An Exploration of Quality Management Improvement of ZC Company Based on Total Quality Management

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Abstract: This paper examines the application and enhancement of Total Quality Management within ZC Company, focusing on the quality control challenges posed by escalating competition in the bead wire industry. Through literature review, interviews, and data analysis, the study delves into the current state of the company's quality management. Utilizing the Analytic Hierarchy Process to determine the weight of evaluation indicators and employing a fuzzy comprehensive evaluation method, the paper identifies existing issues. It then proposes targeted enhancement strategies and safeguard measures to improve product quality and bolster competitiveness, offering insights for similar small and medium-sized enterprises.

Keywords: Total Quality Management; Analytic Hierarchy Process; Fuzzy Comprehensive Evaluation; Quality Management Enhancement

1. Introduction

1.1 Background of the Study

The rapid development of the automotive industry has spurred growth in the tire sector and the upstream bead wire industry. As an established producer of bead wire, ZC Company faces formidable challenges. On one hand, the intensifying industry competition is marked by the emergence of new factories, leading to market oversupply. On the other, rising raw material costs have increased production expenses. Additionally, advancements in automotive lightweighting and speed demand higher performance standards for bead wire.

Since implementing Total Quality Management in 2018, ZC Company has not achieved the desired outcomes. The management demonstrates insufficient commitment to quality management, often prioritizing other factors. Employees lack awareness and a long-term perspective on quality. Although a Total Quality Management system is in place, it is not effectively executed, with certification becoming a formality. Furthermore, the scarcity of quality management professionals and a neglect of training and education further impede progress.

1.2 Purpose and Significance of the Study

The study aims to thoroughly analyze the issues in ZC Company's implementation of Total Quality Management and provide practical improvement recommendations. By refining the quality management system, the study seeks to enhance product quality, reduce production costs, and strengthen the company's competitiveness in Chinese and international markets, facilitating sustainable development.

This research helps identify common problems in Total Quality Management within small and medium-sized enterprises, offering solutions and methods for others, and enriching the application cases of quality management theory in SMEs. Additionally, it aids ZC Company in addressing its challenges, ensuring its foothold in a competitive market, and serves as a practical reference for similar enterprises, thereby advancing the quality management standards throughout the bead wire industry.

1.3 Current Research Status in China and Internationally

International research on total quality management began early and has been extensive. Risk management, under resource constraints, aims to minimize risk impact at the most economical cost. It is a scientifically and rationally structured methodology [1]. It involves systematically identifying, deeply analyzing, and accurately assessing risks using tools like system dynamics to ensure objectives are met within reasonable cost limits, thereby supporting project progress [2]. Zeng Lijun posits that a strong link exists between project

management and quality in enterprises, and good quality is essential for successful project implementation [3].

The bead wire industry started earlier abroad and has reached a mature stage. China's bead wire production has rapidly increased and now accounts for about one-third of global output [4]. Bead wire is primarily used in tires, which creates a strong dependency on the tire industry [5]. Since the quality of bead wire directly affects tire safety and durability, tire manufacturers often conduct extensive lab tests, road tests, and trials to evaluate suppliers [6]. Suppliers are chosen only if their products meet stringent standards and maintain stable quality [7].

The 8D method is one of the widely adopted approaches in the international automotive industry for addressing product quality issues, specifically targeting recurrent problems, significant process quality anomalies, and customer complaints [8]. As a supplier of upstream raw materials to the automotive manufacturing sector, lubrication oil companies can effectively and systematically resolve issues using the 8D method, preventing recurrences and ensuring sustainable quality improvements [9]. The 5M1E management method is a comprehensive quality management approach, serving as a fundamental element for enterprise and factory management. It provides a systematic framework for analyzing the root causes of problems, akin to tracing issues back to their origin [10]. By examining quality management comprehensively from six perspectives—man, machine, material, method, environment, and measurement—it ensures that quality, production, and processes remain under control, thereby enhancing the overall quality level of the enterprise [11].

1.4 Research Content and Methodology

This research encompasses an analysis of the current state of quality management at ZC Company, diagnosis of existing problems, formulation of enhancement strategies, and exploration of safeguarding measures. By conducting a literature review, the theoretical foundation is established. The interview method is employed to gather on-site insights, while data analysis techniques are utilized to uncover underlying issues within quality data. ZC Company serves as the case study to propose targeted strategies.

Literature analysis is used to collect and examine relevant documents, establishing a theoretical basis. By interviewing personnel at various levels within ZC Company, firsthand information is obtained to understand production realities and issues. The 5M1E analysis method is applied to statistically assess quality data, identifying the current status of quality control and potential improvement directions. Through an in-depth examination of issues at ZC Company, improvement measures are proposed, offering a reference for other enterprises.

2. Relevant Concepts and Research Methods

2.1 Quality

Quality refers to the degree to which a set of inherent characteristics of an entity fulfills requirements. The objective of quality is rooted in the behavioral sciences, and it encompasses the goals pursued in terms of quality. Product quality should not simply be maximized; considerations must include market demand and cost factors.

2.2 Quality Management

Quality management is a management approach centered on quality, involving full participation, and aiming for long-term success through customer satisfaction. Its essence includes customer focus, comprehensive participation, continuous improvement, system approach, and economic considerations. The evolution of quality management has traversed stages such as pre-industrial era, Industrial Revolution, formation of modern quality management, rise of Total Quality Management, and current trends, marking a shift from simple experiential to complex systemic management.

2.3 Theoretical Overview of Total Quality Management

Total Quality Management emphasizes continuous improvement, customer satisfaction, and full participation. Its fundamental components encompass quality management philosophy, tools and techniques, organizational culture, quality planning, quality control, quality assurance, quality improvement, and supplier relationship management. The basic principles include customer focus,

employee involvement, process approach, system management, continuous improvement, factual data management, supplier relations, leadership, human resource development, and strategic planning. These principles are interconnected, forming a framework for continuous improvement. Common tools include statistical process control, failure mode and effects analysis, and root cause analysis, which can be used individually or in combination to address quality issues and enhance quality management levels.

3. Analysis of the Current State and Issues in Quality Management at ZC Company

3.1 Overview of ZC Company

Established in the 1970s, ZC Company initially specialized in producing steel wire ropes for mines, later transitioning to the manufacturing of bead wires. It has acquired numerous quality system certifications and invention patents. The company's products are primarily used in tire manufacturing, with a notable presence in markets for pipeline and spring wires as well.

The organizational structure of ZC's quality management system includes the Chairman, General Manager, and several functional departments. The Chairman oversees comprehensive operations and quality management decisions, while the General Manager ensures the effective functioning of the quality management system. Each department has clearly defined responsibilities, covering talent management, financial management, technical research and development, production, sales, and quality inspection.

The production process for ZC's products involves several stages, including pre-treatment of wire rod materials, drawing, heat treatment, pickling, coating, and copper plating. There are slight variations in wire rod selection and process techniques for different products.

3.2 Current State of Product Quality at ZC Company

Clients expect a first-pass yield rate of 95.6% from ZC Company; however, only eight months in 2023 met this standard. The first-pass yield in February was merely 71.8% due to the Spring Festival, indicating significant room for improvement. The customer's scrap rate threshold is set at 1.7%, but most months saw ZC Company far exceed this, reaching 42.86% in February. The losses amounted to $5,944.39 in 2023, necessitating a reduction in scrap rates. There exists a substantial backlog of defective products awaiting resolution, traceable back to 2012, with an increasing trend in unresolved parts in 2023, tying up $130,000, reflecting inadequate quality management and low processing efficiency.

3.3 Evaluation of Quality Management at ZC Company

An evaluation index system for quality management capability was developed based on research and industry standards. It includes primary indicators such as document and information management, fulfillment of management responsibilities, and resource management, along with numerous secondary and tertiary indicators like internal document management and suitability of quality policy. Indicators were selected through expert surveys, and weights for each level were determined using the Analytic Hierarchy Process (AHP). Surveys were distributed to industry experts, and after consistency tests, weights were calculated, such as 0.1235 for quality document information management and 0.0852 for management responsibility fulfillment capability.

Surveys were distributed to management, internal auditors, process technicians, and frontline employees at ZC Company. Out of 50 surveys, 49 were validly returned. The weighted average method was used to process the assessment matrix, establish a scoring table, and calculate scores for each indicator level. For example, the score for internal document management was 82.04, with an overall evaluation result of 64.62.

3.4 Analysis of Quality Management Evaluation Results at ZC Company

The overall quality management score for ZC Company is 64.62, revealing a considerable gap from the "Total Quality Management" goal. The score for quality culture development is a mere 39.66, indicating infrequent quality activities and inadequate communication, which should be a primary focus for improvement. The score for quality-related outcomes is 55.72, affected by low first-pass yield rates and high scrap rates, but these

depend on improvements in other areas and are not direct targets for correction. The measurement, analysis, and improvement capabilities scored 63.99, impacted by issues in handling non-conforming products and quality data analysis, requiring substantial enhancement. Resource management scored 67.02, highlighting deficiencies in workplace environment management and information knowledge management, necessitating strengthened on-site 6S management and further development of information systems.

4. ZC Company's Quality Management Improvement Plan

4.1 Comprehensive Quality Management Improvement Goals for ZC Company

A shift in the quality mindset among all personnel is essential to foster a culture of Total Quality Management, emphasizing correct quality perspectives and the elimination of poor habits. Addressing quality issues resulting from subjective factors, such as design errors and uncontrolled measurement systems, would enhance product quality stability. The improvement of quality data management, including data storage, collection, and application, would provide robust support for quality management.

4.2 Strategy for Enhancing Comprehensive Quality Management at ZC Company

A detailed inspection plan specifying inspection items, methods, standards, frequency, and responsibilities should be considered. Comprehensive inspection standards, rational inspection processes, and suitable inspection methods are recommended. Training for inspection personnel, calibration of inspection equipment, and conducting first article, process, and finished product inspections are advisable. Reinforcing the management of non-conforming products and analyzing and providing feedback on inspection data would contribute to continuous improvement of inspection processes as part of the quality management system, enhancing product quality and market competitiveness.

The heat treatment quenching and copper plating processes are identified as critical steps; analyzing the impact of process parameters on product quality and optimizing process plans would be beneficial. The use of advanced control technologies and equipment may strengthen process monitoring. Establishing a quality alert mechanism and adjusting process parameters promptly would ensure product quality stability.

Reputable suppliers for equipment procurement and regular calibration, along with developing calibration plans, are important considerations. Enhancing equipment maintenance, training operators, controlling the operating environment, and conducting performance verification and comparison tests are significant steps. Statistical process control for monitoring equipment performance, along with recording and tracing equipment information, should be integrated into the quality management system to ensure inspection equipment remains accurate and reliable, safeguarding the reliability of product quality inspections.

5. Safeguard Measures

5.1 Comprehensive Quality Management Through Full Employee Participation

Quality management training is essential to enhance employees' awareness and skills, clarifying quality objectives and individual responsibilities. The establishment of QC teams encourages autonomous problem-solving among employees. Open communication channels, like team meetings and suggestion boxes, facilitate dialogue. Quality goals should be set and broken down by individual contribution, with incentives to motivate participation. Methods such as the PDCA cycle can promote continuous improvement, fostering cross-departmental collaboration and employee involvement in decision-making. The use of visualization management tools, along with leadership's exemplary behavior and standardized processes, ensures total participation in quality management, enhancing product and service quality.

5.2 Strengthening Supplier Management

A rigorous supplier selection process, assessing quality, cost, and delivery capabilities, is crucial. An evaluation system with regular scoring and supplier certification helps maintain standards. Clearly defined contracts establish long-term relationships, enabling continuous monitoring and review. Effective communication and feedback lead to mutual

improvement, risk assessment, and strategy development, while sharing key information and providing supplier training. Tools like supplier quality manuals and electronic data exchange systems can strengthen supplier management, reduce supply chain risks, and improve product quality and customer satisfaction.

5.3 Regular Maintenance of Production Equipment

Maintenance plans based on manufacturers' recommendations and actual operating conditions are necessary for effective equipment management. Routine inspections and scheduled maintenance, supported by trained personnel who record maintenance information, are advised. Adequate spare parts should be stocked, and preventive maintenance strategies implemented, utilizing monitoring technology for condition tracking and fault prediction. Controlling the operational environment and adhering to safety protocols ensure efficient equipment performance, extending lifespan and reducing failure rates and repair costs.

5.4 Production Environment Control

The establishment of production environment control standards, alongside regular monitoring of key indicators like temperature and humidity, is vital. Enhanced cleanliness and material management, along with temperature, humidity, and air quality control, are essential. Reducing noise and vibration pollution, managing lighting appropriately, and standardizing waste management contribute to a better environment. Training employees to raise environmental awareness and skills, coupled with emergency preparedness plans, ensures continuous improvement of environmental controls, providing a stable, safe, and healthy production setting that boosts product quality and competitiveness.

6. Conclusion

This study provides an in-depth analysis of ZC Company's Total Quality Management, uncovering issues such as weak quality culture, insufficient measurement analysis and improvement capabilities, and the need for enhanced resource management. In response to these challenges, a comprehensive quality management improvement plan has been proposed. It includes thorough process inspections, enhanced control over key procedures, and careful attention to monitoring and measurement equipment. Corresponding safeguard measures, such as full employee participation, strengthened supplier management, equipment maintenance, and production environment control, have also been devised.

Looking forward, ZC Company should continue advancing its quality management initiatives, persistently optimizing its quality management system. It is recommended that other small to medium enterprises draw from ZC Company's experiences, prioritizing Total Quality Management. By tailoring suitable quality management strategies to their unique contexts, these enterprises can enhance product quality, boost competitiveness, and achieve sustainable development.

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