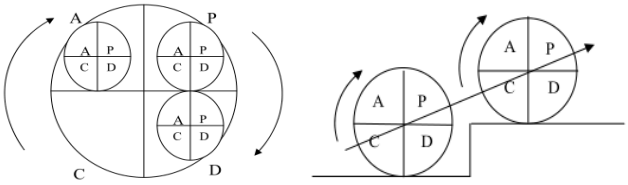


Figure 1. The circle of PDCA

3.2. Advantages

The PDCA(Plan-Do-Check-Act) cycle, known for its tripartite set of advantages, has gained recognition as a highly regarded concept in the realm of continuous improvement and quality management.

Firstly, its cyclical nature creates a continuous loop that helps to continuously resolve difficulties within operational processes. This iterative design guarantees that issues are not just dealt with but are effectively handled to prevent their reoccurrence, hence improving the stability and dependability of the management system.

In addition, the PDCA(Plan-Do-Check-Act) cycle represents a hierarchical structure of cycles, reflecting the layered workflows that are inherent to various divisions within an organization. This framework enables the concurrent examination and enhancement of both micro and macro levels, wherein smaller cycles function within bigger ones, and vice versa. The cycles are interrelated, forming a unified network of feedback loops that cover the entire organization.

Furthermore, the PDCA(Plan-Do-Check-Act) cycle can be likened to a stairway that goes upwards, representing a systematic approach to ongoing improvement. Through each repetition of the cycle, problems are recognized and rectified, driving the organization towards increased levels of operational effectiveness. This approach facilitates a quick and consistent improvement of management skills because of its inherent design that places a high importance on learning and development as a means of addressing problem-solving.

The PDCA(Plan-Do-Check-Act) cycle is defined by its recursive structure, nested cycles, and progressive upward advancement, which collectively create a dynamic environment for continuous quality improvement and organizational growth.

4. Case study

4.1. Description

Hangzhou Lele Food Factory, located on Ganchang Road in the Gongshu District of Hangzhou. The company primarily engages in the production and sales of pastries and other food items, with products distributed to major chain supermarkets within Hangzhou and, in recent years, gradually exporting to countries in Europe and America. At this stage, China has established a closely integrated processing industry chain linked to the procurement of food materials and production. In 2019, the company's main business revenue exceeded 100 million yuan, marking a 300% increase compared to the same period of the previous year, and the taxes contributed approached one million yuan, a 300% increase year-over-year. Currently, our company has acquired export qualification certificates and has been progressively increasing the quantity of exports. However, due to the short establishment period of the company, some imperfections are inevitable, with product quality being the most critical. Yet, as the enterprise and production scale continue to expand, the level of quality management has not kept pace. The most significant challenge the company faces now is how to enhance product quality; strengthening the company's quality management is essential, particularly after achieving the qualification to export to the European Union and expanding into the European market. How to rapidly improve product quality to ensure the company's healthy development is of utmost importance. Meanwhile, as the country exports more food products, competition among enterprises intensifies, underscoring the need to ensure enterprise development; companies should strive to improve product quality to achieve the goal of sustainable development.

The organizational structure of Hangzhou Lele Food Factory adopts a common corporate model with the General Manager holding overall responsibility and managing various functional departments vertically. These include the Office, Procurement Department, Production Department, Sales Department, Human Resources Department, and Finance Department, among other relevant functional entities. Each entity performs its duties in collaboration to ensure the normal operation of the company.

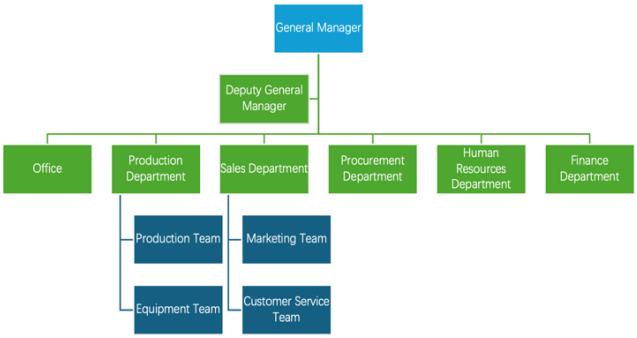


Figure 2. The structure of the company

4.2. Current Quality Management at Hangzhou Lele Food Factory

Hangzhou Lele Food Factory has obtained the ISO 9001:2000 quality system certification, indicating that the company possesses a relatively comprehensive quality management system. The acquisition of these certifications has played a significant role in enhancing the quality of the company's products, earning customer trust, and contributing to a favorable reputation. During the certification process, the implementation of various requirements was quite thorough. Over time, however, most staff members began to equate certification with a guarantee of quality, if the mere attainment of quality system certification would immediately and substantially improve product quality. This perception has led to challenges in detailing and implementing the quality system effectively. When establishing the quality system documentation, the company employed external consulting services. Many of the documents were prepared by

the consultants, and most of the company's staff had not undergone adequate training. This often led to issues in executing the quality management system and prevented the true integration of the ISO 9001 principles into daily management or workflows, at times rendering the quality management system a mere "add-on" rather than an intrinsic part of operations.

While the production and management operations of Hangzhou Lele Food Factory have matured, with comprehensive food quality management systems in place, communications with the company's middle and senior management and frontline workers reveal that the quality management system tends to be merely procedural. Initially, the system was established simply to obtain certification. There remains significant room for improvement in actual quality management activities, necessitating further optimization and refinement.

5. Improving Food Quality Management at Hangzhou LeLe Food Factory

5.1. Identification of Problems and Cause Analysis (P Phase)

5.1.1. Lack of Substantive Quality Management System Operation

A Quality Management System (QMS) encompasses all activities, responsibilities, and processes within an organization aimed at achieving quality objectives for products or services. However, in its practical application, the QMS at Hangzhou Lele Food Factory faces several issues:

(1) Ineffective Implementation: A QMS requires support from senior leadership and the participation of all staff, but some organizations lack sufficient resources and training, resulting in weak implementation.

(2) Cumbersome Documentation: A QMS necessitates extensive documentation and records to ensure consistency and traceability. However, overly complicated documentation has impacted the efficiency of Hangzhou Lele Food Factory and even hindered improvements.

(3) Lack of Continuous Improvement: The essence of a QMS is ongoing improvement. Yet, certain organizations are content merely to achieve certification or adhere to minimum standards without a commitment to continuous improvement.

(4) Inadaptability to Change: The market environment, technology, and regulations are constantly evolving, and the QMS must adjust accordingly. Hangzhou Lele Food Factory has not kept pace with these changes, resulting in a QMS that cannot adapt effectively.

(5) Management Errors: A QMS relies on accurate data and analysis to support decision-making. However, management mistakes or operational errors within the company have prevented the QMS from achieving its intended results.

The quality management documentation at Hangzhou Lele Food Factory undergoes multiple stages including drafting, reviewing, approving, issuing, training, activation, execution, maintenance, modification, replacement, revocation, and destruction. Due to the use of different quality management document and information record templates by various departments and teams, comprehensive tracking of product quality control activities can be compromised. Moreover, the company has vulnerabilities in its document information management, such as production record documents not being saved in a timely manner or missing, arbitrary naming practices, and a lack of regular checks and organizing of file records. Ad hoc creation and alteration of internal records have led to inauthentic original documentation, impeding quality traceability.

5.1.2. Insufficient investment in Quality Management Recourses

Hangzhou Lele Food Factory faces two main issues: inadequate talent reserves and insufficient equipment upgrades.

Firstly, the company requires more high-level talent to meet its developmental needs. Among the existing staff, only 6% hold a bachelor's degree or higher, and the production department has only a few employees with university education. Due to the inability of employees to strictly adhere to the company's quality management systems and standards during production, this has impacted the implementation of quality management within the company. Therefore, the company needs to strengthen training and education for its employees to help them recognize their critical role within the company's quality management system and to enhance their technical skills and overall quality. Furthermore, in terms of reward and punishment mechanisms, there is only punishment without reward. The company enforces a graded punishment for quality-related incidents, but lacks a corresponding incentive mechanism, leading to a lack of enthusiasm among employees. The severity of the punishments is unreasonable; the company employs a middle-ground punishment system, which has proven ineffective and has resulted in unclear accountability.

Table 2. Staffing Situation

Position	Number of People	Number of People			
		Graduate	Bachelor	Associate	High School
Manager	1	0	1	0	0
Deputy Manager	1	0	1	0	0
Office	6	1	1	0	4
Production Department	129	0	1	3	125
Sales Department	10	0	2	6	2
Procurement Department	3	0	1	2	0
HR Department	2	0	1	1	0
Finance Department	3	0	1	2	0
Total	155	1	9	14	131

From the chart provided, it is apparent that the current training situation at the company is as follows: 12% of the employees have not received any training on the quality management system, over 50% have undergone job training but have not been trained in quality management, and 31% have not received any training at all. This indicates that the investment in employee training is far from sufficient.

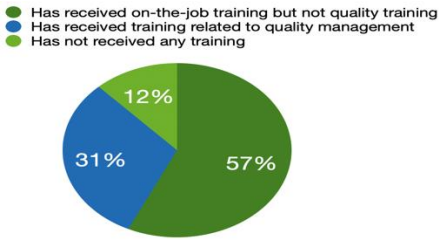


Figure 3. The training situation of the company

5.1.3. Date Collection of Current Issues

Field research was conducted to directly observe personnel and products within the production process at Hangzhou Lele Food Factory. The research team comprised production staff and quality inspectors tasked with identifying current operational challenges. The investigation pinpointed the following nine categories of recurrent issues:

(1) Ineffective Implementation: Initiatives and protocols are not being adequately applied across the production floor.

(2) Incomplete Information: Essential details are frequently missing from records and reports.

(3) Unstandardized Data Management: There is a lack of uniformity in how data is collected, stored, and analyzed.

(4) Primitive Food Processing Techniques: The methods employed in food preparation and processing are outdated.

(5) Excessive Traceability Time: The time required to trace products through the production process is too long.

(6) Overly Complicated Documentation: Documentation practices are cumbersome and not user-friendly.

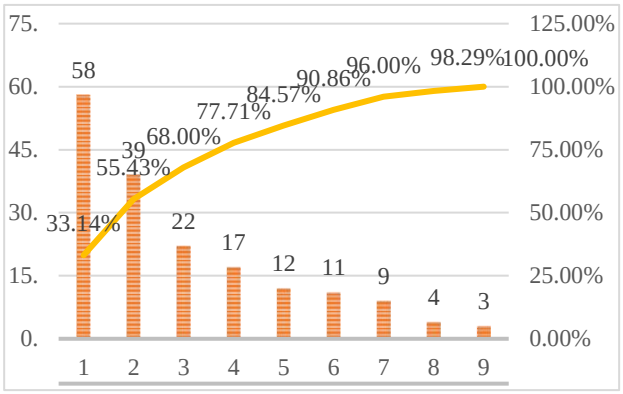
(7) Outdated Technology and Equipment: The technology and equipment in use are not up to current industry standards.

(8) Improper Manual Operations: Errors in manual operations are frequent due to inadequate training or oversight.

(9) Complexity in the Production Process: The production process is unnecessarily complex, leading to inefficiencies.

The incidence rates of these issues are illustrated in Table3. Analysis of the data revealed that the top three issues occurred 126 times, representing 77% of all noted problems. This significant proportion highlights the urgent need for targeted interventions in these areas.

Table 3. Frequency Chart of Nine Types of Existing Issues



*1 = Ineffective Implementation; 2 = Incomplete Information; 3 = Unstandardized Data Management; 4 = Primitive Food Processing Techniques; 5 = Excessive Traceability Time; 6 = Overly Complicated Documentation; 7 = Outdated Technology and Equipment; 8 = Improper Manual Operations; 9 = Complexity in the Production Process.

To analyze the causes of quality issues more comprehensively, it is necessary to conduct field investigations and, in conjunction with the 4M1E method (Man, Machine, Material, Method, and Environment), create a cause-and-effect diagram to formulate countermeasures. This approach allows for a systematic examination of all factors involved in the production process and identifies key areas where improvements are required. By using the 4M1E method, the company can ensure that each aspect of production is scrutinized for potential issues, leading to more targeted and effective solutions to enhance overall quality management.

Table 4. Using 4M1E method analyzing the quality management.

Environment	Material	Man	Machine	Methods
Improve workplace conditions.	Supplier evaluation	Strengthen training	Update equipment	Standardize operations
	Improve procurement standards	Standardize operations	Regular maintenance	Strengthen guidance
	Inconsistent material quality	Lack of training	Insufficient inspection	Operating procedures not standardized
		Irregular operation	Measurement tools outdated	Lack of operation guidance
			Equipment aging	
			Maintenance is not timely	

5.2. Identification of Problems and Cause Analysis (D Phase)

5.2.1. Enhancing the Company's Food Quality Management System

The optimization of the company's food quality management system encompasses three specific areas:

(1) Adopting Advanced International Technologies and Equipment: Actively introducing advanced international food quality testing technologies and equipment to enhance the efficiency and standards of food inspections. This step aims to increase the rigor and scientific approach of the testing processes, thereby strengthening overall food quality management.

(2) Enhancing Technical Exchange and Communication: Strengthening the exchange of technical knowledge and experiences between food processing units. By sharing inspection techniques and experiences, the overall level of food inspection activities at Hangzhou Lele Food Factory can be elevated.

(3) Learning from International Best Practices: Drawing on the advanced experiences of countries like those in Europe and America in the realm of food quality inspections. The goal is to refine and optimize existing inspection standards to improve the accuracy of inspections and enhance the supervision of food quality.

This iterative process ensures that improvements are constantly being made in response to operational feedback

and evolving industry standards.

5.2.2. Improving the Company's Production Process

To integrate the PDCA(Plan-Do-Check-Act) cycle deeply with the company's efforts to improve the production process, the following measures can be taken:

(1) Establishing a Quality Management System: By setting up a rigorous quality management system that includes quality control, quality inspection, and quality assurance, the quality and stability of the production process can be ensured, providing data support for process improvements.

(2) Introducing Advanced Technology and Equipment: The adoption of advanced production technologies and equipment can enhance production efficiency and quality while reducing production costs and environmental impacts.

(3) Training Employees: By training employees, their skills and professionalism can be enhanced, along with fostering a sense of responsibility and team spirit, thus providing strong human resource support for improving the production process.

(4) Establishing Performance Evaluation and Incentive Mechanisms: By creating performance evaluation and incentive systems, employee motivation and creativity can be stimulated, promoting dedication and teamwork, and providing effective management support for enhancing the production process.

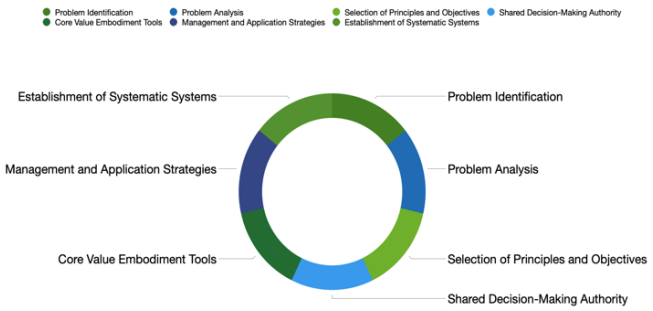


Figure 4. Quality Management Issues Combined with the PDCA(Plan-Do-Check-Act) cycle.

5.2.3. Establishing a Comprehensive Traceability System

(1) Designing a Traceability Plan: Determine which products need a traceability plan, the purpose of the traceability, and the scope and duration of the traceability.

(2) Identifying Traceability Elements: Based on the stages of production, processing, transportation, and storage of the product, identify the elements that need to be traced, such as the source of raw materials, production dates, batch numbers, and quality inspection reports.

(3) Establishing a Record-Keeping System: Create a system to record information at each stage of the product lifecycle and archive these records for future reference.

(4) Establishing a Traceability Mechanism: In case of issues, the system should be able to promptly trace back to the source of the problem and take appropriate measures to address it.

(5) Audit and Regulation: Conduct periodic audits and regulation of the traceability system to ensure its proper functioning. Employ advanced technological tools like barcodes, QR codes, and RFID to enhance the efficiency of traceability.

(6) Training Employees: Train employees involved in production, processing, transportation, and storage on the relevant knowledge and skills needed to properly use the traceability system and to enhance their awareness of quality and safety.

(7) Establishing a Feedback Mechanism: Record feedback, complaints, and suggestions from consumers in a timely manner and take measures to improve the quality and safety of products.

By implementing these steps, the company can ensure the reliability and effectiveness of its traceability system, which is crucial for maintaining product quality and consumer trust.

Figure 5. The Traceability Mechanism

5.2.4. Improvements for Insufficient Investment in Quality Management Resources

(1) Optimizing Recruitment Channels: Expand the recruitment channels and scope to attract more talent to join the company's quality management team. This could involve utilizing online job portals, attending career fairs, and leveraging professional networks.

(2) Strengthening Internal Talent Development: Improve the overall quality and professional skills of employees through internal training programs, job rotation, and other developmental opportunities. This will enhance the talent pool available for quality management tasks within the company.

(3) Establishing a Comprehensive Talent Incentive Mechanism: Develop an incentive system that includes competitive salaries, benefits, and clear career progression opportunities to motivate and retain skilled personnel dedicated to quality management.

(4) Increasing Investment in Training: Invest in comprehensive training programs for new employees and regular training and assessments for existing staff to enhance their professional knowledge and skills.

By implementing these strategies, the company can ensure a robust pipeline of skilled professionals ready to uphold and enhance its quality management standards, thereby supporting continuous improvement and operational excellence.

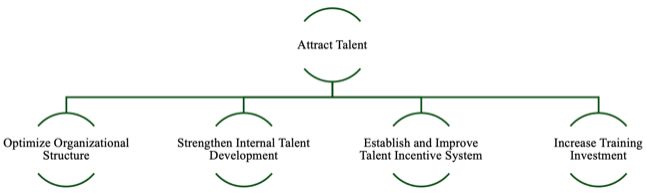


Figure 6. To attract the talent.

5.3. Control Effect Check (C Phase)

5.3.1. Internal Loss Costs

Implementing quality improvements does not necessarily mean incurring costs; on the contrary, effective quality

improvements can reduce costs, shorten delivery times, and ultimately help the company maximize profits. Hangzhou Lele Food Factory experienced significant enhancements not only in quality but also in production volume, coupled with a substantial reduction in costs. The quality improvement team spending two weeks to identify, improve, and control this area, finding the optimal process parameter settings and operational methods. After the improvements were completed (table 5), the procedures for this area were standardized and turned into a brief tutorial, which was then posted at the worksite. Following the improvements, a month of quality tracking showed not only a significant reduction in product defects but also a daily reduction in scrap output to 5 tons. This has greatly increased production volume and reduced the cost per unit product.

Table 5. Comparative Analysis of Conditions Before and After Improvements

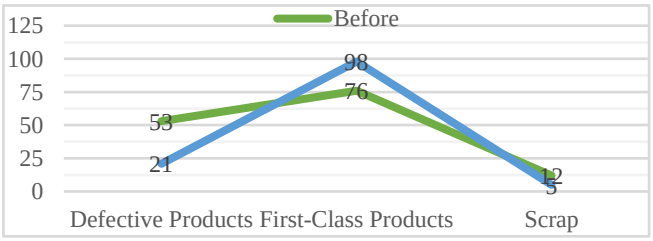


Table 6. Comparative Analysis of Conditions Before and After Improvements (2)

	Defective Products	First-Class Products	Scrap
Before	53 Ton	76 Ton	12 Ton
After	21 Ton	98 Ton	5 Ton

5.3.2. Customer Complaint Rate

The ultimate judge of quality is the customer, and a product that satisfies the customer is considered a quality product. After analyzing historical data from Hangzhou Lele Food Factory, we found that the freshness of the products is a critical factor in customer complaints, accounting for 88.03% of the grievances, both in terms of quantity and financial loss. Addressing this customer complaint not only reduces unnecessary losses for the company but also enhances profits. Moreover, customer satisfaction significantly increases as a result.

The quality improvement team analyzed these issues to identify the root causes of customer complaints and implemented corresponding improvements. Firstly, strengthening the connections between departments is crucial. After the planning department issues orders based on customer requirements, it is essential to ensure all information is shared promptly. The products must be manufactured according to the technical specifications provided by the customers. Additionally, before packaging, using an appropriate sieve for a secondary sorting process is advisable. This way, everyone can adjust their improvements based on their outcomes. For instance, there are many reasons for product complaints within the company, but 80% of the complaints are due to products not being fresh enough, while other reasons account for only 20%. After addressing these three points, the quality management team found that over 80% of the complaints had been resolved, as illustrated in the table below.

Table 7. Comparison of Customer Complaint Rates Pre- and Post-Improvement

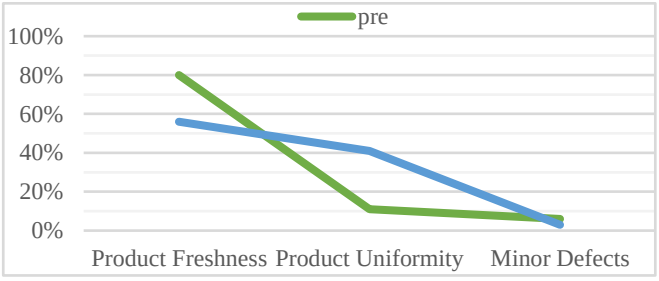


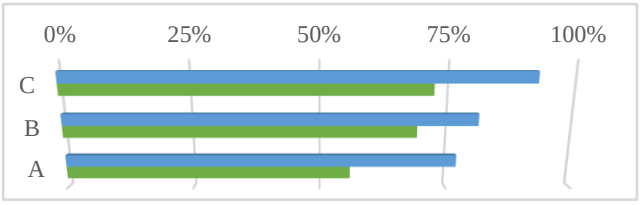
Table 8. Comparison of Customer Complaint Rates Pre- and Post-Improvement (2)

	Product Freshness	Product Uniformity	Minor Defects
pre	80%	11%	6%
post	56%	41%	3%

5.3.3. Internal Loss Costs

After improving the quality management system, The Company has increased the first-time pass rate of raw materials to 95%. By refining the weighing procedures and regularly calibrating weighing instruments, the company has successfully prevented the issue of excessive addition of food additives.

Table 9. Compliance Rates by Category of Food Raw Material Suppliers



It is evident from the improvements that, after implementing the enhanced strategies, there was a notable increase in the compliance rates of supplier quality for the years 2022 and 2023, as shown in table 9. Post-improvement, the compliance rates for suppliers of food raw materials grades A, B, and C all saw significant improvements in 2023.

Additionally, the company optimized its existing supplier base, effectively controlling the number of suppliers while significantly enhancing quality. The following table shows a comparison of the scale of suppliers for Hangzhou Lele Food Factory before and after the supply chain optimization.

Table10. Comparison of Supplier Scale Before and After Supply Chain Optimization

Year	Food Raw Material Suppliers	Food Additive Suppliers	Production Auxiliary Material Suppliers	Sanitation and Disinfection Suppliers	Logistics Suppliers
Before	28	6	22	4	7
After	17	4	14	4	6

Through supplier optimization, although the number of suppliers included in the company's approved list has decreased, by establishing strategic partnerships with qualified suppliers, the level of supplier service and product quality have been enhanced, meeting the production and operational needs of Hangzhou Lele Food Factory. The table below shows the statistics for the first-time inspection pass rate of raw materials from February to May 2023 at Hangzhou Lele Food Factory.

Table 11. Statistics on the First-Time Inspection Pass Rate of Raw Materials

Pass Rate (%)	Feb.	Mar.	Apr.	May.
2023	94.3	94.1	95.6	97.3

From the table, it is evident that Hangzhou Lele Food Factory, through optimizing supply chain management and signing strategic cooperation agreements with some suppliers, has implemented specialized production and supply of raw materials tailored to its own production needs. This approach not only enhanced the enthusiasm of suppliers for further cooperation but also improved their production and after-sales service levels. Hangzhou Lele Food Factory has thus transformed its previously zero-sum interactions with suppliers into a win-win partnership. According to the statistics on the first-time inspection pass rate of raw materials, the supplier delivery quality is stable and orderly, which lays a solid foundation for ensuring the product quality and achieving quality objectives at Hangzhou Lele Food Factory.

5.3.4. Enhanced Product Feedback Process

Since the implementation of quality management measures at Hangzhou Lele Food Factory, all departments have increasingly focused on product quality, comprehensively collecting quality management information, and providing more timely feedback. This allows the quality control department to promptly identify quality issues in the production process. The table below illustrates the improvement in quality data management and utilization before and after the improvements at Hangzhou Lele Food Factory.

Table12. Quality Data Management and Utilization Before and After Improvement

Item	Internal Quality Information	External Quality Information	Corrections	Corrective Actions	Preventive Measures
Before	112	58	140	12	3
After	154	39	189	101	55

From the table, it is evident that since the implementation of improvements in the quality management system, there has been an enhancement in the internal quality information at Hangzhou Lele Food Factory. The quality control across various processes has become more stringent, and the collection of information has improved; meanwhile, the external quality issues have decreased, indicating continuous improvements in product quality.

The implementation of corrective actions clearly reflects Hangzhou Lele Food Factory's commitment to continuous improvement in managing quality issues. Compared to the previous year, the formulation and execution of corrective actions have increased more than sevenfold, and the establishment of preventive measures has increased seventeenfold. It is precisely through the extensive proposal and implementation of these corrective and preventive measures that repetitive issues have been effectively prevented, leading to more stable product quality and continuously enhanced management standards at the factory.

5.3.5. SSOP and GMP

Currently, Hangzhou Lele Food Factory adheres primarily to Good Manufacturing Practices (GMP) and Sanitation Standard Operating Procedures (SSOP) during its production process. According to SSOP guidelines, ice and water used in food production must meet drinking water standards and are tested quarterly by the quarantine department. All surfaces that meet food are made of stainless steel, which helps prevent the risk of foreign object contamination. Additionally, areas for raw food production are separated from cooked food production areas, with production processes flowing from high-cleanliness to lower-cleanliness zones to ensure that employees' hands are disinfected and clean. Employees are required to undergo an annual physical examination, and only those who pass are permitted to continue working. The table below shows the SSOP and GMP scores for Hangzhou Lele Food Factory from March to May 2023.

Table13. SSOP and GMP Scores of Hangzhou Lele Food Factory

	2023.3	2023.4	2023.5
SSOP score	90.6	91.5	92.1
GMP score	91.2	91.5	92.3

Through the analysis provided, it is evident that Hangzhou Lele Food Factory has continuously improved its hygiene standards. However, there remains a gap compared to leading companies in the industry, primarily due to deficiencies in employee assessment and training, which make it challenging to fully implement and adhere to SSOP and GMP standards. This highlights the need for enhanced training programs and more rigorous assessment mechanisms to ensure that the standards are met consistently across all operations.

5.4. Action Summary and Cycle (A Phase)

5.4.1. Cultivating a Quality Culture

Building a quality culture elevates quality from a management focus to a consciousness level, transforming it into a unique corporate culture, philosophy, and working atmosphere. This transition from regulated compliance to voluntary employee adherence helps unify staff quality awareness, enhance product quality, and strengthen the core competitiveness of the enterprise. To ensure the smooth implementation of improvement strategies, this paper formulates a structured approach based on the actual situation of Hangzhou Lele Food Factory. Leveraging the structured characteristics theory of quality culture and the carrier of Total Quality Management (TQM) theory, the enterprise's quality culture is developed from four aspects: spiritual culture, systemic culture, behavioral culture, and material culture, structured from higher to lower levels.

The CEO advocates and approves Hangzhou Lele Food Factory’s quality policies and objectives and endorses incentive systems. Following the core principles of TQM,

which emphasize a customer-centered business philosophy and continuous quality improvement, the CEO has approved specific quality policies and objectives, providing the necessary resources to achieve these quality improvements. Additionally, to encourage employee participation in quality improvement, the company has established an incentive mechanism that aligns with employee psychological expectations. These measures are expected to effectively enhance employee motivation, encouraging proactive participation in quality improvement, and thus fostering the company's growth and development. To ensure that these policies are fully implemented within the company, the incentive mechanisms approved by the CEO will be promoted at all levels of the company. This approach ensures that every employee recognizes their vital role within the enterprise, further understands the company's quality goals, and builds consensus. It encourages staff to enhance collaboration and communication, jointly facilitating the successful execution of quality improvement initiatives.

Table 14. The quality improvement activities

	Activity Form	Activity Cycle
1	Contest	Monthly
2	Essay	Quarterly
3	Training	Monthly
4	Institutional Discussion	Monthly

5.4.2. Supervision, Recognition, And Continuous Improvement

To ensure the smooth operation of quality management, the company has established a Quality Management Task Force that develops schedules based on departmental quality goals, with inspections and improvements conducted monthly. The team compiles quality issues that arise and generates quality inspection reports, which are then distributed to the Quality Management Steering Committee and relevant departments. In response to quality issues, department leaders employ the 5W1H analytical approach to carefully analyze the causes and resolve problems, preventing their recurrence. To encourage employee participation in quality improvement, the company implements a fair and reasonable performance evaluation mechanism. Employees who make outstanding contributions are selected for recognition and their achievements are publicized within the company. These measures are designed to enhance employee motivation and encourage more proactive involvement in quality improvement initiatives. Furthermore, by continuously repeating these activities and adhering to the PDCA management philosophy, the company persistently enhances its quality management efforts, thereby enriching and perfecting its management experience.

By encouraging employees to integrate quality awareness into their daily work, everyone is motivated to participate in quality improvement. This approach ensures the transmission and innovation of quality culture in both content and form, driving the sustainable development of the enterprise.

5.4.3. Summarizing the Cycle Process and Improving the QM System

After completing one cycle of the Deming Cycle (PDCA), a systematic analysis and study of the quality issues arising during the production process of the flat panels were conducted. Adjustments were made to the previous production processes, including improvements in techniques, personnel training, and equipment maintenance. These improvements significantly enhanced the overall quality level of the panel production, providing a necessary technical foundation for the development and production of related products in the future.

Addressing the quality issues that emerged and were unresolved during the first Deming Cycle (PDCA), we further collected and summarized feedback from the field. We conducted in-depth analyses of the causes and proposed specific improvement measures. In the next Deming Cycle (PDCA), following a comprehensive quality management approach, we will focus on monitoring and actively addressing these issues. This process has further refined the handling of residual items and enhanced the system's quality control efficiency.

The implementation of the PDCA(Plan-Do-Check-Act) cycle has shortened the production cycle and reduced losses due to human or mechanical issues, laying a technical foundation for the systematization and regularization of the panel production process. It has also facilitated cost savings for the company.

6. Conclusion

We To prevent substandard food from harming public health, relevant departments should focus on improving the food quality and safety standards system, refining food management regulations and policies, strengthening food safety supervision and enforcement, and optimizing the food quality and safety inspection system. These measures aim to enhance the effectiveness of food quality management to ensure the quality and safety of food, thereby promoting the harmonious and healthy development of society.

This paper is based on an analysis and improvement of food quality management issues at Hangzhou Lele Food Factory using the PDCA (Plan-Do-Check-Act) cycle approach. The analysis identified several problems in the factory's routine operations, including inadequate operation of the quality management system, poor traceability of company food products, a rough food production process, and insufficient investment in quality management resources. To address these issues, the paper proposed four improvement strategies: enhancing the company's food quality management system, improving the production process, establishing a comprehensive traceability system, and increasing investment in quality management. Following the implementation of these improvement measures, Hangzhou Lele Food Factory saw a noticeable reduction in internal loss costs and customer complaint rates, and a significant enhancement in supplier quality compared to before the optimization. Feedback on the factory’s products became more prompt. The new quality management system is directly linked to the operational strategy of Hangzhou Lele Food Factory. It not only has significant practical implications for the company's operational development and the achievement of various performance indicators but also serves as an important guide for the management and growth of personnel.

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