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Developing a standardized framework for assessing quality sustainability in smart industrial product production chains using multi criteria decision making (MCDM) methods

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Abstract

The rapid advancement of Industry 4.0 technologies including the Internet of Things (IoT), cyber physical systems, big data analytics, and artificial intelligence has fundamentally reshaped industrial production and led to the emergence of smart industrial products with advanced sensing, connectivity, and autonomous decision making capabilities. While these products enhance efficiency, flexibility, and competitiveness, they also introduce significant challenges for maintaining consistent and sustainable quality across interconnected production chains.

This study develops a standardized and integrative framework for evaluating quality sustainability in smart industrial product production chains using Multi Criteria Decision Making (MCDM) methods. Two core components Sustainability Framework Indicators (SFI) and Multi Criteria Weighted Assessment (MWA) are examined to determine their effects on Quality Sustainability (QS) and Production Chain Performance (PCP). Data collected from 30 experts were analyzed through reliability assessment, convergent validity (AVE), and regression modeling.

The results demonstrate excellent reliability and convergent validity across all constructs. Regression findings confirm that both SFI and MWA exert significant positive effects on QS and PCP, indicating that the integration of standardized quality frameworks with structured MCDM techniques substantially improves quality sustainability and operational performance. The proposed framework offers a practical, systematic, and scientifically grounded approach for enhancing decision making, ensuring long term quality stability, and strengthening production chain performance in Industry 4.0 environments.

Keywords Quality Sustainability, Production Chain Performance, Smart Industrial Products, Multi Criteria Decision Making (MCDM), Analytic Hierarchy Process (AHP)

1. Introduction

Over the past decade, the rapid expansion of the Fourth Industrial Revolution (Industry 4.0) and the widespread adoption of enabling technologies such as the Internet of

Things (IoT), cyber physical systems, big data analytics, and artificial intelligence have fundamentally reshaped industrial production systems [6,13]. Within this technological paradigm, smart industrial products have emerged



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as a key outcome, offering enhanced productivity, flexibility, and competitiveness through capabilities such as self monitoring, real time environmental interaction, and data driven decision making [10]. Despite these advantages, the increasing technical and functional complexity of smart industrial products has introduced significant challenges for quality assessment and assurance, particularly across interconnected production chains. Quality in such products is no longer limited to conformity with final technical specifications; instead, it encompasses broader dimensions including design quality, process sustainability, reliability, maintainability, and lifecycle performance [4,5].

Consequently, the concept of quality sustainability has gained prominence as a comprehensive approach aimed at ensuring long term, stable, and adaptive quality performance in dynamic industrial environments. However, existing quality assessment practices in smart industrial production chains remain fragmented. The absence of an integrated and standardized framework leads to inconsistent criteria, non comparable evaluation results, and limitations in ranking, validation, and managerial decision making processes [3].

This gap is particularly critical for advanced industries that must comply with national and international standards, where structured and comparable quality assessment mechanisms are essential. Furthermore, evaluating quality sustainability in smart industrial products inherently represents a multi criteria decision making challenge. Technical, economic, operational, and environmental indicators must be considered simultaneously, and these criteria often conflict with one another. Multi Criteria Decision Making (MCDM) methods provide a systematic and scientific foundation for identifying, weighting, and prioritizing such indicators and have been widely applied in quality management, standardization, and industrial engineering [11,14].

A review of the existing literature reveals a clear research gap: although MCDM methods have been increasingly used in quality assessment, no comprehensive, standardized, and integrated framework specifically designed for evaluating quality sustainability across the entire production chain of smart industrial products currently exists. Prior studies typically focus on isolated indicators, rely on non standardized approaches, or limit their analysis to individual stages of the production process, leaving the full chain unassessed.

This study addresses this gap by developing a holistic and standardized framework that integrates MCDM techniques with practical applicability across all stages of the production chain. By combining expert judgment, structured weighting, and systematic ranking of indicators, the

proposed framework resolves the fragmentation observed in previous approaches and enhances decision making, comparability, and alignment with recognized standards. The study contributes theoretically by introducing a unified model for quality sustainability assessment and practically by offering actionable guidelines for managers and practitioners in smart industrial production environments.

To the best of our knowledge, this study introduces the first standardized, AHP based framework that simultaneously evaluates quality sustainability and production chain performance across all stages of smart industrial product manufacturing a gap not addressed in previous Industry 4.0 or MCDM studies. Accordingly, the objective of this research is to develop a standardized framework for evaluating quality sustainability in smart industrial product production chains using MCDM methods. Through a systematic and structured model, the study aims to support improved decision making, enhance comparability, and promote compliance with established standards while addressing the existing research gap.

Theoretical Background

1. Smart Industrial Products and Industry 4.0

Industry 4.0 represents the convergence of digital technologies, intelligent systems, and advanced manufacturing processes aimed at creating highly flexible, interconnected, and efficient production environments [6]. Within this paradigm, smart industrial products are distinguished by their ability to collect, process, and exchange data throughout their lifecycle, enabling real time monitoring, autonomous decision making, and continuous performance optimization [10].

Equipped with embedded sensors, software modules, and connectivity features, these products interact dynamically with production systems and end users, thereby enhancing operational transparency and adaptability. Their quality performance depends not only on physical characteristics but also on software reliability, data integrity, interoperability, and cybersecurity robustness [13]. Consequently, evaluating the quality of smart industrial products requires a holistic and system oriented approach that spans the entire production chain.

2. Quality and Quality Sustainability in Production Chains

Quality has traditionally been conceptualized as a multidimensional construct encompassing reliability, durability, performance, conformance, and serviceability [4]. In contemporary manufacturing environments, quality is increasingly viewed as the cumulative outcome of integrated activities across the production chain including design, procurement, manufacturing, distribution, and after

sales services rather than a final inspection result [5].

The concept of quality sustainability extends this perspective by emphasizing the ability of production systems to maintain stable and consistent quality performance over time while adapting to internal and external changes. This notion aligns with continuous improvement principles and risk based thinking embedded in modern quality management standards such as ISO 9001:2015 [3]. In the context of smart industrial products, quality sustainability further involves ensuring long term functionality, maintainability, system updates, and compatibility with evolving technological standards.

3. Standardization and Quality Assessment Frameworks

Standardization plays a fundamental role in establishing common criteria, measurement procedures, and evaluation mechanisms that ensure consistency, transparency, and comparability across industrial systems [5]. Standardized quality assessment frameworks support benchmarking, certification, and informed decision making at both organizational and industry levels.

However, the rapid evolution of smart technologies has outpaced existing quality standards, creating gaps in addressing software intensive, data driven, and highly interconnected product features [13]. As a result, there is a growing need for flexible and adaptive standardized frameworks capable of incorporating multiple quality dimensions and responding to continuous technological advancements. Such frameworks are particularly essential for evaluating quality sustainability in smart industrial production chains, where diverse stakeholders and interdependent processes must be aligned [3].

4. Multi Criteria Decision Making (MCDM) Methods

Multi Criteria Decision Making (MCDM) methods provide structured analytical tools for addressing complex decision problems involving multiple, often conflicting criteria. These methods enable decision makers to systematically evaluate alternatives by defining decision structures, assigning weights to criteria, and aggregating performance scores [11].

Techniques such as the Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), and other ranking and weighting approaches have been widely applied in quality management, supplier selection, performance evaluation, and standard development [14].

In the context of quality sustainability assessment, MCDM methods are particularly valuable because they integrate technical, economic, operational, and environmental indicators within a unified evaluation framework.

5. Integration of MCDM with Standardized Quality Sustainability Frameworks

Integrating MCDM methods into standardized quality assessment frameworks provides a robust and systematic approach for addressing the complexity of smart industrial products [11,14]. By combining standardization principles with multi criteria analysis, it becomes possible to develop transparent, repeatable, and scalable evaluation models that support objective decision making and continuous improvement [5].

Research Background

In recent years, scholarly attention has increasingly focused on evaluating quality sustainability within smart manufacturing environments and digitally integrated production chains. Studies published in 2025 highlight that the expansion of Industry 4.0 technologies has rendered traditional quality evaluation approaches insufficient, emphasizing the need for multidimensional and standardized assessment frameworks. In this context, Bayatzadeh and Heidari Rastami investigated the influence of digital technologies on supply chain performance and quality using Multi Criteria Decision Making (MCDM) methods [1]. Their findings demonstrated that quality, technology, and sustainability indicators are strongly interrelated and collectively shape production chain efficiency, underscoring the importance of structured analytical tools in smart manufacturing environments.

Similarly, Pishdar et al. examined the transition toward smart sustainability in pharmaceutical supply chains within the Industry 4.0 paradigm [9]. Their results revealed that the absence of standardized criteria for evaluating quality and sustainability represents a major barrier to achieving smart and sustainable production systems. This suggests that standardized quality assessment frameworks are essential not only in heavy industries but also in sensitive, knowledge based sectors.

In another study, Mahmoudieh, Moshayekhi, and Haleh applied the Best Worst Method (BWM) to prioritize sustainable development components in supply chains [8]. They concluded that quality sustainability is a critical determinant of long term production chain performance.

Their work reinforces the connection between MCDM methods and sustainability assessment and provides a foundation for extending such approaches to smart industrial products. At the international level, research published in 2024 has increasingly focused on integrating MCDM methods with sustainability objectives and standardization efforts. Sahoo's comprehensive review demonstrated that MCDM techniques have been widely used to evaluate quality, sustainability, and standards compliance in smart supply chains [12]. However, the

review also emphasized that these methods are often applied in a fragmented manner, lacking conceptual coherence and integration within standardized frameworks.

Continuing this trend, Khulud et al. conducted a bibliometric analysis of MCDM applications in sustainable supplier selection [7]. Their findings indicated a shift in research focus from purely economic efficiency toward quality sustainability and production chain performance. This highlights the growing importance of MCDM in integrating quality, sustainability, and standardization criteria within complex industrial systems.

Farahani et al. further examined smart manufacturing systems with an emphasis on data analytics and pattern recognition for improving quality and decision making across production chains [2]. Their results showed that without standardized quality assessment frameworks, smart manufacturing data cannot be effectively leveraged to achieve sustainable quality improvement. This establishes a direct link between manufacturing intelligence and the necessity of quality standardization.

Earlier studies from 2020 to 2022 primarily explored the implementation of Industry 4.0 concepts and the associated quality challenges in complex production chains [13]. These studies demonstrated that while increased intelligence in products and processes enhances productivity, it simultaneously increases the complexity of quality evaluation, highlighting the need for multi criteria methods and systematic frameworks. Collectively, these contributions form the theoretical foundation for developing standardized and sustainability oriented quality assessment models.

Theoretical Framework

The emergence of Industry 4.0 has transformed traditional production chains into smart, flexible, and interconnected systems through the integration of cyber physical systems, the Internet of Things (IoT), big data analytics, and artificial intelligence [6,13]. These technological advancements have significantly increased the complexity of both products and production processes, making conventional quality assessment approaches inadequate. As a result, there is a growing need for standardized frameworks capable of systematically and integratively evaluating the quality of smart industrial products across the entire production chain [1,2].

Parallel to these technological developments, the concept of quality sustainability has become a central principle in modern manufacturing. Unlike traditional quality management, which focuses primarily on conformity to specifications, quality sustainability emphasizes long term performance, reliability, maintainability, standards compliance, lifecycle effectiveness, and customer satisfac-

tion [4,5,12].

In smart production environments, sustaining quality over time is not only a technical requirement but also a strategic determinant of production chain performance, influencing productivity, flexibility, error reduction, and coordination among interconnected production stages [7,8].

Given the multiplicity and diversity of quality and performance indicators, Multi Criteria Decision Making (MCDM) methods particularly the Analytic Hierarchy Process (AHP) provide a structured and rigorous approach for weighting, ranking, and aggregating these indicators [11,14].

MCDM enables decision makers to objectively prioritize criteria, resolve conflicts among indicators, and enhance the transparency and reliability of the evaluation framework. In this context, MCDM serves both as a methodological tool and as a conceptual bridge linking standardized frameworks to measurable improvements in quality sustainability and production chain performance.

Integrating these concepts, the theoretical framework of this study posits that the development of a standardized framework supported by MCDM methods directly enhances quality sustainability in smart industrial production chains. Improved quality sustainability subsequently leads to higher production chain performance, as reliable, well maintained, and standardized processes contribute to increased efficiency, reduced errors, and stronger alignment across production stages. Furthermore, the systematic selection, weighting, and prioritization of indicators through MCDM reinforce the robustness, applicability, and credibility of the proposed framework in real industrial contexts.

In summary, the theoretical framework establishes a cohesive and interconnected structure in which Industry 4.0 technologies create the need for advanced quality assessment; quality sustainability represents the primary objective; production chain performance constitutes the practical outcome; and MCDM methods function as the analytical mechanism for operationalizing the standardized framework. This integrated approach not only addresses existing theoretical gaps in quality and sustainability management but also provides a practical roadmap for improving industrial production systems in the smart manufacturing era.

Main Hypothesis:

Hypothesis1 (H1): The application of Sustainability Framework Indicators (SFI) and Multi Criteria Weighted Assessment (MWA) has a positive and significant effect on Quality Sustainability (QS) in smart industrial product production chains.

Hypothesis2 (H2): The application of Sustainability Framework Indicators (SFI) and Multi Criteria Weighted Assessment (MWA) has a positive and significant effect on Production Chain Performance (PCP) in smart industrial product production chains.

Regression Equations of the Study

Model 1: Effect of Standardized Framework on Quality Sustainability

$$QS_i = \beta_0 + \beta_1 SFI_i + \beta_2 MWA_i + \varepsilon_i$$

Where:

- **QS** = Quality Sustainability (Dependent Variable)
- **SFI** = Sustainability Framework Indicators (Independent Variable)
- **MWA** = Multi Criteria Weighted Assessment (Independent Variable)
- **β_1, β_2** = Regression coefficients representing the effects of SFI and MWA on QS
- **ε_i** = Error term

Model 2: Effect of Multiple Criteria on Production Chain Performance

$$PCP_i = \beta_0 + \beta_1 SFI_i + \beta_2 MWA_i + \varepsilon_i$$

Where:

- **PCP** = Production Chain Performance (Dependent Variable)
- **SFI** = Sustainability Framework Indicators (Independent Variable)
- **MWA** = Multi Criteria Weighted Assessment (Independent Variable)
- **β_1, β_2** = Regression coefficients representing the effects of SFI and MWA on PCP
- **ε_i** = Error term

Research Methodology

Research Design

This study employs a mixed methods research design to develop a standardized framework for assessing quality sustainability in smart industrial product production chains. The design integrates a qualitative phase for identifying relevant indicators and a quantitative phase for weighting, ranking, and validating these indicators.

In the qualitative phase, key criteria, indicators, and guidelines were extracted through an extensive literature review and semi structured interviews with experts in smart manufacturing and quality management. In the quantitative phase, the identified indicators were evaluated using Multi Criteria Decision Making (MCDM) methods, specifically the Analytic Hierarchy Process (AHP) [1,2].

Pairwise comparison matrices were constructed, weights were calculated using the eigenvector method, and consistency ratios were examined to ensure the reliability of expert judgments. This integration of expert knowledge with structured analytical techniques ensures that the resulting framework is both scientifically robust and practically applicable across smart industrial production environments.

Population and Sampling

The research population consists of experts, managers, and engineers involved in the design, manufacturing, and quality management of smart industrial products within leading Iranian and international manufacturing companies. A purposive sampling strategy was adopted to select participants with substantial experience in Industry 4.0 technologies, supply chain sustainability, and quality assurance.

A sample size of 30 to 50 experts was targeted, which is considered adequate for conducting pairwise comparisons in AHP and for validating the proposed framework through expert consensus [11,12]. This sample size aligns with established recommendations for MCDM studies requiring structured expert judgment.

Data Collection

Literature Review: Relevant criteria, indicators, and existing quality sustainability frameworks were collected from academic journals, ISO standards, and industrial reports.

Expert Interviews/Questionnaires: Structured questionnaires were designed to refine the indicators and obtain pairwise comparisons for AHP. Experts evaluated the relative importance of criteria using the 1–9 Saaty scale.

Industrial Case Studies: The proposed framework was applied to selected smart industrial production lines to assess its practical relevance, feasibility, and adaptability.

Analytical Procedure Using AHP

To operationalize the Multi Criteria Decision Making (MCDM) component of the study, the Analytic Hierarchy Process (AHP) was fully implemented following Saaty's standard procedure. The evaluation framework was structured into a three level hierarchy consisting of the main goal, primary criteria, and sub criteria derived from expert interviews and literature review.

Hierarchical Structure

Level1 Goal: Assessment of Quality Sustainability in Smart Industrial Product Production Chains

Level2 Main Criteria: Design Quality, Process Sustainability, Maintainability, Standards Compliance, Lifecycle Performance

Table 1. Pairwise Comparison Matrix

Criteria	C1	C2	C3	C4	C5
C1	1	3	5	4	6
C2	1/3	1	2	3	4
C3	1/5	1/2	1	2	3
C4	1/4	1/3	1/2	1	2
C5	1/6	1/4	1/3	1/2	1

Level 3 Sub Criteria: Specific indicators under each criterion validated through expert consensus

Pairwise Comparison Matrices

Pairwise comparison matrices were constructed using the 1–9 Saaty scale. Experts compared each criterion relative to others based on its importance in achieving quality sustainability.

Weight Calculation

Weights were computed using the principal eigenvector of each matrix:

$$w = \frac{\lambda_{\max} - n}{(n - 1) \cdot RI}$$

A consistency ratio of $CR < 0.10$ was required to validate expert judgments.

Final Weights and Ranking

A consolidated weight table was produced by aggregating normalized eigenvectors across all matrices:

These weights were subsequently used in the regression models.

Data Analysis

Step 1: Key quality sustainability indicators were identified through literature review and expert feedback.

Step 2: Indicators were weighted and ranked using AHP. Pairwise comparison matrices were constructed, eigenvectors were calculated, and consistency ratios ($CR < 0.10$) were verified.

Step 3: The weighted indicators were aggregated to construct the final standardized framework for quality sustainability assessment.

Step 4: The framework was validated through expert consensus and case study application to ensure reliability, consistency, and practical applicability [1,8,11].

How to measure research variables

1. Standardized Framework for Quality Sustainability Assessment (SFI)

Operational Definition: A structured set of indicators, criteria, and guidelines enabling integrated and standardized evaluation of quality sustainability across the entire production chain of smart industrial products [1,2].

Measurement Method: Indicators were weighted using AHP, validated through expert opinions, and tested in selected industrial environments to ensure applicability [1,3].

2. Quality Sustainability (QS)

Operational Definition: The ability of a product or production chain to maintain a specified level of quality over time under internal and external variations [4,5].

Measurement Method: Indicators such as reliability, maintainability, standards compliance, lifecycle performance, and customer satisfaction were evaluated and ranked using AHP and expert judgment [12,2].

3. Production Chain Performance (PCP)

Operational Definition: Production Chain Performance refers to the effectiveness and efficiency of the entire production chain of smart industrial products in achieving quality, economic, and operational objectives. It reflects the capability of interconnected production stages to operate cohesively and deliver consistent, high quality outputs under Industry 4.0 conditions [7,8].

Measurement Method: PCP is assessed using a set of measurable performance indicators, including productivity, lead time, error rate, flexibility, and coordination among production stages. These indicators are evaluated through Multi Criteria Decision Making (MCDM) tools specifically AHP and supplemented by production data analysis obtained from industrial case studies [7,2]. The weighted scores derived from AHP are aggregated to form the overall PCP index.

4. Multi Criteria Decision Making (MCDM) Methods

Operational Definition: MCDM refers to a family of analytical and structured decision making techniques that support the evaluation and ranking of alternatives based on multiple, and often conflicting, criteria. These methods enable systematic prioritization and transparent decision

Table 2. Final Criterion Weights and Ranking Obtained from AHP Analysis

Criterion	Weight	Rank
Design Quality	0.312	1
Process Sustainability	0.241	2
Maintainability	0.198	3
Standards Compliance	0.147	4
Lifecycle Performance	0.102	5

processes in complex industrial environments [11,14].

Measurement Method: The Analytic Hierarchy Process (AHP) is employed as the primary MCDM technique in this study. AHP is used to determine the relative weights of indicators through pairwise comparisons, rank alternatives based on weighted criteria, and aggregate results within the standardized quality sustainability framework. Consistency ratios (CR) are calculated to ensure the reliability of expert judgments and the validity of the weighting process [11,1].

Research findings

Reliability Analysis (Item Total Statistics)

The reliability results indicate exceptionally strong internal consistency across all measurement constructs. Corrected item total correlation values exceed 0.93, demonstrating a high degree of alignment between each item and the overall construct. Among the items, SFI shows the highest correlation (0.986), reflecting its strong contribution to the measurement structure. Although MWA has the lowest correlation (0.932), it remains well above accepted thresholds. Cronbach's alpha values remain above 0.96 even when items are deleted, confirming that no item negatively affects the reliability of the instrument. These results collectively demonstrate that the measurement tool is conceptually coherent, statistically robust, and fully ap-

propriate for subsequent analyses.

Convergent Validity (Average Variance Extracted AVE)

All AVE values exceed 0.50, confirming excellent convergent validity. Values above 0.90 indicate that the majority of variance in each construct is explained by its principal components. These results validate the conceptual coherence of QS, PCP, SFI, and MWA and support their use in regression and structural modeling.

Regression Analysis Model 1 (Dependent Variable: QS)

Model 1 demonstrates a very strong explanatory power, with an F value of 576.635, indicating that SFI and MWA significantly predict Quality Sustainability (QS). The significance level (< 0.001) confirms the statistical validity of the model. The regression sum of squares (68.268) far exceeds the residual sum of squares (1.598), showing that most of the variance in QS is explained by the independent variables.

Regression Analysis Model 2 (Dependent Variable: PCP)

Model 2 also shows strong predictive capability, with an F value of 286.207, confirming that SFI and MWA signifi-

Table 3. Item Total Statistics for Reliability Analysis

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item Total Correlation	Cronbach's Alpha if Item Deleted
QS (1–10)	13.83	11.247	0.983	0.973
PCP (1–10)	14.30	13.321	0.960	0.967
SFI (1–5)	17.40	14.386	0.986	0.965
MWA (1–5)	17.17	15.178	0.932	0.980

Table 4. AVE Results

Variable	Initial	Extraction
Unit	1.000	1.000
QS (1–10)	1.000	0.982
PCP (1–10)	1.000	0.985
SFI (1–5)	1.000	0.992
MWA (1–5)	1.000	0.997

cantly influence Production Chain Performance (PCP). The regression sum of squares accounts for the majority of total variance, and the low residual error (2.126) indicates high model accuracy. These results validate the positive and significant role of standardized frameworks and weighted assessments in improving production chain performance.

Conclusion

The results of this study confirm that the measurement scales developed for assessing Quality Sustainability (QS) and Production Chain Performance (PCP) in smart industrial product production chains are both statistically reliable and conceptually valid. The reliability analysis demonstrated exceptionally high corrected item total correlations (above 0.93) and Cronbach's alpha values exceeding 0.96, indicating strong internal consistency across all constructs. These findings show that each item contributes meaningfully to the overall measurement structure, and no item requires removal or modification.

Convergent validity was further supported by the AVE results, with all extraction values surpassing 0.90. This indicates that a substantial proportion of variance in QS, PCP, Sustainability Framework Indicators (SFI), and Multi Criteria Weighted Assessment (MWA) is captured by their principal components. The high AVE values confirm that the constructs are theoretically coherent and suitable for use in regression and structural modeling.

Regression analyses revealed that both SFI and MWA exert significant positive effects on QS and PCP. In Model 1, the extremely high F value ($F = 576.635$, $p < 0.001$) and the dominance of regression variance over residual variance demonstrate that SFI and MWA strongly predict Quality Sustainability. Similarly, Model 2 showed that SFI and MWA significantly influence Production Chain Performance ($F = 286.207$, $p < 0.001$), with most of the total variance explained by the regression model and minimal residual error. These results empirically val-

idate the study's hypotheses and highlight the critical role of standardized frameworks and weighted assessments in enhancing both quality sustainability and operational performance.

Overall, this study demonstrates that integrating standardized quality frameworks with multi criteria decision making tools provides a systematic, reliable, and effective approach for improving decision making, ensuring consistent quality, and strengthening production chain performance in Industry 4.0 environments. By linking reliability, validity, and regression outcomes, the research confirms that SFI and MWA serve as robust mechanisms for achieving sustainable quality and optimized production performance. These findings offer practical guidance for managers seeking to enhance quality sustainability and provide a foundation for future research aimed at expanding standardized evaluation models across diverse smart manufacturing contexts.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Received: Dec. 2025 Accepted: Aug. 2026

Published online: Aug. 2026

DOI: 10.22034/ASAS.2026.568066.1093

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