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Optimization and Improvisation of operational processes in Quality Assurance using House of Quality (HoQ)

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ABSTRACT

Purpose: This study aims to optimize and improvise software quality assurance operational processes using the House of Quality (HoQ) framework by translating stakeholder requirements into prioritized technical and operational actions.

Design/Methodology/Approach: The study adopts a case-study-based and analytical approach by integrating Voice of Customer (VoC) inputs, Quality Function Deployment (QFD), House of Quality matrices, Pareto analysis, and scatter diagrams to identify critical process parameters and prioritize improvement initiatives in software testing environments.

Findings: The results indicate that risk-based regression testing, automation framework enhancement, and parallel execution are the most influential factors in improving test efficiency, reducing regression cycle time, enabling early defect detection, and enhancing software quality and customer satisfaction.

Originality/Value: This study extends the application of the House of Quality (HoQ) beyond traditional manufacturing contexts to real-time software quality assurance processes. It proposes a customer-centric framework for prioritising quality assurance improvement initiatives and integrates multiple quality management tools with HoQ to support data-driven decision-making. The study also demonstrates the practical applicability of HoQ through a case study from the software industry, thereby addressing a notable research gap in the application of quality function deployment techniques within software engineering.

Paper Type: View Point

KEYWORDS: House of Quality (HoQ) | Quality Function Deployment (QFD) | Software Quality Assurance | Process Optimization | Operational Improvement

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Introduction

In the contemporary business environment, organizations are increasingly challenged to deliver superior quality while maintaining operational efficiency, sustainability, and customer satisfaction. The growing complexity of markets, rapid technological advancements, and rising customer expectations require organizations to adopt systematic quality management approaches that align operational processes with customer requirements (Beheshtinia et al., 2023; Carvalho et al., 2021). Traditional quality improvement methods primarily emphasize internal operational efficiency; however, they often fail to effectively integrate the voice of the customer into decision-making processes, leading to service gaps, inefficient resource utilization, and reduced organizational competitiveness (Mamaghani & Barzin, 2019; Negara & Junita, 2025).

To overcome these limitations, organizations have increasingly adopted Quality Function Deployment (QFD) as a customer-oriented quality management methodology that systematically translates customer needs into technical and operational specifications (Akao, 1990). At the core of QFD is the House of Quality (HoQ), which provides a structured framework for identifying customer requirements, establishing relationships with technical characteristics, and prioritizing improvement initiatives (Hauser & Clausing, 1988). By integrating the Voice of Customer (VoC) into product and process development, HoQ enables organizations to improve decision-making, optimize resource allocation, and develop solutions that simultaneously satisfy customer expectations and organizational objectives (Alatas et al., 2025; Suryaningrat, 2016).

The application of HoQ has expanded considerably beyond traditional product design and manufacturing into diverse sectors such as retail services, education, banking, supply chain management, sustainable packaging, and construction. Previous studies have demonstrated that HoQ effectively improves product quality, enhances service performance, strengthens customer satisfaction, and supports sustainable operational improvements by systematically prioritizing technical responses based on customer requirements (Alatas et al., 2025; Mamaghani & Barzin, 2019; Negara & Junita, 2025). Furthermore, integrating HoQ with complementary approaches such as SERVQUAL, Fuzzy Analytic Hierarchy Process (Fuzzy-AHP), and Lean methodologies has enhanced its capability to address multi-criteria decision-making problems, manage uncertainty, and support strategic quality planning across different organizational contexts (Badreddine et al., 2022; Beheshtinia et al., 2023).

Recent developments associated with Industry 4.0 have further strengthened the relevance of HoQ by enabling organizations to integrate digital technologies such as artificial intelligence, big data analytics, cloud computing, and the Internet of Things into quality management systems. These technologies facilitate real-time monitoring of customer requirements, predictive quality analysis, and continuous process improvement, transforming conventional quality management into the broader concept of Quality 4.0 (Carvalho et al., 2021). Consequently, HoQ is increasingly viewed not only as a product development tool but also as a strategic framework for supporting digital transformation, cross-functional collaboration, and sustainable organizational performance (Beheshtinia et al., 2023).

Despite the extensive application of HoQ and QFD across multiple industries, existing research has primarily focused on product design optimization, customer satisfaction assessment, or sector-specific quality improvement initiatives. Comparatively fewer studies have comprehensively examined HoQ as an integrated framework for simultaneously improving operational performance, cross-functional coordination, customer-centric decision-making, and process sustainability. Therefore, this study seeks to address this gap by exploring the application of the House of Quality as a strategic quality management tool for translating customer requirements into prioritized operational improvements, thereby enhancing organizational effectiveness, service quality, and long-term sustainability.

This paper focuses on the optimization and improvisation of operational processes using the House of Quality framework. It explores how HoQ can be effectively utilized to enhance process performance, reduce inefficiencies, and ensure that operational outputs are closely aligned with customer expectations. By integrating customer-centric thinking with structured analytical techniques, the study aims to contribute to the development of more responsive, efficient, and quality-oriented operational strategies.

Figure 1: House of Quality

Literature review

Feri and Noormayasari (2026) examined Quality Function Deployment (QFD) as a cross-functional management approach for service organizations to improve operational performance and process sustainability. The authors found that QFD enhanced interdepartmental coordination, reduced service response time, increased customer satisfaction, and minimized operational errors. Finally, they concluded that integrating customer requirements into organizational processes through the House of Quality framework supports sustainable service delivery while effectively managing operational complexity.

Alatas et al. (2025) applied the Quality Function Deployment (QFD) method to develop an eco-friendly cup holder design that replaces plastic bags by translating customer requirements into technical specifications through the House of Quality (HoQ). The authors evaluated customer preferences using the Voice of Customer (VoC), HoQ, and the Pugh Matrix to identify the most suitable design concept. Finally, Alatas et al. (2025) concluded that QFD effectively supports sustainable product development by improving packaging functionality, customer satisfaction, brand identity, and environmental responsibility.

Negara and Junita (2025) investigated the application of Quality Function Deployment (QFD)integrated with the House of Quality (HoQ) and SERVQUAL to optimize service quality in a retail store. The authors identified gaps between customer expectations and perceived service quality, prioritized improvement areas, and translated them into technical service requirements. Finally, Negara and Junita (2025) concluded that integrating SERVQUAL with QFD enables organizations to formulate targeted service improvement strategies that enhance customer satisfaction, loyalty, and competitive advantage.

Mamaghani and Barzin (2019) employed Quality Function Deployment (QFD) to improve the design quality of school furniture by translating students' needs into technical design specifications through the House of Quality (HoQ). The authors evaluated functional, ergonomic, material, structural, and aesthetic requirements using surveys, questionnaires, and interviews to identify critical design improvements. Finally, Mamaghani and Barzin (2019) concluded that QFD provides an effective customer-oriented design framework that enhances product quality, ergonomics, and user satisfaction.

Beheshtinia et al. (2023) proposed a Fuzzy Three-Dimensional House of Quality (3D-HOQ) model to integrate and coordinate organizational activities across marketing and human resource departments. The authors combined QFD, SERVQUAL, and fuzzy theory to identify customer and employee requirements, prioritize technical actions, and improve organizational coordination. Finally, Beheshtinia et al. (2023) concluded that the proposed 3D-HOQ framework enhances cross-functional collaboration, reduces operational inconsistencies, and improves service quality through integrated decision-making.

Badreddine et al. (2022)developed an integrated Fuzzy-AHP and House of Quality (HoQ) framework to evaluate and prioritize Lean Construction Concepts for offsite construction projects. The authors employed fuzzy multi-criteria decision-making to assess lean practices based on organizational objectives and customer requirements while minimizing subjective judgments. Finally, Badreddine et al. (2022) concluded that integrating Fuzzy-AHP with HoQ provides a reliable decision-support approach for selecting lean concepts that improve operational efficiency and project performance.

Carvalho et al. (2021)reviewed the evolution of Quality 4.0 by examining the integration of traditional quality management practices with Industry 4.0 technologies. The authors analyzed how digital technologies such as the Internet of Things, Big Data, Cloud Computing, and artificial intelligence enhance quality management through real-time monitoring and data-driven decision-making. Finally, Carvalho et al. (2021) concluded that Quality 4.0 enables organizations to improve operational efficiency, product quality, and continuous quality management in digitally transformed environments.

Suryaningrat (2016)implemented Quality Function Deployment (QFD) to identify consumer expectations and develop a sustainable food supply chain for processed cassava products in Indonesia. The author translated customer requirements into technical responses using the House of Quality (HoQ) and integrated them with key supply chain activities to improve product quality. Finally, Suryaningrat (2016) concluded that QFD effectively aligns consumer expectations with production and supply chain processes, thereby supporting continuous product improvement and sustainable supply chain management.

Quality Function Deployment (QFD)

Quality Function Deployment is a customer-focused methodology that translates customer needs into technical and operational specifications. QFD ensures that customer expectations are considered throughout the process improvement cycle. It improves communication across departments, reduces rework, and supports data-driven decision-making. The first and most critical phase of QFD is the development of the House of Quality.

House of Quality (HoQ)

The House of Quality is a matrix-based tool that connects customer requirements (WHATs) with technical or operational responses (HOWs). It includes importance ratings, relationship matrices, and correlation analyses. HoQ enables organizations to identify key operational drivers and prioritize actions that provide the highest value while considering trade-offs among process parameters.

Proposed HoQ Methodology

Initially, the customer requirements were identified and prioritized. Based on the customer requirements, technical or operational parameters are mapped with the customer requirements using HoQ matrix. Upon analysis of the requirements, technical calculations were made and priority rates were defined to focus on the improvements in the operational processes.

b. Reduced Regression Cycle Time

- Regression testing should be completed within the sprint timeline.
- Shorter regression cycles allow faster deployment of dental application updates.

c. High Test Coverage of Critical Dental Workflows

- Core workflows such as patient registration, appointment scheduling, billing, and clinical records must be thoroughly tested.
- Missing coverage may lead to operational and compliance risks.

d. Minimal Manual Testing Effort

- Repetitive manual testing should be minimized.

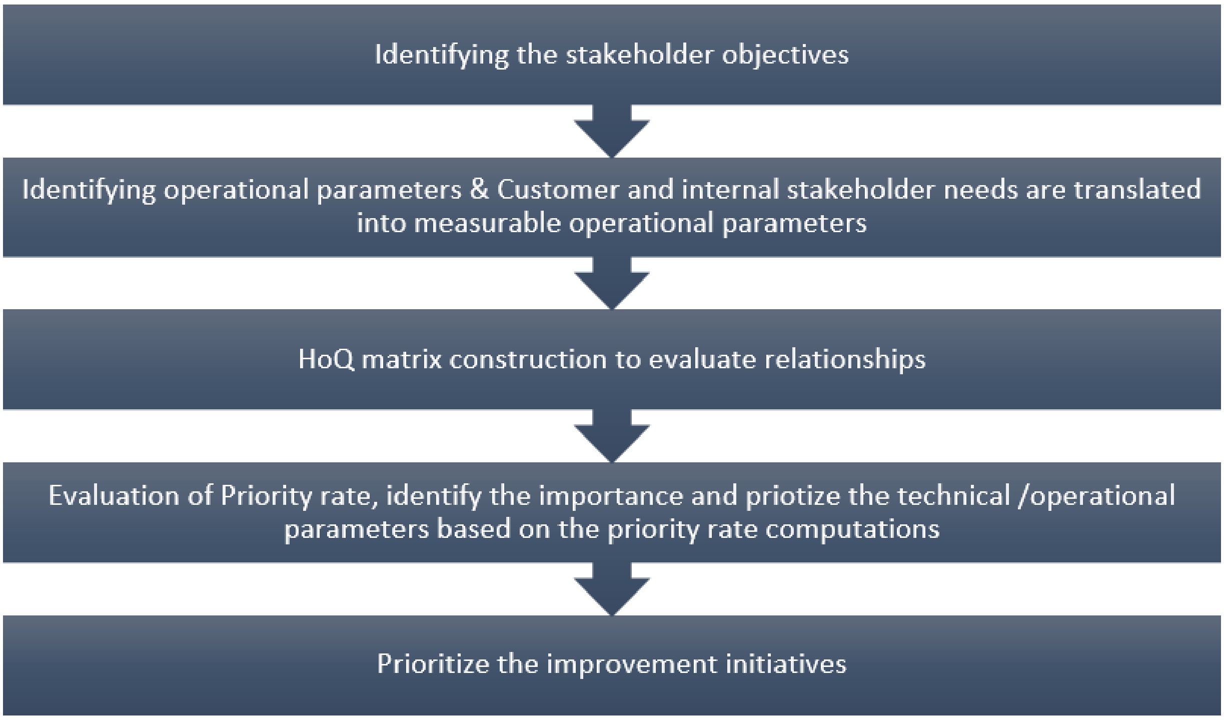

Figure 2. Proposed House of Quality (HoQ) Methodology

Customer / Stakeholder Requirements (WHATs) for HoQ

(Perspective: dentists, clinic staff, QA team, product owners)

a. Faster Test Case Execution

- Test cases should execute quickly to support frequent releases.
- Long execution times delay sprint completion and feedback cycles.
- Automation is expected to reduce human dependency and testing fatigue.
- **Early Detection of Defects**
- Defects should be identified early in the sprint to avoid late-stage fixes.
- Early detection improves software reliability and reduces rework.

f. **Stability of Test Scripts**

- Automated test scripts should be reliable and not fail due to minor UI or data changes.
- Stable scripts reduce maintenance effort and false failures.

g. **Easy Test Case Maintenance**

- Test cases should be easy to update when dental workflows or UI changes occur.
- High maintenance overhead slows down sprint progress.

h. **Accurate Test Reporting and Traceability**

- Test results should be clearly reported with traceability to requirements and user stories.
- Stakeholders should quickly understand test status and risks.

i. **Compliance and Data Security Validation**

- Testing must ensure compliance with healthcare data standards (e.g., patient data privacy).
- Security-related test cases must not be skipped during regression cycles.

j. **Seamless Integration with Sprint Activities**

- Testing activities should align smoothly with sprint planning and CI/CD pipelines.
- Delays in testing should not block sprint goals or releases.

Customer Requirements (WHATs) vs Technical Parameters (HOWs)

WHATs (Customer / Stakeholder Requirements)

Table 1. Customer / Stakeholder Requirements (WHATs)

WHATs (Customer / Stakeholder Requirements)		
ID	**Customer Requirements (WHATs)**	**Importance**
W1	Faster test case execution	5
W2	Reduced regression cycle time by focusing on major changes for that sprint/release	5
W3	Focus on impacted modules/areas of sprint/release	4
W4	Reduced manual testing effort by automation	4
W5	Early detection of defects	5
W6	Stable and maintainable test scripts	3
W7	Clear documentation, reporting and traceability	5

HOWs (Technical / Operational Parameters)

Table 2. Technical / Operational Parameters (HOWs)

HOWs (Technical / Operational Parameters)	
ID	**Technical Parameters (HOWs)**
H1	Test automation framework enhancement
H2	Parallel test execution
H3	Risk-based regression test selection
H4	CI/CD pipeline integration
H5	Test data management and mocking
H6	Modular and reusable test script design
H7	Centralized test reporting and dashboards

House of Quality (HoQ) Matrix

Relationship scale used:

- **9= Strong relationship**
- **3 = Moderate relationship**
- **1 = Weak relationship**
- **0 = No relationship**

Table 3. House of Quality (HoQ) Relationship Matrix

HoQ Relationship Matrix							
WHATs/HOWs	H1	H2	H3	H4	H5	H6	H7
W1	9	9	3	3	1	1	0
W2	9	9	9	3	1	1	0
W3	3	1	9	1	3	3	1
W4	9	3	3	3	1	3	0
W5	3	1	9	9	3	1	1
W6	3	1	1	1	3	9	0
W7	1	0	1	3	0	1	9

Technical Priority Calculation

Table 4. Technical Priority Calculation

Technical priority calculation		
Priority score=∑(Importance×Relationship)		
HOWs	Priority score	Priority rate
H1	130	Very High
H2	160	Very High
H3	84	High
H4	88	High
H5	135	Very High
H6	45	Low
H7	75	Medium

Tools used

i. ISHIKAWA OR FISHBONE DIAGRAM

The fishbone (Ishikawa) diagram presented illustrates the key factors influencing the **quality of test case development** in software engineering. It organizes these influencing elements into a structured cause-and-effect framework, where the central effect is the outcome of interest, and the contributing causes are grouped into major categories.

The first contributing factor is **skilled employees**, which represents the capability and expertise of the testing personnel. Competent professionals play a crucial role in accurately interpreting requirements, designing effective test cases, and identifying potential defects. Their knowledge and experience directly enhance the reliability and coverage of the testing process.

The second factor, **proper test data**, emphasizes the importance of using accurate, relevant, and well-structured datasets during testing. High-quality test data enables realistic execution scenarios, improves validation accuracy, and increases the likelihood of detecting functional and non-functional defects.

The third factor, **complete requirements analysis**, highlights the necessity of a clear and comprehensive understanding of system requirements before test case design. Incomplete or ambiguous requirements can lead to insufficient test coverage, resulting in missed defects and reduced software quality.

The fourth factor, **environment standardization**, refers to maintaining a consistent and controlled testing environment. A standardized environment ensures repeatability of test results, reduces inconsistencies caused by configuration differences, and enhances the reliability of testing outcomes.

The fifth factor, **smooth process**, represents the efficiency and structure of the test case development workflow. A well-defined process ensures proper coordination among stakeholders, reduces delays, and promotes systematic execution of testing activities.

Overall, the diagram demonstrates that the quality of test case development is not dependent on a single factor but is the result of multiple interrelated elements. By addressing these contributing factors collectively, organizations can significantly improve testing effectiveness, reduce defects, and enhance overall software quality.

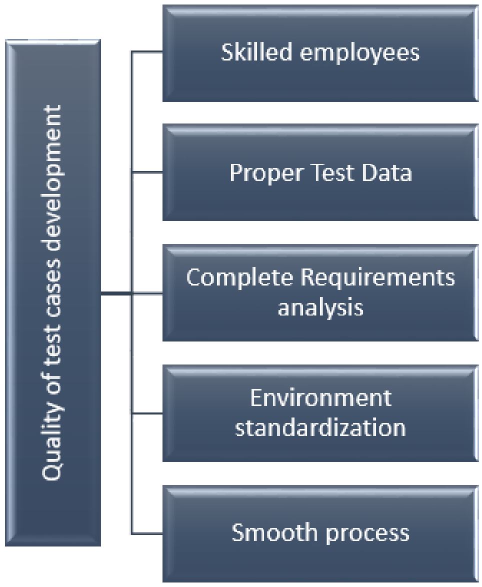

Figure 3 Fishbone Diagram for Quality of Test Case Development

ii. PARETO ANALYSIS

Here's a **realistic industry-style sample dataset** for defect reporting and how **Pareto Analysis (80/20 rule)** helps to identify major impact areas and strategies to reduce its occurrence.

Table 5. Pareto Analysis Dataset for Defect Reporting

S. No	Defect type	Frequency(Number of defects reported)	Cumulative frequency
1	Functional issues	318	318
2	User Interface Issues	212	530
3	Issues related to Integration	161	691
4	Performance issues in application	129	820
5	Security issues	80	900
6	Compatibility related defects	61	961
7	Documentation issues	39	1000

Major defect categories that should be concentrated are

1. Functional related issues
2. User interface issues

Strategies for Quality Assurance Engineers based on Pareto Analysis

1. Focus improvement on requirements clarifications to reduce functional defects
2. Review UI design for reducing UI related defects

iii. SCATTER DIAGRAM

Relationship between Test Coverage and Production Defects

Data represents 12 consecutive software releases of a web-based enterprise application.

- **Independent Variable (X):** Test Coverage (%)
- **Dependent Variable (Y):** Production Defects (post-release defects reported within 30 days)

Table 6. Test Coverage versus Production Defects Dataset

Release	Test Coverage (%)	Production Defects
R1	55	48
R2	60	42
R3	62	39
R4	68	34
R5	70	30
R6	72	28
R7	75	24
R8	78	20
R9	80	18
R10	85	14
R11	88	10
R12	92	7

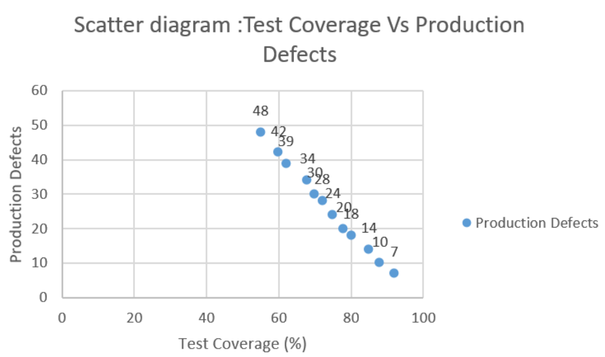

Figure 4. Scatter Diagram: Test Coverage vs Production Defects

Scatter Diagram Interpretation

The scatter plot demonstrates a **strong negative correlation** between test coverage and production defects.

Key Observations:

1. As test coverage increases, production defects consistently decrease.
2. Releases below 65% coverage show significantly higher defect leakage.
3. Beyond ~80% coverage, defect reduction stabilizes but continues to decline gradually.
4. The relationship appears approximately linear and inversely proportional.

Statistical Insights

1. Correlation Type: **Negative**
2. Practical Implication: Higher test coverage reduces defect leakage.
3. Quality Strategy Insight: Investing in improved coverage (automation + requirement traceability) significantly improves production stability.
4. Case study: Application of House of Quality in Software Quality Assurance at ABC Company

This case study explores the implementation of the House of Quality (HoQ) within the software development and Quality Assurance (QA) processes at ABC Company, a global leader in IT services. The objective was to enhance software product quality by systematically aligning customer expectations with technical and testing requirements in an Agile development environment.

Customer Requirements were identified through client feedback, user stories, and service-level agreements, focusing on attributes such as system reliability, performance, usability, security, and defect-free delivery. These were translated into technical requirements, including test coverage, automation levels, defect detection efficiency, response time benchmarks, and compliance standards. The HoQ matrix was used to map Customer Requirements to technical requirements, enabling prioritization based on their impact on customer satisfaction.

To strengthen the process, the organization integrated QA tools and information systems such as test management platforms and continuous integration pipelines, ensuring real-time tracking of quality metrics. Cross-functional collaboration between developers, testers, and business analysts was enhanced through structured communication enabled by HoQ. Additionally, weighted scoring and decision models were applied to optimize testing strategies and resource allocation.

The implementation resulted in improved defect prevention, higher test efficiency, reduced release cycles, and increased customer satisfaction. This case highlights the effectiveness of adapting HoQ to software engineering, particularly in QA processes, and demonstrates its potential in bridging the gap between customer expectations and technical quality delivery in modern software development environments.

Results and Discussions

- **Risk-based regression (H3)** and **automation framework enhancement (H1)** emerged as the most critical technical drivers.
- **Parallel execution (H2)** significantly supports faster test execution and reduced regression time.
- **Modular test design (H6)** improves long-term stability and maintainability.
- **Centralized reporting (H7)** enhances visibility but has a lower direct impact on execution speed.

Conclusion

This study demonstrates the effectiveness of the House of Quality (HoQ) as a structured framework for systematically translating customer requirements into quantifiable software quality and testing parameters. By integrating HoQ with quality assurance (QA) practices and information systems, the proposed approach enhances requirement prioritization, facilitates early defect identification, and improves overall development efficiency. The results indicate that HoQ not only strengthens the alignment between customer expectations and technical implementation but also supports more informed and data-driven decision-making throughout the software development lifecycle.

Furthermore, the application of HoQ in a software engineering context highlights its versatility beyond traditional manufacturing domains, offering a practical mechanism for managing complex requirement interdependencies and trade-offs. The study thereby underscores the potential of HoQ as a strategic tool for achieving continuous quality improvement and customer-centric development. Future research may extend this work by integrating HoQ with emerging methodologies such as agile frameworks, AI-driven testing, and real-time analytics to further enhance its applicability in dynamic software development environments.

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Annexure 18.1.5

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4	www.jakala.com	1	Publication
6	www.graygroupintl.com	1	Internet Data

Reviewers Memorandum

Reviewer's Comment 1: The manuscript presents an interesting and practically relevant application of the House of Quality (HoQ) in software quality assurance. The integration of customer requirements with operational and technical parameters provides a structured framework for process improvement. As a future research direction, the authors may consider discussing the applicability of the proposed HoQ framework in other domains such as healthcare, banking, manufacturing, or public services. Such comparative applications would further demonstrate the versatility and scalability of the proposed approach while broadening its practical significance.

Reviewer's Comment 2: The proposed methodology is logical, well-organized, and supported through an industry-oriented case study, making the paper valuable for both researchers and practitioners. To further strengthen the contribution, future studies may validate the proposed framework using multiple case studies or organizations operating under different software development methodologies such as Agile, DevOps, or hybrid development environments. Such validation would provide additional evidence regarding the robustness and wider applicability of the framework.

Reviewer's Comment 3: The inclusion of complementary quality management tools such as the Fishbone Diagram, Pareto Analysis, and Scatter Diagram enhances the practical value of the study and demonstrates the usefulness of integrating multiple quality improvement techniques. Future research may explore the incorporation of emerging digital technologies such as Artificial Intelligence, Machine Learning, predictive analytics, or Quality 4.0 concepts with the House of Quality framework to enable real-time decision-making and continuous process optimization in software quality assurance.

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Editorial Excerpt

The article has 9% of plagiarism which is the accepted percentage as per the norms and standards of the journal for publication. As per the editorial board's observations and blind reviewers' remarks the paper had some minor revisions which were communicated on a timely basis to the authors (Sahithi; Sai Chandra; Marri Pradeep Kumar; N. Venkateshwarlu), and accordingly, all the corrections had been incorporated as and when directed and required to do so. The comments related to this manuscript are noticeably related to the theme "Optimization and Improvisation of operational processes in Quality Assurance using House of Quality (HoQ)" both subject-wise and research-wise. The manuscript is well-written, systematically organized, and addresses a contemporary topic with significant academic and industrial relevance. The study successfully demonstrates the applicability of the House of Quality framework in software quality assurance and offers meaningful managerial implications. Additionally, incorporating a brief section outlining the practical implications for software development organizations and identifying potential avenues for future research would further enhance the overall contribution and readership value of the paper. After comprehensive reviews and the editorial board's remarks, the manuscript has been categorized and decided to publish under the "**View Point**" category.

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