



DIGITAL TRANSFORMATION OF QUALITY MANAGEMENT SYSTEMS: EVALUATING THE IMPACT OF LIMS AND QMS INTEGRATION ON LABORATORY EFFICIENCY AND DATA INTEGRITY

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ABSTRACT

This study investigates the impact of integrating Laboratory Information Management Systems (LIMS) and Quality Management Systems (QMS) on laboratory efficiency, operational transparency, and data integrity. Through an evaluation of practical implementations and key performance indicators, the research assesses how digital transformation enhances compliance and productivity in laboratory quality management. Survey results reveal no statistically significant differences among respondent groups regarding the perceived impact of LIMS, QMS, or their integration. However, there is strong consensus on the importance of these systems in improving data efficiency and safety. LIMS contributes by automating data entry and sample tracking, while QMS enhances procedural standardization and

traceability. Their integration further strengthens data reliability, reduces human error, and supports accreditation requirements. Based on these findings, the study recommends advancing technical integration, establishing standardized policies, training personnel in system interoperability, and investing in robust digital infrastructure to support seamless system integration and sustainable quality enhancement.

KEYWORDS: LIMS-QMS Integration, Laboratory Efficiency, Data Integrity, Digital Transformation, Quality Management Systems.

1) INTRODUCTION

In recent years, laboratories across various scientific and industrial sectors have faced increasing demands for accuracy, speed, regulatory compliance, and cost efficiency. These pressures have driven organizations to adopt advanced digital solutions to optimize their operations and safeguard the integrity of their data. Among these solutions, the integration of Laboratory Information Management Systems (LIMS) with Quality Management Systems (QMS) has emerged as a critical enabler of operational excellence and regulatory adherence (Samsudin et al., 2023).

LIMS primarily manages laboratory workflows, sample tracking, and data collection, ensuring streamlined processes and reduced manual errors. Meanwhile, QMS frameworks provide structured approaches to maintaining quality standards, documentation control, and regulatory compliance. When effectively integrated, LIMS and QMS create a unified digital ecosystem that enhances laboratory efficiency, minimizes redundancies, improves decision-making, and ensures data reliability throughout the analytical lifecycle (Shah et al., 2020).

Despite these potential benefits, many laboratories struggle with siloed systems, inconsistent data governance, and gaps between quality assurance objectives and operational practices. These challenges raise important questions about the measurable impact of LIMS-QMS integration on laboratory performance and its role in ensuring data integrity—an essential factor in meeting stringent international regulations such as ISO/IEC 17025, FDA 21 CFR Part 11 (FDA, 2018; ISO, 2017), and Good Laboratory Practices (GLP). Quality Management Systems (QMS), on the other hand, enforce structured quality assurance and documentation across processes, aligning with frameworks such as ISO 9001:2015 to ensure organizational consistency and transparency (Feng et al., 2022).

Integrating LIMS and QMS offers synergies: accelerated workflows, reduced duplication, and enhanced data fidelity. Integration enables real-time data sharing, unified audit trails, proactive identification of quality issues, and significant reductions in manual labor and errors (Samsudin et al., 2023).

This research aims to evaluate how integrating LIMS and QMS affects laboratory efficiency, operational transparency, and the robustness of data management. By examining practical implementations, identifying key performance indicators, and analyzing the extent of

improvement in compliance and productivity, this study contributes to the growing body of knowledge on digital transformation in laboratory quality management.

2) Research Problem

As laboratory operations grow increasingly complex and regulatory requirements become more stringent, understanding the differences and synergies between LIMS vs QMS has never been more important. This comprehensive guide will help laboratory professionals, quality managers, and decision-makers navigate this crucial choice for optimal laboratory quality management system implementation (Sheoran & Thakur, 2023).

Although laboratories increasingly adopt LIMS and QMS solutions, many implementations occur in isolation rather than as an integrated framework, resulting in fragmented processes and inefficiencies (Aziz et al., 2022). Manual handoffs between systems can lead to data duplication, inconsistencies, and delays in decision-making, undermining the intended benefits of digitalization. Furthermore, there is insufficient empirical evidence on whether integrating LIMS with QMS leads to tangible improvements in laboratory efficiency, regulatory compliance, and data integrity.

This gap is critical because laboratories operate in highly regulated environments where non-compliance can lead to costly recalls, reputational damage, and legal penalties (FDA, 2018). Without clear metrics and case-based evidence, laboratory managers and policymakers lack a robust basis to justify the investment required for full system integration.

From the above, the research problem can be formulated in the following main question:

"What is the effect Evaluating the Impact of LIMS and QMS Integration on Laboratory Efficiency and Data Integrity?"The following sub-questions branch out from it

1. What is the impact of a laboratory information management system (LIMS) on the efficiency and integrity of laboratory data?
2. What is the impact of a quality management system (QMS) on the efficiency and integrity of laboratory data?

3) Previous studies

Study (Sheoran, Thakur, 2023)The purpose of this research is to examine the most recent studies that have focused on improving quality through the implementation of Total Quality

Management (TQM) in the construction industry, as well as the suitable uses of TQM in the various phases of building projects. The building industry is a significant source of revenue for emerging countries like India. The construction industry in India is second only to the agricultural sector in terms of employment. The construction industry is confronted with numerous management and quality issues. This standard, which is part of the ISO 9000 standard series, contains a collection of instructions on how to build up a quality management system for processes that have an impact on their products or services. The most significant benefit of system deployment is improved management and work efficiency for the company, whereas the most significant drawback is a lack of awareness of the system among the personnel. For these implementation obstacles to be overcome, it is necessary to increase preparation and auditing (both internal and external).

Study (EMMANUEL, 2024) aimed to examine how each contributes to enhanced operational performance and patient's safety, it also addresses the common challenges laboratories face while implementing Quality Management System such as resource constraints, resistance to change, and compliance complexities, and it proposes strategic solutions to overcome these barriers. Ultimately, Quality Management System serves as a foundation for excellence in healthcare diagnostics, where accuracy not only drives efficiency but also saves lives. The implementation of a Quality Management System in medical laboratories is critical to improving patient's care. A Quality Management System enhances diagnostic accuracy, reduces turnaround time, and increases patient's safety by minimizing errors. While challenges to implementation exist, particularly in resource-constrained settings, the long-term benefits of adopting a Quality Management System far outweigh the initial costs. By fostering a culture of quality and continuous improvement, Quality Management System helps laboratories deliver better, faster, and safer diagnostic services, ultimately improving healthcare outcomes for patients.

Study (Ullagaddi, 2024) explores the incentives for digital transformation in the pharmaceutical industry, focusing on the need for a more robust QMS. It examines the challenges companies face in achieving a digitally enabled QMS, such as legacy systems, data integrity issues, and resistance to change. The article also discusses the benefits of regulatory compliance, including improved product quality, reduced risk of noncompliance, enhanced operational efficiency, and increased patient trust. Future trends and opportunities in the digital transformation of QMS, such as the adoption of blockchain technology for

supply chain transparency and data integrity, the integration of Internet of Things (IoT) devices for real-time quality monitoring and predictive maintenance, the leveraging of big data analytics and machine learning for continuous quality improvement, and the collaboration with regulators to develop industry-wide standards for digital quality management are explored.

Study (Edayan et al., 2024) aims to synthesize the existing empirical studies on the utilization of integration technologies for Software-to-Software (S2S) communication in automating clinical laboratory processes. This study systematically examined integration technologies in LIS using PubMed and following PRISMA 2020 guidelines. The three-phase methodology included a scoping analysis, methodological analysis, and a gap analysis, focusing on S2S communication, interoperability frameworks, data standards, communication protocols, and challenges in LIS integration technologies. Analysis of 28 sample studies revealed a complex landscape in LIS integration shaped by end-users, care providers, and researchers. Clinical laboratories prioritize integration, focusing on patient data and sustainability. Standards like HL7 and FHIR ensure interoperability. Eleven methodologies highlight system development in Health Information Systems (HIS).

Study (Adaran, et al., 2025) aims to achieve a minimum of 2 Stars WHO-AFRO rating at the external audit of ten public medical Laboratories within twelve months of intervention using improved documentation and institutionalization of robust QMS. The 12-month implementation of laboratory QMS in ten Lagos State's public secondary health facilities revealed substantial progress. Nine Medical laboratories in the study had a baseline WHO-AFRO rating of 0 Star, while General Hospital Ikorodu had a baseline rating of 1 Star. Sixty percent of the medical laboratories demonstrated commendable QMS improvement and achieved 3 Stars WHO-AFRO rating each, while twenty percent of the medical laboratories attained 2-Stars each. However, the remaining twenty percent of the health facilities achieved minimal improvements, securing 1 Star WHO-AFRO rating each.

By reviewing previous studies, the research concludes that the Previous studies have mainly focused on either QMS or LIMS individually, while limited research has examined the combined impact of their integration on laboratory efficiency and data integrity.

4) Study objective

The researcher aims from the field study to identify the views of the study sample regarding the following:

- Identify the impact of the Laboratory Information Management System (LIMS) on the efficiency and integrity of laboratory data.
- Recognize the impact of the Quality Management System (QMS) on the efficiency and integrity of laboratory data.
- Identify the impact of integration between the Laboratory Information Management System (LIMS) and the Quality Management System (QMS) on the efficiency and integrity of laboratory data.

5) The importance of research

The importance of research stems from the increasing role of digital transformation in improving quality management frameworks and laboratory operations. The integration of Laboratory Information Management Systems (LIMS) with Quality Management Systems (QMS) represents a crucial step toward enhancing operational performance, ensuring data integrity, and meeting global compliance requirements. The importance of this research can be summarized The scarcity of research that addressed the research topic, as it is expected that the integration of LIMS with QMS will contribute to reducing the time to complete tests, simplifying tracking processes, reducing human errors, and enhancing the integrity and quality of data through integration between the two systems.

6) Study hypotheses

In light of the objective of the study, the researcher can test the following research hypotheses

- **The first hypothesis (H0₁):** "There are no statistically significant significant between the surveyed categories about the impact of the Laboratory Information Management System (LIMS) on the efficiency and integrity of laboratory data."
- **The Second hypothesis: (H0₂)** "There are no statistically significant differences between the categories of respondents about the quality management system (QMS) on the efficiency and integrity of laboratory data."
- **The third hypothesis: (H0₃)** " There are no statistically significant differences between the surveyed categories on the impact of the integration between the Laboratory Information Management System (LIMS) and the Quality Management System (QMS) on the efficiency and integrity of laboratory data."

7) Theoretical Framework

(A) Laboratory Information Management System

A LIMS acts as the central nervous system for a pharmaceutical lab, integrating various processes, instruments, and data points into a cohesive, digital framework. It transforms chaotic data streams into organized, actionable insights, enabling labs to operate with greater efficiency, accuracy, and compliance. For lab managers, QA/QC leads, and scientific staff, understanding and leveraging the full potential of a LIMS is paramount to maintaining competitive edge and ensuring patient safety (Bradley, 2025).

A Laboratory Information Management System (LIMS) is specialized software designed to manage laboratory data, samples, and workflows. It serves as the central hub for organizing and tracking samples, tests, and results throughout the laboratory process (Famili, Cleary, 2022).

A foundational LQMS provides a framework to address gaps in process or product performance and risks present throughout the laboratory's workflow, any of which could lead to a critical error that compromises the organization's credibility (Pillai, Fox, 2025).

Key LIMS functions include: (Dhanushkodi et al., 2023)

- Sample registration, tracking, and chain of custody management
- Test assignment and scheduling
- Results capture and validation
- Report generation and distribution
- Instrument integration and data collection
- Inventory management
- Sample storage location tracking

LIMS platforms excel at organizing the data-intensive aspects of laboratory operations. They transform chaotic data streams into structured, accessible information that supports decision-making and operational efficiency. As we approach 2025, LIMS technologies are undergoing profound transformation, driven by technological advancements and evolving healthcare needs (Klaytong et al., 2025).

Modern LIMS platforms now incorporate artificial intelligence and machine learning capabilities, enabling more sophisticated analysis, predictive modeling, and automated

decision-making. These intelligent systems can identify complex patterns, predict potential errors, and optimize workflow efficiency—transforming data processing across various scientific disciplines. Innovative platforms like Scispot now offer AI-assisted search features allowing users to find information using natural language prompts and extract real-time insights from data (Edayan et al., 2024).

(B)Quality management system (QMS)

A laboratory quality management system (QMS) is a comprehensive framework of policies, processes, and procedures designed to ensure consistent quality outcomes and regulatory compliance. While LIMS focuses on data and sample management, QMS is concerned with quality control, process standardization, and compliance (Sheoran& Thakur, 2023).

Quality Management Systems (QMS) are the cornerstone of pharmaceutical manufacturing, ensuring that products consistently meet the required quality and regulatory standards. A QMS is a comprehensive framework encompassing all aspects of a company's operations, from product development and manufacturing to distribution and post-market surveillance (Tomić et al., 2010). The primary objectives of a QMS are to prevent quality issues, detect and correct deviations, and drive continuous improvement in processes and products.

Key QMS functions include: (Adaran et al., 2025)

- Document control and version management
- Training records and competency assessment
- Audit management and findings tracking
- Corrective and Preventive Action (CAPA) workflows
- Deviation and nonconformance management
- Change control processes
- Risk assessment tools

A quality management system in the laboratory plays a crucial role in meeting regulatory standards like ISO 17025, GLP, and FDA requirements. It provides the structure needed to consistently deliver reliable results while maintaining compliance, the evolution of QMS reflects a shift toward greater integration, sustainability, and customer-centric approaches. Quality is no longer viewed as a static goal but rather as a dynamic journey that demands innovation, collaboration, and unwavering commitment.

(C) Benefits of Integration of LIMS and QMS

Rather than viewing lims vs qms as an either/or decision, many laboratories are finding value in integrated solutions that combine both capabilities. The integration of LIMS and QMS creates a unified ecosystem that addresses both operational efficiency and quality assurance, It is as follows: (Haleem et al., 2022)

1. **Seamless Data Flow:** Integration eliminates manual data transfer between systems, reducing errors and saving time. Quality events can be automatically linked to specific samples or tests.
2. **Unified Compliance Management:** An integrated system provides a single source of truth for regulatory compliance, with consistent audit trails and document control across laboratory data and quality processes.
3. **Comprehensive Analytics:** When quality data and operational metrics reside in the same system, laboratories gain deeper insights into the relationships between processes, quality outcomes, and efficiency.
4. **Streamlined User Experience:** Staff benefit from a consistent interface regardless of whether they're handling samples, reviewing results, or managing deviations.
5. **Reduced Turnaround Time (TAT):** LIMS integration cuts turnaround time by automating data entry and task assignments, eliminating delays caused by manual processes. By ensuring real-time data availability and quicker access to results, an integrated system speeds up decision-making and reduces waiting time for test outcomes.
6. **Real-Time Collaboration:** Cloud-based LIMS-QMS integration allows multiple users across different locations to access and share data in real time, improving collaboration among teams. It ensures seamless communication and data exchange, enabling decision-making without geographical barriers.
7. **Increased Profitability:** Integrating LIMS with QMS boosts profitability by reducing manual labor, which cuts operational costs and minimizes errors. Automated workflows and real-time data sharing increase efficiency, allowing laboratories to handle higher volumes of work without additional resources.

8) Field Study

Study Society and Sample

This study targets a set of key categories within the laboratory environment, and includes laboratory information management system (LIMS) users of technicians and analysts who deal directly with data entry and processing, quality management system (QMS)

administrators such as quality coordinators and quality assurance specialists, as well as information systems specialists responsible for operating and supporting LIMS systems (QMS) and ensuring their integration, as well as managers responsible for managing operations and making decisions based on laboratory data.

Managing the survey list

The researcher distributed the e-mail about the target groups of the study, and it reached a percentage, and this is evident through the following table

Table (1) Sample size.

Target groups	N
Laboratory Information Management System (LIMS) users	55
In-Lab Quality Management System (QMS) Officers	16
GIS Specialist	33
Executives	20
Total	124

Fifth: Statistical Analysis of Survey List Items

First: Internal consistency coefficient of the survey list

The internal consistency coefficient was used to determine the consistency of each of the survey questions with the section to which it belongs, in addition to the extent to which each axis is related to the total score of the section to which it belongs, by calculating the averages of the correlation coefficients between each of the questions of the sections and the total score of the section to which it belongs. This was done by using the correlation coefficient (Pearson) at a significance level (0.01), as shown in the following table:

Table (2) The internal consistency coefficient of the survey list.

Assumptions	Impact of LIMS on the efficiency and integrity of laboratory data	Impact of QMS on laboratory data efficiency and integrity	The impact of integration between (LIMS) and (QMS) on the efficiency and integrity of laboratory data	Average survey list as a whole
Impact of LIMS on the efficiency and integrity of laboratory data	1			
Impact of QMS on laboratory data efficiency and	0.801**	1		

integrity				
The impact of integration between (LIMS) and (QMS) on the efficiency and integrity of laboratory data	0.768**	0.796**	1	
Average survey list as a whole	0.935**	0.930**	0.914**	1

**** Indicates the significance of the correlation coefficient at a significant level (0.01)**

Source: SPSS Output Outcomes

It is clear from the previous table that all the elements of the survey list are valid and consistent, as the values of the correlation coefficients confirmed this, and all of them were significant at the level of (0.01).

1- Stability and honesty score (Alpha Cronbach) for the survey list as a whole

The reliability and validity of the survey list as a whole can be measured as the tool used to measure and analyze the results, using the Cronbach Alpha coefficient, which is shown in the following table.

Table (3) The degree of stability and validity of the survey list.

Number of phrases for the survey list as a whole	Number of questions	(Cronbach's alpha)	Self-reliability coefficient
Impact of LIMS on the efficiency and integrity of laboratory data	6	0.902	0.949
Impact of QMS on laboratory data efficiency and integrity	6	0.893	0.944
The impact of integration between (LIMS) and (QMS) on the efficiency and integrity of laboratory data	6	0.810	0.900
Total	18	0.868	0.931

Source: SPSS Output Outcomes

It is clear from the previous table that the stability coefficient (Alpha Cronbach) for each of the study variables is greater than (0.5), which indicates the stability of the statements for each of these variables.

Through the coefficient of stability (Alpha Cronbach), it is possible to reach the coefficient of subjective validity for each of the variables, such as:

Self-validity coefficient= square root of the stability coefficient Alpha Cronbach

It is clear to the researcher from the previous table that the coefficient of subjective validity for each of the study variables is greater than (0.5), which indicates the validity of the statements that make up each of these variables.

Sixth: Statistical Analysis of Assumptions

1- Descriptive Analysis of Study Variables

The following table shows the results of the descriptive analysis of the study:

Table (4) Descriptive Statistics.

z	Paragraphs	Mean	Standard deviation	Order of Importance
1	LIMS contributes to the organization and automation of laboratory data entry processes.	4.31	.788	4
2	The LIMS system allows to minimize errors caused by manual data entry.	4.34	.795	2
3	LIMS facilitates quick access to information and laboratory results.	4.31	.756	3
4	LIMS enables sample tracking across all stages of analysis.	4.23	.837	6
5	LIMS easily integrates with various laboratory devices and equipment.	4.28	.802	5
6	LIMS provides reports and analyses that support decision making.	4.45	.589	1
Total		4.32	0.761	—
1	The laboratory adheres to clear, approved quality policies and procedures.	4.49	.618	1
2	Periodic quality reviews are conducted to ensure adherence to standards.	4.43	.614	3
3	Staff are regularly trained on Standard Operating Procedures (SOPs)	4.39	.683	6
4	The quality system encourages continuous improvement in processes.	4.45	.655	2
5	All laboratory processes and results are documented in compliance with quality requirements.	4.43	.627	4
6	Non-conformities are handled with a clear mechanism that prevents their recurrence.	4.39	.647	5
Total		4.43	0.640	—
1	The integration of LIMS and QMS contributes to improving the accuracy of laboratory data.	4.49	.618	2
2	Integration between LIMS and QMS helps to store data in a secure way that prevents unauthorized access.	4.41	.796	5
3	Integration between LIMS and QMS contributes	4.34	.697	6

	to retrieving old data when needed.			
4	Integration between LIMS and QMS reduces data loss or corruption.	4.52	.577	1
5	Integration between LIMS and QMS supports the ability to trace the source of any data or results.	4.42	.711	3
6	Integration between LIMS and QMS provides backups periodically to ensure business continuity.	4.42	.797	4
Total		4.44	0.699	—

Outputs (SPSS)

It is clear from the previous table that the average of all statements is greater than (3), and this indicates that there is a general trend towards approving the impact of LIMS on the efficiency and integrity of laboratory data, with an arithmetic average (4.32). There is also a general trend towards approving the impact of the (QMS) system on the efficiency and integrity of the data, with an arithmetic mean of (4.33). There is also a general trend towards approving the impact of the integration between (LIMS) and (QMS) on the efficiency and integrity of the laboratory data, with an arithmetic mean of (4.44). It is also noted that the standard deviation of all phrases is less than one, and this indicates a decrease in dispersion in the sample responses to these phrases.

Second: Testing hypotheses

1- First Hypothesis Test

The first hypothesis (H_0) indicates that “there are no statistically significant differences between the surveyed populations on the impact of the Laboratory Information Management System (LIMS) on the efficiency and integrity of laboratory data”.

This hypothesis was tested by applying the Kruskal-Wallis’s test, the results of which were shown in the following table.

Table (6) (Kruskal Wallace) test to show the differences in the opinions of those interested in the impact of the quality management system (QMS) on the efficiency and integrity of laboratory data.

Questions	Categories	number	Mean	Relative importance value	Chi-Square significance	Sig..
Impact of the Quality Management System (QMS) on the efficiency and integrity of laboratory data	Laboratory Information Management System (LIMS) users	55	44.72	4	1.613	0.446
	In-Lab Quality Management System (QMS) Officers	16	57.88	3		
	GIS Specialist	33	82.56	1		
	Executives	20	82.00	2		

Source: SPSS Output Outcomes

It is clear from the previous table that the level of significance is greater than (0.05), and therefore the null hypothesis is accepted, and the alternative hypothesis is rejected, and this means that "there are **no statistically significant differences between the surveyed categories about the impact of LIMS on the efficiency and integrity of the data.**" This means that there is agreement among the surveyed groups on the importance of the impact of LIMS on the efficiency and integrity of laboratory data, as this system contributes to raising the efficiency of data by automating its entry and accurately tracking samples, and enhances its safety by ensuring confidentiality, reducing errors and preventing tampering or loss.

2- Hypothesis Test 2

The second hypothesis (H_0_2) indicates that "there are **no statistically significant significant differences between the surveyed categories about the quality management system (QMS) on the efficiency and integrity of laboratory data**".

This hypothesis was tested by applying the Kruskal-Wallis's test, the results of which were shown in the following table:

Table (7) (Kruskal-Walli's) test to show the differences in the opinions of those interested about the impact of the quality management system (QMS) on the efficiency and integrity of laboratory data.

Questions	Categories	number	Mean	Relative importance value	Chi-Square significance	Sig..
Impact of the Quality Management System (QMS) on the efficiency and integrity of laboratory data	Laboratory Information Management System (LIMS) users	55	51.76	4	8.864	0.310
	In-Lab Quality Management System (QMS) Officers	16	57.59	3		
	GIS Specialist	33	81.50	1		
	Executives	20	64.60	2		

Source: SPSS Output Outcomes

It is clear from the previous table that the level of significance is greater than (0.05), and therefore the null hypothesis is accepted and the alternative hypothesis is rejected, and this means "there are no statistically significant differences between the categories of the respondents about the impact of the quality management system (QMS) on the efficiency and integrity of the laboratory data." This means that there is agreement among the surveyed categories on the importance of the impact of the Quality Management System (QMS) on the efficiency and integrity of laboratory data, as this system helps to raise the efficiency of laboratory data by standardizing procedures and improving the accuracy of work, and enhances its safety by applying controls and standards that ensure integrity, confidentiality and traceability.

3- Hypothesis Test 3

The third hypothesis (H_0_3) indicates that "there are no **statistically significant differences between the surveyed populations on the impact of the integration between the Laboratory Information Management System (LIMS) and the Quality Management System (QMS) on the efficiency and integrity of the laboratory data**".

This hypothesis was tested by applying the Kruskal-Wallis test, the results of which were shown in the following table:

Table (8) (Kruskal Wallace) test to show the differences in the opinions of those interested about the extent to which the integration between the Laboratory Information Management System (LIMS) and the Total Quality Management System (QMS) affects the efficiency and integrity of laboratory data.

Questions	Categories	number	Mean	Relative importance value	Chi-Square significance	Sig..
The impact of integration between the Laboratory Information Management System (LIMS) and the Total Quality Management System (QMS) on the efficiency and integrity of laboratory data	Laboratory Information Management System (LIMS) users	55	50.44	4	6.842	0.330
	In-Lab Quality Management System (QMS) Officers	16	55.13	3		
	GIS Specialist	33	78.55	1		
	Executives	20	75.10	2		

Source: SPSS Output Outcomes

It is clear from the previous table that the level of significance is greater than (0.05), and therefore the null hypothesis is accepted and the alternative hypothesis is rejected, and this means that **"there are no statistically significant differences between the categories of respondents on the impact of integration between the Laboratory Information Management System (LIMS) and the Quality Management System (QMS) on the efficiency and integrity of laboratory data."** This means that there is agreement among the respondents on the importance of integration, as this integration contributes to enhancing the accuracy of data entry, standardizing work procedures, reducing the likelihood of human errors, as well as improving the reliability of data and increasing its ability to meet quality and accreditation requirements.

CONCLUSION

The results of the study show that there are no statistically significant differences between the surveyed groups about the impact of the Laboratory Information Management System (LIMS) on the efficiency and integrity of laboratory data. ” There is agreement among the surveyed groups on the importance of the impact of LIMS on the efficiency and integrity of laboratory data, as this system contributes to raising the efficiency of data by automating their

entry and accurately tracking samples, and enhances their safety by ensuring confidentiality, reducing errors and preventing tampering or loss. In addition, there are no statistically significant differences between the categories of respondents about the quality management system (QMS) on the efficiency and integrity of laboratory data.” There is agreement among the surveyed categories on the importance of the impact of the Quality Management System (QMS) on the efficiency and integrity of laboratory data, as this system helps to raise the efficiency of laboratory data by standardizing procedures and improving the accuracy of work, and enhances its safety through the application of controls and standards that ensure integrity, confidentiality and traceability. Moreover, there are no statistically significant differences between the respondents' categories on the impact of the integration between the Laboratory Information Management System (LIMS) and the Quality Management System (QMS) on the efficiency and integrity of laboratory data.” There is agreement among the respondents on the importance of this integration in enhancing the accuracy of data entry, standardizing work procedures, reducing the likelihood of human errors, as well as improving the reliability of data and increasing its ability to meet quality and accreditation requirements.

Thus the study recommends the following

- Enhancing the technical integration between LIMS and QMS to ensure the safe and smooth flow of data and avoiding the recurrence of information entry or loss.
- Developing standardized policies and procedures to control the quality of laboratory data, while adopting the integration between the two systems as a basic standard in accreditation and quality.
- Train employees and users on how to use LIMS and QMS in an integrated manner, which enhances the efficiency and accuracy of data handling.
- Investing in digital infrastructure within laboratories to provide a technological environment capable of accommodating the integration of systems without technical obstacles.

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