SCIENTIFIC OASIS

Journal of Intelligent Decision Making and Granular Computing

Journal homepage: www. jidmag.org
ISSN: 3042-3759

Development of an Integrated Quality System Index (QSI) for Aviation Ground Handling Operations Using the Fuzzy LAAW Method

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ARTICLE INFO

Article history:
Received 30 May 2026
Received in revised form 1 July 2026
Accepted 6 September 2026
Available online 11 September 2026

Keywords:
Ground Handling; Multi-Criteria Decision Making; LAAW Method; Quality System Index; Performance Measurement

ABSTRACT

Ground handling has become increasingly complex, creating a growing need for comprehensive performance measurement that integrates multiple dimensions of operational quality. This study develops an integrated Quality System Index (QSI) that combines key performance indicators (KPIs) related to safety, security, service quality, and regulatory compliance into a unified assessment framework. KPIs from these four dimensions are structured hierarchically, and their relative importance is determined using judgments collected from a panel of 96 ground-handling professionals with expertise in the respective areas. The experts are classified into three organizational groups: directors and managers, coordination and station chiefs, and auditors and specialists. A fuzzy multi-criteria decision-making framework based on the Logarithmic Additive-Weighting-Coefficient Estimation (LAAW) method is employed to determine KPI weights and analyze differences in perceived importance across organizational levels. The proposed QSI is designed not only to provide an overall performance score but also to prevent strong performance in one dimension from compensating for unacceptable performance in critical areas such as safety, security, or regulatory compliance. The framework therefore combines integrated performance assessment with the identification of dimension-specific weaknesses. The resulting QSI can support comparisons among ground-handling stations and reporting periods, facilitate the identification of previously unrecognized performance deficiencies, and guide continuous improvement initiatives. The analysis further reveals KPIs whose importance remains consistent across organizational groups and those whose perceived importance varies according to organizational responsibility.

1. Introduction

Aviation as a commercial sector has, in the last few decades, grew exponentially in share of global economy. As a result, its subsidiary fields grew, both in size and complexity. Largest of them is ground services. It is aviation's core building block and touches on almost all of a passenger's flight experience from luggage processing to ramp operations to passenger boarding and aircraft guidance at takeoff and arrival [1]. It plays an indispensable role in maintaining operational efficiency and the

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https://doi.org/10.31181/jidmgc21202651

upkeep of passenger satisfaction [2]. Because ground-level activities always serve as an interface between their customers, the airlines and their passengers, their success or failure have cascading effects on aviation be it positive or negative. By determining an airline's reliability, punctuality and safety, they play a behind the scenes but still essential role in an airline's life [3]. But that role comes with a catch. If aviation and through it ground services are so multifaceted, which they are, then they inevitably become equally difficult to analyze where simplified perfect scores in one parameter like service quality might overshadow shortcomings of another [4, 5]. For that reason, this study proposes a Quality System Index (QSI) to be used for ground services. A composite grade that is made up of Quality, Compliance, Security, and Safety; each with several of their own specific Key Performance Indicators (KPIs) acting as distinct pillars to grade the same final product.

Some past research has chosen to deal with the complexity in question by using Multi-Criteria Decision-Making (MCDM) approaches to put a mathematical template on which the parallel data can be installed [6–8]. This study in particular employs the Logarithmic Additive Weighting Coefficient Estimation (LAAW) method variant of MCDM, grounded in fuzzy logic theory, to construct a QSI out the four mentioned subfields and their respective KPIs. The method has been shown to translate subjective, real-world operational insights into consistent, mathematically sound weights effectively in the past [7, 9]. And by bringing in the personal judgments from 96 aviation professionals (largest ever in size for a study of this nature) across not just various subfields but of organizational hierarchy as well, it also gives us insights to what varies and what remains firm in prioritization

1.1 Literature Review

1.1.1 Foundations and subfields for performance measurement in commercial aviation

Commercial aviation suffers from 2 major stress points at the same time; It is both extremely complicated and just as competitive with narrow profit margins. In such sectors every small advantage matters. In aviation specifically, safety and quality metrics are essential for any hope of long-term viability [3, 6]. To meet this task, methods have been deployed that are as complex as the industry they review [10]. For example, Akbaba, [11], Akyurt [7] and İnan [10] have deployed the Balanced Scorecard approach. In an industry where the day-to-day operations at the airport level can sometimes feel far off from the long-term goals at a corporate administration level, it is a method that can provide the necessary integration for it.

Multi-Criteria Decision-Making (MCDM) methods that were specifically tailored for multifaceted superstructures can be especially helpful [6, 12]. Past literature documents applications of a variety of MCDM models like the Analytic Hierarchy Process (AHP), TOPSIS, and the Logarithmic Additive Weighting Coefficient Estimation (LAAW) method to weigh performance criteria and rank alternatives [6, 7]. Grounded in fuzzy set theory, these methods capture the subjective and ambiguous judgments of aviation experts, transforming linguistic assessments into consistent, reliable, and mathematically recognizable numerical weights [6, 7, 13, 14].

1.1.2 Safety

Of all the subfields listed and studied here, safety is by far the most important one. Shortcomings of it risk a lot more than shortcomings in passenger satisfaction or on-time-performance, considering it involves risks to human life. But the impossibility of reaching perfection in safety is acknowledged in ICAO Annex 19 [15] (Safety Management) where the definition of safety is to reduce it to acceptable levels rather than to exterminate it. In the past, approach to aviation safety has been the conventional compliance focused way, viewing it as a legally mandated statistic to measure up to, in need of updated methods to it [16, 17]. However, the modern aviation analysis is moving beyond the regulatory compliance alone approach as viewing it insufficient [4, 17]. Some studies have attempted to view safety from a modern MCDM method [2, 8, 18].

If aviation is to have a modern Safety Management System, as ICAO mandates, the Safety Performance Indicators (SPIs) available have to be reviewed in such modernized methods. Previous studies show that focusing strictly on lagging indicators like accidents and fatality rates alone is not enough and developing approaches that prioritize proactive analysis with the goal of continuous improvement is needed [4, 17]. Methodology for standardizing SPI rates have been provided in ICAO Annex 19 [15]. However, to allow room for variety that is inevitable due to cultural and economic varieties in the industry, even a standardized list of SPIs is left up to the local level. Analysis methods then are even more open to interpretation and development.

Cotemporary safety research also indicates that the difficulty of analysis in this area stems from the "soft" organization factors' effects, such as safety culture and mindfulness, employee feedback loops [4]. These are abstract enough concepts that are difficult to measure. If safety as a culture is to thrive in a ground services company, there should be a culture of incentivizing the personnel to report by creating a Just Culture of openness [17, 19]. Also, structural quality of the reporting mechanisms contributes to safety culture [4].

1.1.3 Quality

While safety focuses on the mitigation of the potential negative, quality takes on the improvement of the positive, such as the standardization and efficiency of processes and the improvement of customer needs [20]. Modernized approaches have also found place in the quality subfield. Total Quality Management (TQM) and ISO 9001 bring the systematized quality standards to aviation and show how they are more than checkboxes, that they bring continuous improvement, error prevention and a united participation of organizational units [21]. While safety might not be on a passenger's mind when it is executed efficiently in the background, quality is something that every passenger notices, consciously or unconsciously. Its indispensable role in passenger experience has led to studies utilizing multidimensional systems to better understand ground services' effects on commercial aviation as a customer experience [22]. It has shown that the airport level service colors the impressions of passengers on the airline itself. This persists even though most airlines outsource their ground level services to ground service companies through SLAs [13]. Airlines therefore must put the expectation forward towards those companies to reinforce quality standards [22]. Given its essential role in customer satisfaction, institutional approach to proactively improving it and rejecting the idea that it is a cost burden is essential [20, 21]. To accomplish it, regular Management Review Meetings must improve both the process and its own approaches by analyzing their available data [11, 21]. Modernized approaches to its analysis have already been introduced as MCDMs [7, 13, 23].

1.1.4 Compliance

Compliance within an aviation context means, at its core, the process of maintaining the pyramid structure of rules that organize the sector, whether it be the international standards on it, national sovereign laws and regulations, and finally the corporate rules, be it internal standard operating procedures (SOPs) or SLA specific requirements [20]. International frameworks for them are provided by the International Air Transport Association, which does not mandate details on a finished product, but offers a guideline structure to enable global standardization on the topic [23].

Though it is a necessary and essential part of the sector that allows its diverse parts to cohere within the same system, the zero-findings mentality that is common in companies regarding auditing results has led to a misunderstanding on optimization that compliance alone is good enough [5]. If it is seen persistently as a static position to maintain rather than part of a wholistic structure of continuous improvement, it will not serve. In fact, more recent research on the issue has included Audit Finding Closure Time and Corrective Action Closure Time as KPIs to monitor as well [20]. Modernized analysis in MCDM on the field have been brought to regulatory compliance as well [7, 8].

1.1.5 Security

Security as a subfield has been relatively less focused on by the airlines and ground services compared to quality and safety. But its influence can be drastic when neglected; Even one exposed vulnerability can be used by bad actors to the point of reshaping geopolitics. In the post 9/11 world, much more sensitive approaches have been taken to airport security, and studies focusing on it have correlated to this trend as well. Concepts like Airport Collaborative Decision Making (A-CDM) and Total Airport Management (TAM) developed by EUROCONTROL have been examples of modernized and systematized structure improvements on the security front [24]. They have operated as the integration of KPIs on the topic with speed of modern communication to share real time data with the diverse group stakeholders at the airport, be they government or corporate.

Milbredt & Deutschmann, [24] have even introduced a similar index to the one in this study, except only focusing on service vs. security, building it on Key Control Parameters (KCPs) controlled by the management (such as security patrols per passenger, officer training days, technical equipment availability etc.) and comparing them with non-controllable (passenger density, national threat levels) factors. Others have gone with a more deconstructive method of putting “vulnerability” under the microscope, dissecting from every angle and bringing the “proactive over reactive” mindset to airport security [3]. Cultivation of a proactive security culture is part of Milbredt & Deutschmann [24] as well, citing and building on earlier work on risk-driven proactiveness. It has also been a subfield recently studied by the multicriteria approaches [8, 25].

2. Methodology

This study uses the Fuzzy LAAW method to put the acquired KPIs through a mathematical evaluation and create a weighted ranking of both the KPIs and their subfields. Conventional Multi-Criteria Decision-Making (MCDM) approaches—such as the Analytic Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)—have been widely applied to analyze airline and airport ground operations under uncertainty [6, 18]. The Fuzzy LAAW method, originally developed as an MCDM to be utilized in a complex industry also on a global scale Deveci *et al.,* [9] and adapted for ground-handling performance evaluations [7]. In this study, by transforming the linguistic assessments of the 96 surveyed aviation professionals into triangular fuzzy numbers and utilizing a logarithmic additive algorithm based on an absolute anti-ideal reference point, Fuzzy LAAW drastically reduces the number of required judgments, minimizes cognitive inconsistency, and ensures mathematically stable criteria weights across all 14 underlying QSI indicators.

2.1 Selecting and Structuring the Method

The study is constructed with the methodology and aim of measuring and comparatively weighing the fields and KPIs constituting the proposed Quality System Index (QSI). It seeks to take a field that is rife with ambiguity due to expert opinions’ subjective judgments, as well as competing metrics (the quality factors such as OTP running in opposition to the deliberative steadiness needed for safety) to harmonize Quality, Safety, Security and Compliance. The task is difficult. Thus, a complex mathematical method is needed.

Step 1. Classifying the Raw Data: A list of KPIs representing Quality, Safety, Security and Compliance was compiled and separated under its respective subfield.

Step 2. Expert Opinion for Prioritization: A panel was assembled from 96 individuals, each of whom representing at least one subfield. All ranks from managers down to field inspectors were covered.

Step 3. Mathematically Weighing the Results: An MCDM was applied. Specifically, The Logarithmic Additive Weighting Coefficient Estimation (Fuzzy LAAW) method was used to aggregate the subjective judgments of said experts into quantified, numerically translated criteria weights.

Step 4. Comparative Final Analysis: The results were compared and contrasted with the goal of understanding how priorities change across the corporate hierarchy, operational proximity and the types of responsibility.

2.2 Algorithmic Structuring of Fuzzy Numbers

Though aviation is, in theory, largely a mathematical and mechanical sector, in reality it faces myriad subjectivity due to a lack of data in the moment, and diversity related differences in perspectives to same issues. The main problem with translating such personal judgments to statistics and numbers has always been the failure of capturing the inherently human elements of hesitation, emotional responses based on anecdotes, momentary exaggeration. This study makes use of the preestablished Fuzzy MCDM approaches to bridge that divide, and uses the Triangular Fuzzy Numbers (TFNs) rather than simple, dual comparisons to better simplify ambiguities. The membership function of a TFN is defined as:

$$\mu(\lambda) = \frac{\lambda - l}{m - l} \ \text{if} \ l \le \lambda \le m \tag{1}$$

$$\mu(\lambda) = \frac{u - \lambda}{u - m} \ \text{if} \ m \le \lambda \le u \tag{2}$$

$$\mu(\lambda) = 0 \ \text{otherwise} \tag{3}$$

2.3. Implementation Steps of the Fuzzy LAAW Method

2.3.1 Creation of the criterion priority vector

Experts prioritize the criteria by assigning a higher TFN from the fuzzy scale to the more important criterion and a smaller TFN to the less important criterion, yielding a fuzzy priority vector $Y^t = (\tilde{\theta}_1{}^t, \tilde{\theta}_2{}^t, \dots, \tilde{\theta}_n{}^t)$ for each expert t ($1 \le t \le k$), where $\tilde{\theta}_j{}^t = (\theta_j{}^{(l)t}, \theta_j{}^{(m)t}, \theta_j{}^{(u)t})$represents the TFN assigned by expert t to criterion j

2.3.2 Determination of the absolute anti-ideal point

A reference point representing the lowest performance is identified as the absolute anti-ideal point ξ_{AIP}, determined as a value lower than the minimum of all fuzzy priority values across criteria. This point serves as the constant which, all the criteria is compared to.

2.3.3. Combining and aggregating expert opinions

This step is where the data from various sources are harmonized. The Bonferroni function is used to aggregate the subjective judgments of the pool of experts into a single common value. K in the equation stands for the individuals who have expertise in at least one of the subfields and α_1, α_2 serve as the stabilizers.

$$\tilde{\theta}_j = \left(\theta_j^{(l)}, \theta_j^{(m)}, \theta_j^{(u)}\right) = \begin{pmatrix} \left(\frac{1}{k(k-1)} \sum_{x=1}^{k} \left(\theta_j^{(l)(x)}\right)^{\alpha_1} \sum_{y=1, y\neq x}^{k} \left(\theta_j^{(l)(y)}\right)^{\alpha_2}\right)^{\frac{1}{\alpha_1+\alpha_2}}, \\ \left(\frac{1}{k(k-1)} \sum_{x=1}^{k} \left(\theta_j^{(m)(x)}\right)^{\alpha_1} \sum_{y=1, y\neq x}^{k} \left(\theta_j^{(m)(y)}\right)^{\alpha_2}\right)^{\frac{1}{\alpha_1+\alpha_2}}, \\ \left(\frac{1}{k(k-1)} \sum_{x=1}^{k} \left(\theta_j^{(u)(x)}\right)^{\alpha_1} \sum_{y=1, y\neq x}^{k} \left(\theta_j^{(u)(y)}\right)^{\alpha_2}\right)^{\frac{1}{\alpha_1+\alpha_2}} \end{pmatrix} \tag{4}$$

2.3.4. Calculation of the relative vector

Aggregation alone does not serve to streamline the processing of the data. It is then processed by weighing all the criteria against the same reference point to establish a baseline consistency, and yields more focused and grounded results by rather than comparing all against one another.

$$\tilde{\gamma}_j = \frac{\tilde{\theta}_j}{\xi AIP} \tag{5}$$

2.3.5. Calculation of weighting factors

Criterion weights are obtained through a logarithmic transformation in which $\tilde{\gamma}_j = \left(\gamma_j^{(l)}, \gamma_j^{(m)}, \gamma_j^{(u)}\right)$ the elements of the fuzzy relation vector A, while $\tilde{b} = \prod_{j=1}^{n} \tilde{\gamma}_j$ and the coefficients are weighed to reach the conclusion $\sum_{j=1}^{n} \omega_j = 1$.

$$\tilde{\omega}_j = \frac{\ln(\tilde{\gamma}_j)}{\ln(\tilde{b})} = \left(\frac{\ln\left(\gamma_j^{(l)}\right)}{\ln\left(b^{(u)}\right)}, \frac{\ln\left(\gamma_j^{(m)}\right)}{\ln\left(b^{(m)}\right)}, \frac{\ln\left(\gamma_j^{(u)}\right)}{\ln\left(b^{(l)}\right)}\right) \tag{6}$$

2.4 Adapting the MCDM model to our research

For the purposes of structuring the QSI with it, the Fuzzy LAAW method was used separately to the judgments of each of the three respondent groups — directors and managers, coordination and station chiefs, and auditors and specialists — to determine the relative importance of the four QSI subfields and their fourteen KPIs. Applying the same method independently to each group allows the resulting weight structures to be compared directly, so that the sensitivity of the prioritization to organizational level and operational proximity can be assessed.

2.5 Benefits and shortcomings of the method

Using the Fuzzy LAAW method has a lot of benefits for a study with this purpose. First and the most important is to ease the pressure on experts' qualitative judgment. Nuances of experience-based intuition gets form and structure in carefully factored into a grade through Fuzzy corrections. Another advantage is that a strictly dualistic MCDM, such as Saaty's AHP, would cause serious exhaustion in the responder since dual comparison grows exponentially in size. With Fuzzy LAAW the complexity remains low. A third benefit is having an absolute anti-ideal point to compare to, which allows for future inclusion of new KPIs (or removal of existing ones) without distorting existing measurements.

However, one limitation of this approach, and it is not a minor one, is that it built on panel's quality. If the panel is not representative enough in any way, the study will fail to capture the view that aspect. To mitigate this, this study uses dozens of experts - 96 to be exact – from all 4 subfields and all ranks from the top management down to the most frontline auditors.

3. The Application

3.1 Defining the Process

The study formats the topic as a three-level structure. The first level defines the overarching objective — the Quality System Index (QSI) for aviation ground services. The second level comprises the four principal fields: Quality (4 KPIs), Safety (4 KPIs), Security (3 KPIs), and Compliance (3 KPIs). The third and final level shows, in a numerical classification, the fourteen KPIs that provide the quantifiable foundations for performance evaluation. The structure is demonstrated Figure 1.

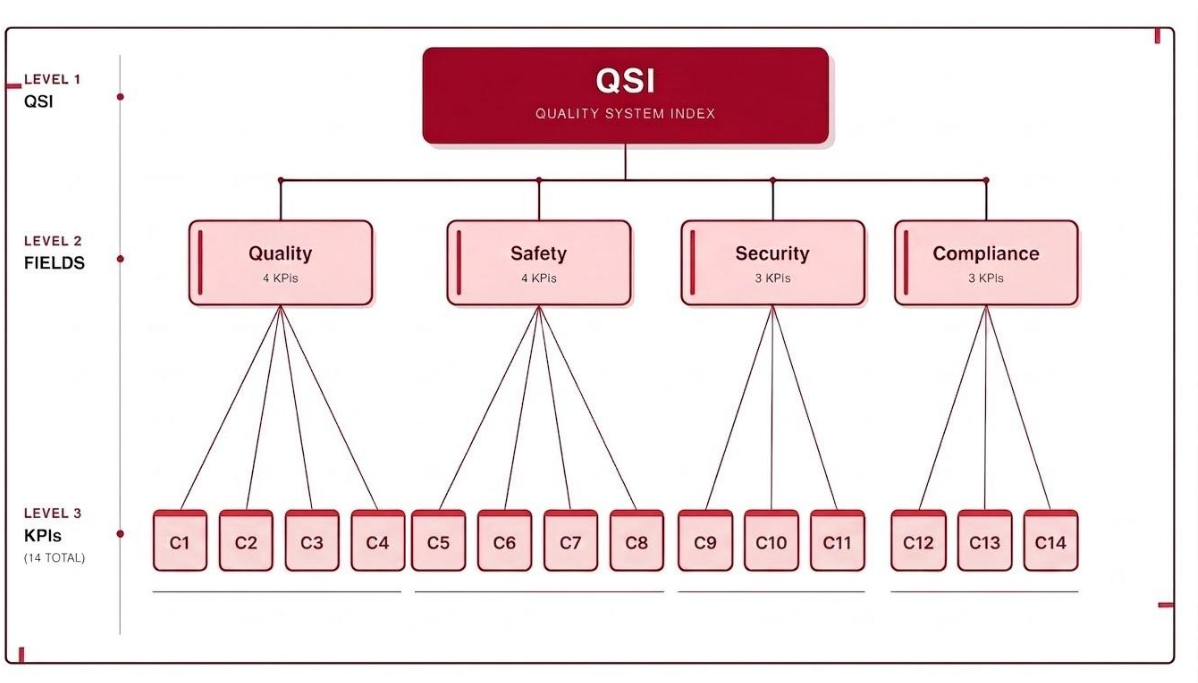

Fig. 1. QSI decision hierarchy (Level 1: QSI; Level 2: four fields; Level 3: 14 KPIs)

3.1.1 Listing and defining the parameters

C1 Process Completion Rate: Shows the ratio of operational processes completed within the reporting period to the total number of planned processes.

C2 Average Document Approval Time: Represents the average duration required for the approval of operational and technical documents.

C3 Management Systems ISO Standard: Reflects the level of conformity with ISO-based management system standards (e.g., ISO 9001).

C4 Management Review (YGG) Presentation Agenda Item Completion Rate: Shows the ratio of agenda items presented and closed at Management Review Meetings.

C5 Integrated Audit Findings Closure Rate: Represents the overall rate of adherence to corporate policies, procedures, and standard operating instructions.

C6 Quality Control Realization Percentage Rate: Shows the ratio of nonconformities identified during internal and external quality control inspections.

C7 Percentage Improvement in the Top 15 NCS Items: Represents the improvement rate achieved in the fifteen highest-priority non-conformity/occurrence items tracked by the organization.

C8 SAB Presentation Agenda Item Completion Rate: Shows the ratio of agenda items presented and closed at Security Advisory Board (SAB) meetings.

C9 Percentage Improvement in Security Feedback: Represents the rate of improvement in the volume and quality of security-related feedback and near-miss reporting.

C10 Percentage Improvement in Security Culture: Shows the rate of improvement in employee security-culture survey results.

C11 Percentage Improvement in Safety Culture: Shows the rate of improvement in employee safety-culture survey results.

C12 SPI Rate: Safety Performance Indicator rate, expressing safety occurrences relative to a standardized operational denominator (e.g., per number of departures).

C13 Percentage Improvement in Safety Feedback: Represents the rate of improvement in the volume and quality of safety-related feedback and hazard reporting.

C14 SRB Presentation Agenda Item Completion Rate: Shows the ratio of agenda items presented and closed at Safety Review Board (SRB) meetings.

[Note: for internal consistency, the agenda-completion KPIs C8 and C14 are referred to uniformly as SAB and SRB respectively throughout this article; the underlying committees may also be referenced elsewhere in organizational documentation by their Turkish abbreviations (GDK and EGGK).]

3.2 Participants and Data Sourcing

The evaluation process was carried out with the participation of 96 personnel employed at a ground handling company. The crew was picked to reflect 3 layers. Each contributed a different operational perspective to the equation. 1 director and 2 managers [n=3] represent the upper management's larger, strategic perspective; coordination chiefs and station chiefs [n=16] represent a relatively more familiar experience with localized management; and finally, the auditors and specialists [n=77] bringing the most on-the-ground, localized and independent perspective about the practical nuances of the process. Overall, they provide full spectrum of quality management from top to bottom.

4. Results

4.1 Evaluation by Directors and Managers

Table 1 and Table 2 show the evaluation results of the upper management. The highest importance is given to the KPIs Improvement in Safety Culture (0.1321), the SPI rate (0.1102) and in third the Percentage Improvement in the Top 15 NCS Items (0.0931). We can see that at the management level the main strategic concerns are in safety culture and compliance improvements. Conversely, the KPIs that were given the lowest weights are the SRB Presentation Agenda Item Completion Rate (0.0322), the Management Review Presentation Agenda Item Completion Rate (0.0351), and the SAB Presentation Agenda Item Completion Rate (0.0354).

4.2 Evaluation by Coordination and Station Chiefs

A close study of the results from to this group, shown in Table 3 and Table 4, reveals to us that the three highest-weighted KPIs are the Percentage Improvement in Safety Culture (0.1309), the SPI Rate (0.1103), and the Percentage Improvement in Security Feedback (0.1002), reflecting this group's closer proximity to daily field operations and its consequent emphasis on both safety and security feedback mechanisms. The three lowest-weighted KPIs are the SRB Presentation Agenda Item Completion Rate (0.0352), the Management Review Presentation Agenda Item Completion Rate (0.0402), and the Process Completion Rate (0.0514).

4.3 Evaluation by Auditors and Specialists

The results for the auditors and specialists group, shown in Table 5 and Table 6, indicate that the three highest-weighted KPIs are, once again, the Percentage Improvement in Safety Culture (0.1301), the SPI Rate (0.1103), and jointly the Percentage Improvement in the Top 15 NCS Items and the Percentage Improvement in Security Feedback (0.0903 each). The three lowest-weighted KPIs are the SRB Presentation Agenda Item Completion Rate (0.0352), the Management Review Presentation Agenda Item Completion Rate (0.0401), and jointly the Management Systems ISO Standard and Integrated Audit Findings Closure Rate (0.0503 and 0.0502 respectively).

Table 1
Evaluation by directors and managers

KPI	Weight (%)	Weight	Rank
C1. Process Completion Rate	9	0.0914	5
C2. Average Document Approval Time	7.5	0.0753	7
C3. Management Systems ISO Standard	5	0.0523	10
C4. Management Review (YGG) Presentation Agenda Item Completion Rate	3.5	0.0351	13
C5. Integrated Audit Findings Closure Rate	5	0.0512	11
C6. Quality Control Realization Percentage Rate	6	0.0612	9
C7. Percentage Improvement in the Top 15 NCS Items	9	0.0931	3
C8. SAB Presentation Agenda Item Completion Rate	3.5	0.0354	12
C9. Percentage Improvement in Security Feedback	9	0.0924	4
C10. Percentage Improvement in Security Culture	7.5	0.0752	8
C11. Percentage Improvement in Safety Culture	13	0.1321	1
C12. SPI Rate	11	0.1102	2
C13. Percentage Improvement in Safety Feedback	7.5	0.0757	6
C14. SRB Presentation Agenda Item Completion Rate	3.5	0.0322	14

Table 2
Field-level weights — directors and managers

Field	Weight (%)	Weight	Rank
Safety	35	0.3519	1
Quality	25	0.2505	2
Compliance	20	0.2089	3
Security	20	0.2036	4

Table 3
Evaluation by coordination and station chiefs

KPI	Weight (%)	Weight	Rank
C1. Process Completion Rate	5	0.0514	12
C2. Average Document Approval Time	6	0.0603	9
C3. Management Systems ISO Standard	5	0.0517	10
C4. Management Review (YGG) Presentation Agenda Item Completion Rate	4	0.0402	13
C5. Integrated Audit Findings Closure Rate	5	0.0515	11
C6. Quality Control Realization Percentage Rate	6	0.0645	8
C7. Percentage Improvement in the Top 15 NCS Items	9	0.0929	4
C8. SAB Presentation Agenda Item Completion Rate	7	0.0701	7
C9. Percentage Improvement in Security Feedback	10	0.1002	3
C10. Percentage Improvement in Security Culture	8	0.0802	5
C11. Percentage Improvement in Safety Culture	13	0.1309	1
C12. SPI Rate	11	0.1103	2
C13. Percentage Improvement in Safety Feedback	7.5	0.0755	6
C14. SRB Presentation Agenda Item Completion Rate	3.5	0.0352	14

Table 4
Field-level weights — coordination and station chiefs

Field	Weight (%)	Weight	Rank
Safety	35	0.3519	1
Security	25	0.2505	2
Compliance	20	0.2089	3
Quality	20	0.2036	4

Table 5
Evaluation by auditors and specialists

KPI	Weight (%)	Weight	Rank
C1. Process Completion Rate	5	0.0502	11
C2. Average Document Approval Time	6	0.0607	9
C3. Management Systems ISO Standard	5	0.0503	10
C4. Management Review (YGG) Presentation Agenda Item Completion Rate	4	0.0401	13
C5. Integrated Audit Findings Closure Rate	5	0.0502	11
C6. Quality Control Realization Percentage Rate	7	0.0704	7
C7. Percentage Improvement in the Top 15 NCS Items	9	0.0903	3
C8. SAB Presentation Agenda Item Completion Rate	7	0.0701	8
C9. Percentage Improvement in Security Feedback	9	0.0903	3
C10. Percentage Improvement in Security Culture	8	0.0801	5
C11. Percentage Improvement in Safety Culture	13	0.1301	1
C12. SPI Rate	11	0.1103	2
C13. Percentage Improvement in Safety Feedback	7.5	0.0751	6
C14. SRB Presentation Agenda Item Completion Rate	3.5	0.0352	14

Table 6
Field-level weights — auditors and specialists

Field	Weight (%)	Weight	Rank
Safety	35	0.3507	1
Security	24	0.2405	2
Compliance	21	0.2109	3
Quality	20	0.2013	4

5. Conclusions

After an exhaustive evaluation of all available data, we can see some patterns emerging. Across all three groups, Safety is unambiguously the highest-weighted field, and the same three KPIs — Percentage Improvement in Safety Culture, SPI Rate, and (with minor variation) a compliance- or security-related improvement indicator — occupy the top positions. Likewise, the same KPI, the SRB Presentation Agenda Item Completion Rate, is consistently the lowest-weighted criterion across all three groups, and agenda-completion KPIs in general (Management Review, SAB, and SRB) are consistently ranked among the least influential criteria. This convergence suggests that the centrality of safety culture and safety performance monitoring, and the comparatively low strategic weight of administrative/meeting-completion metrics, are organizationally shared perceptions that hold regardless of hierarchical level.

The principal point of divergence concerns the relative ordering of Quality versus Security and Compliance at the field level. Directors and managers rank Quality as the second most important field (0.2505), ahead of Compliance and Security. By contrast, both the coordination and station chiefs group and the auditors and specialists group rank Security second (0.2505 and 0.2405, respectively) and place Quality last among the four fields (0.2036 and 0.2013, respectively). This pattern indicates that respondents with more direct, day-to-day accountability for airside operations and independent responsibilities assign relatively greater strategic weight to security and compliance-related oversight, while senior management retains a relatively stronger orientation toward quality as a differentiator of corporate performance — a pattern broadly consistent with prior findings that operationally proximate personnel tend to emphasize field-level risk and process indicators more heavily than strategic, customer or brand oriented indicators.

These findings collectively support the central premise of the proposed QSI framework: That while Safety, Quality, Compliance, and Security constitute distinct, non-fully-compensatory dimensions of ground handling performance whose relative importance is largely stable across organizational levels for the core safety dimension, it shifts somewhat in the secondary ordering of Quality, Compliance, and Security depending on respondents' operational vantage point. This reinforces the potential of a unified QSI, while underlying the difficulties in its construction.

While the sample size of experts is largest ever for such an evaluation, it is focused on a sector that spans the globe with ground services personnel from virtually all cultures on the planet. Since its foundational building block is to converge the personal judgments of people to a single score, further research based on personnel with different cultural backgrounds and different on-the-ground priorities, as well as different MCDMs to bring alternative methods of aggregation and harmonization to such diverse perspectives.

Acknowledgement
This research was not funded by any grant.

Conflicts of Interest
The authors declare no conflicts of interest.

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