Research on Enhancing the Operational Quality Management of the East China Air Traffic Management Bureau

Zizhou Guo

Jiangsu Air Control Sub-bureau, Nanjing 210000, Jiangsu, China
DOI: 10.32629/memf.v5i6.3188

Abstract: Since the 2016 "10.11" incident at Shanghai Hongqiao Airport, global focus on air traffic controllers' quality has increased. As a crucial pillar of the aviation industry, air traffic control (ATC) ensures flight safety. However, with only 18,000 controllers in China by 2023, ATC development lags behind airlines, resulting in an inadequate quality evaluation system. This paper investigates the operational quality management of the East China Air Traffic Management Bureau. It assesses current management, identifies problems, and analyzes causes, proposing strategies to enhance operational quality based on these findings.

Keywords**:** air traffic control; quality management system; quality requirement elements

1. Introduction

China's rapid economic growth has made it the world's second-largest aviation market, with 39 airports handling over 10 million passengers annually. This surge places greater demands on Air Traffic Control (ATC), as airlines and passengers seek safer, more efficient services. To meet these needs, ATC must enhance efficiency and safety, improving service quality and reducing costs for sustainable development.

The East China Air Traffic Management Bureau, under the CAAC, manages air traffic in the region, overseeing major hubs like Shanghai Pudong and Hongqiao Airports. Using advanced ATC technologies, the bureau ensures safe flight operations and continuously improves quality management through Flight Information, Tower Control, Approach Control, and Area Control Services.

2. Overview of the East China Air Traffic Management Bureau

2.1 Current Operational Quality Management Status

2.1.1 Current Status

Despite previously stable operational quality, the 2016 "10.11" incident damaged the bureau's reputation. Increased flight volumes without adequate ATC development have strained the system, with unsafe incidents rising from 44 in 2017 to 68 in 2023. A 2024 satisfaction survey revealed only 28.9% of service recipients were satisfied, while 47.79% were dissatisfied. Key issues included flight planning, distress handling, delays, communication problems (e.g., radio interference, unclear transmissions), and inaccurate meteorological services

2.1.2 Causes of Operational Quality Issues

The gap between operational quality and expectations arises from insufficient incentives in the public ATC sector,leading to staff complacency.Managerial formalism—emphasizing procedures over practical solutions—hinders effective problem-solving and risk management.Rising flight volumes further burden controllers, especially in tower control units with insufficient personnel.Systemic issues,such as uneven focus among departments,result in neglect of tower control and increased unsafe incidents.Enhancing ATC quality is crucial for aviation safety,requiring adjustments to policies and management models.

3. Design of the Operational Quality Management Plan

Employing Quality Function Deployment (QFD), also known as the "House of Quality," the study analyzes operational quality to propose improvement strategies. QFD helps transform customer needs into technical specifications, providing targeted quality management objectives.

Steps include:

(1) Constructing the Quality Requirement Deployment Table

(2) Constructing the Quality Requirement Technical Element Table
(3) Synthesizing the Two-Dimensional Table of Quality Requirements and Quality Elements
(4) Performing Importance Conversion

3.1 Constructing the Operational Quality Requirement Deployment Table

Frontline controllers provide air traffic control services, collaborating with airport companies and serving airlines—mainly crew members—as recipients. To capture diverse needs, questionnaires were distributed to airline crew members, passengers, airport operation centers, air traffic control experts, and controllers. Data were integrated and analyzed based on indicator similarities. The Operational Quality Requirements(A) were categorized into five dimensions: Safety(B1), Efficiency(B2), Economy(B3), Reliability(B4), and Employee Needs(B5). Safety includes Aircraft Operational Separation(C11), Efficient Special Situation Handling(C12), Accurate and Timely Control Services(C13), and Reducing Runway Incursion Risk(C14). Efficiency encompasses Reducing ATC-Caused Flow Control(C21), Reasonable Release Sequence Arrangement(C22), Reducing Air and Ground Waiting Time(C23), and Efficient Flight Plan Approval(C24). Economy covers Reducing Aircraft Operating Costs(C31), Improving Flight Punctuality(C32), and Providing Continuous Climb and Descent Services(C33). Reliability involves Perfecting Special Situation Plans(C41), Reliable Communication, Navigation, and Surveillance Equipment(C42), and Controllers Meeting Skill Standards(C43). Employee Needs include Perfecting Incentive Mechanisms(C51), Scientific Scheduling for Energetic Duty(C52), and Meeting Personal Growth Needs(C53). This categorization reflects key areas identified through the survey, providing a foundation for enhancing operational quality at the East China Air Traffic Management Bureau.

3.1.1 Determining Indicator Weights

Using the Delphi method, 10 ATC professionals rated the importance of indicators on a 1–9 scale. To minimize subjectivity, highest and lowest scores were discarded, averages matched to the nearest scale value to construct the judgment matrix.

Weights were calculated using Analytic Hierarchy Process (AHP) software, summarized in Table 1.

Table 1. Summary of Weights of Indicators at All Levels

Goal Level	First-Level Indicators	Weight	Second-Level Indicators	Weight
A	B1	0.3481	C11	0.0559
			C12	0.0873
			C13	0.0348
			C14	0.1700
	B2	0.0945	C21	0.0308
			C22	0.0154
			C23	0.0342
			C24	0.0140
	B3	0.0896	C31	0.0152
			C32	0.0397
			C33	0.0347
	B4	0.2899	C41	0.1123
			C42	0.0492
			C43	0.1284
	B5	0.1780	C51	0.0291
			C52	0.0959
			C53	0.0529

3.1.2 Consistency Check

Consistency checks ensured validity using the formula:

$$CR = CI / RI, \; CI = \frac{\lambda_{max} - n}{n - 1}$$

All matrices passed the consistency check, indicating valid data.

3.2 Constructing the Operational Quality Technical Element Table

To transform air traffic control (ATC) operational quality requirements into concrete technical elements and achieve the objectives of operational quality management, we developed the operational quality technical elements based on the previous requirement table and expert opinions. These technical elements are categorized into five first-level indicators: Safety (D1), Efficiency (D2), Economy (D3), Reliability (D4), and Employee Needs (D5). Under Safety (D1), the second-level indicators include Frequency of Aircraft Conflict Alerts (E11), Reasonableness and Operability of Special Situation Checklists (E12), and Improvement of Runway Incursion Prevention Measures (E13). Efficiency (D2) encompasses Flight Delays Caused by ATC Reasons (E21), Utilization Rate of Airspace Resources (E22), and Coordination Enthusiasm of Adjacent Control Units (E23). Economy (D3) consists of Flight Punctuality (E31) and Aircraft Operating Costs (E32). Reliability (D4) involves Reliability of ATC Equipment (E41), Reliability of ATC Personnel Skills (E42), and Duty Status of Frontline Personnel (E43). Employee Needs (D5) include Reasonableness of Performance Assessment Mechanisms (E51) and Efficient Training Programs (E52).

3.3 Importance Conversion between Requirement and Technical Elements

The House of Quality translates customer requirements into technical specifications. Correlations are represented using symbols: △ (weak, 1 point), ○(moderate, 2 points), ◎ (strong, 3 points). The importance of a technical element equals the sum of the products of correlation scores and corresponding requirement weights. Subjective weight is the ratio of its importance to the total importance.

Key Weight Results:

Calculations identify key technical elements and their weights: E42 (ATC Personnel Skills Reliability) at 0.1996, the most crucial for improving operational quality; E12 (Special Situation Checklists) at 0.1352; E52 (Efficient Training Programs) at 0.1062; E13 (Runway Incursion Prevention) at 0.1017; E41 (ATC Equipment Reliability) at 0.0812; and E51 (Performance Assessment Mechanisms) at 0.0766.

Elements like E31 (Flight Punctuality) and E32 (Aircraft Operating Costs) have lower weights, indicating a minor impact on overall quality.

4. Strategies for Enhancing Operational Quality

Focusing on high-weight technical elements, the following strategies are proposed:

(1) Strengthening ATC Personnel Skills

Establish hierarchical training programs—including initial, refresher, and specialized training—with simulation exercises and practical drills. Conduct regular skill evaluations to ensure standards and provide personalized improvement plans.

(2) Optimizing Special Situation Checklists

Improve special situation checklists by having expert teams revise them for clarity and conciseness, incorporating best practices. Test these checklists in simulated environments and optimize them based on feedback from frontline controllers.

(3) Establishing Efficient Training Programs

Establish efficient training programs by developing customized long-term and short-term plans that cover professional knowledge, operational skills, and emergency handling. Use diverse methods like case studies, simulations, and online learning to enhance engagement. Employ professional trainers—experienced controllers and experts—to ensure practical training.

References

[1] Air Traffic Management Bureau of the Civil Aviation Administration of China. Technical Guidelines for the Operational Quality Management System of the Civil Aviation Air Traffic Management System [G]. Beijing: Civil Aviation Administration of China, 2009.

[2] ir Traffic Management Bureau of the Civil Aviation Administration of China. Implementation Framework and Planning of the Operational Quality Management System of the Civil Aviation Air Traffic Management System [G]. Beijing: Civil Aviation Administration of China, 2009.

[3] Gao Yang, Mou De. Analytic Hierarchy Process in Aviation Safety Assessment—AHP [J]. China Safety Science Journal, 2000, 10(3): 38-41.

[4] Ternov S, Akselsson R. A method, DEB analysis, for proactive risk analysis applied to air traffic control[J]. Safety Science,2004, 42(7):657-673.

[5] International Civil Aviation Organization. Safety Management Manual [R]. Third Edition. Montreal: International Civil Aviation Organization, 2013.
[6] International Organization for Standardization. GB/T19000-2000. Quality Management Systems—Fundamentals and Vocabulary [S]. Beijing: China Standards Press, 2000.

Author Bio

Zizhou Guo, 1993, male, Han nationality, Xuzhou, Jiangsu Province, assistant engineer, master degree, economics and management science.