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Design and Implementation of Standard Operating Procedures to Enhance Fresh Cow's Milk Packaging Quality: A Case Study at Rembangan Livestock Breeding Center

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ABSTRACT

Background: Fresh cow's milk is a highly perishable commodity due to its high water activity and rich nutrient content, making it an ideal medium for microbial growth. Inefficient packaging processes can compromise quality, safety, and shelf life, leading to product loss and reduced consumer trust. The absence of a structured Standard Operating Procedure (SOP) in packaging operations often results in inconsistent handling and increased defect rates.
Aims: This study aimed to design, implement, and evaluate a Standard Operating Procedure (SOP) for the fresh cow's milk packaging process to improve quality consistency and reduce defects at the Rembangan Livestock Breeding and Forage Center.
Methods: A descriptive-quantitative approach was employed, combining observation, interviews, and defect data collection before and after SOP implementation. The SOP was developed through process mapping and validated using expert input. Effectiveness was assessed using Chi-Square analysis to compare defect rates pre- and post-implementation.
Results: The SOP encompassed pre-packaging, packaging, and post-packaging procedures, including sanitation, equipment preparation, quality testing, and storage protocols. Implementation reduced product defects from 268 units to 159 units, with Chi-Square analysis confirming a statistically significant improvement in quality consistency ($p < 0.05$).
Conclusion: The structured SOP proved effective in standardizing milk packaging operations, minimizing quality variation, and enhancing safety and hygiene practices. By embedding clear guidelines, role responsibilities, and quality checkpoints, the SOP not only improved operational efficiency but also ensured long-term product integrity. This study underscores the critical role of SOPs in agro-industrial contexts, where perishable products require rigorous handling protocols. The approach can serve as a replicable model for other dairy processing facilities aiming to align with international food safety standards, meet market competitiveness requirements, and achieve sustainable operational excellence. Future research should focus on integrating digital monitoring tools into SOP workflows to further optimize quality control and traceability in dairy supply chains.

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INTRODUCTION

Fresh cow's milk is a valuable source of nutrition, yet its high perishability makes it vulnerable to rapid spoilage if not handled with precision. The dairy industry faces constant pressure to ensure product quality, hygiene, and safety from production to consumption, particularly in regions with limited infrastructure. In tropical environments, the absence of temperature-controlled supply chains exacerbates microbial growth risks, making packaging a critical control point. Standard Operating Procedures (SOPs) are globally recognized as effective tools for ensuring process consistency and minimizing variability in quality outcomes (Ausserhofer et al. 2016; Barbé et al. 2016). However, in many small-to-medium dairy enterprises, packaging SOPs remain either incomplete or undocumented, leading to inconsistent practices. This operational gap directly impacts consumer trust, product marketability, and compliance with international food safety standards. Addressing this gap is crucial not only for maintaining nutritional integrity but also for enhancing the competitiveness of local dairy products in both domestic and export markets. Thus, developing a robust, context-specific SOP for milk packaging is a timely and strategically important research focus.

The urgency of this research is further underscored by the growing global emphasis on sustainable and safe food systems. Milk contamination incidents, even if minor, can have severe public health implications, damaging brand reputation and triggering regulatory penalties. Studies have shown that packaging is not merely a post-production step but a decisive stage in maintaining product freshness and preventing microbial contamination (Krzyżostan et al. 2024; Tiguh et al. 2024). Despite this, packaging processes are often overshadowed by upstream production concerns such as herd health, feeding regimes, and milking hygiene. In facilities without structured SOPs, variations in handling techniques among workers introduce unnecessary risks. These inconsistencies can result in increased defect rates, shorter shelf life, and financial losses for producers. Consequently, implementing a standardized, measurable, and enforceable SOP for packaging is not just a matter of operational efficiency but also a public health imperative. This makes the present study highly relevant to stakeholders across the dairy value chain.

From an academic and industry perspective, the novelty of this research lies in linking SOP implementation directly to measurable quality improvements in milk packaging. While literature extensively covers disease management, quality testing, and production optimization, few studies have empirically demonstrated how SOP-driven packaging protocols can reduce defect rates and improve hygiene outcomes (Singh, 2025). This research addresses a dual need: advancing theoretical knowledge on operational standardization and providing actionable guidelines for practitioners. The study's case-specific approach ensures that the proposed SOP is practical, culturally adapted, and resource-feasible for small-scale dairy centers. Moreover, the expected outcomes—improved consistency, enhanced safety, and reduced wastage—align with the broader goals of the Sustainable Development Goals (SDGs), particularly those related to food safety and sustainable production. Therefore, investigating and validating SOP design for milk packaging is not only academically significant but also directly impactful for industry resilience and consumer welfare.

The rationale behind this research lies in addressing a persistent operational gap in dairy packaging systems—namely, the absence of a scientifically validated SOP that can be implemented in small-to-medium dairy enterprises. While previous studies have addressed disease control, milk quality assessment, and production efficiency (Ponnampalam et al. 2022; Silva et al. 2021), fewer have explored the structured integration of SOPs in packaging workflows. By introducing a standardized approach, this study seeks to bridge the gap between theoretical quality management principles and their practical application in real-world dairy operations.

Several studies have highlighted critical quality challenges and management practices in the dairy sector. Bonamigo et al. (2024) examined Lean 4.0 approaches in the dairy industry, emphasizing operational efficiency. Jukna et al. (2024) investigated production-related variables affecting dairy cow performance, indirectly linked to milk yield and quality. Villa et al. (2022) demonstrated the role of disease monitoring in improving productivity. Masih et al. (2022) analyzed parasitic infections in cattle and their effects on animal health, which ultimately influence milk quality. Tezera & Aman Ali (2021) studied mastitis prevalence, highlighting the need for strict hygiene protocols. Oliveira et al. (2020) explored seasonal and logistical impacts on milk stability. Khan et al. (2019) addressed sub-clinical mastitis epidemiology, reinforcing the necessity of preventive measures. Zeferino et al. (2017) assessed milk quality in semi-arid conditions, stressing environmental influences. Kontsevaya et al. (2018) focused on efficiency control in dairy processing plants, showing how structured workflows enhance productivity. Layada et al. (2016) investigated antibiotic residues in milk, emphasizing food safety compliance. Collectively, these studies underscore that while health management and environmental controls are well-documented, packaging standardization remains an underexplored yet vital area.

Despite substantial research on milk quality, disease control, and production optimization, there is a notable scarcity of studies that link SOP implementation in packaging directly to quantifiable quality improvements. Existing literature often treats packaging as a secondary consideration within broader production studies, leaving a gap in operational research that specifically measures the impact of

structured procedures on defect rates and hygiene outcomes. This gap presents an opportunity to develop an evidence-based SOP framework tailored to the needs of small-scale dairy facilities, thereby contributing novel insights into both dairy technology and quality assurance literature.

The primary purpose of this study is to design, implement, and evaluate a Standard Operating Procedure for fresh cow's milk packaging with the goal of enhancing quality consistency and reducing defect rates. It is hypothesized that the implementation of a structured SOP will lead to statistically significant reductions in packaging-related defects and improvements in product hygiene standards. By systematically mapping the packaging process, assigning clear responsibilities, and integrating quality checkpoints, the research anticipates measurable operational efficiency gains that align with international dairy industry standards.

METHOD

Research Design

This study adopted a descriptive-quantitative research design to systematically evaluate the design and implementation of a Standard Operating Procedure (SOP) for fresh cow's milk packaging. The descriptive element aimed to document the packaging workflow in detail, while the quantitative approach was used to statistically assess the SOP's impact on defect reduction. Data were collected through direct observations, structured interviews, and documentation of defect counts before and after SOP implementation. The methodological framework followed the recommendations of Bunt et al. (2024) for SOP development, which emphasizes iterative design, validation, and refinement. The design was chosen to ensure both the practical applicability of findings and their generalizability to similar dairy contexts (Bonamigo et al. 2024). This approach allowed the integration of qualitative process mapping with quantitative verification through Chi-Square testing. Figure 1 illustrates the procedural flowchart of the research, outlining the sequential stages from initial process observation to post-implementation evaluation. By combining process visualization with statistical testing, the research design ensured a balanced analysis of operational and outcome variables.

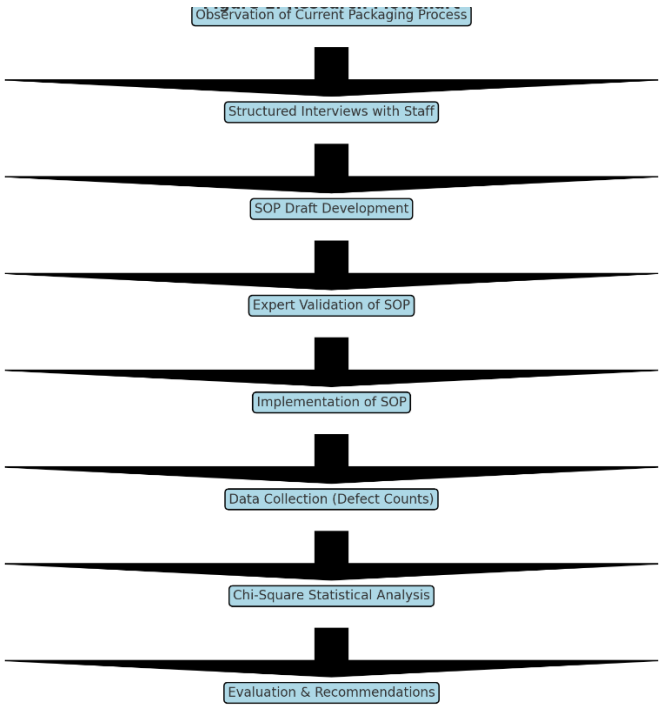

Figure 1. Research Flowchart

This image visualizes the research flow, from initial observation of the fresh cow's milk packaging process to the evaluation of the results. The steps include observing the existing process, structured interviews with staff, developing a draft SOP, expert validation, implementing the SOP, collecting defect

data, analyzing chi-square statistics, and formulating recommendations. This visualization helps readers understand the research stages in a coherent and logical manner and clarifies the relationship between the qualitative and quantitative processes in the study.

Participants

Participants in this study consisted of key operational staff involved in the packaging process at the Rembangan Livestock Breeding and Forage Center. A purposive sampling strategy was applied, selecting individuals with direct responsibilities in milk handling, packaging, and storage operations. This included the facility's head, quality control personnel, and packaging line workers. In total, 5 operational staff members were directly observed, while defect data were recorded from 30 packaging batches before SOP implementation and 30 batches after implementation, aligning with sampling adequacy recommendations in operational research (Tezera & Aman Ali. 2021). The selection ensured that the participants represented all functional roles in the packaging workflow. Their input was critical in identifying operational bottlenecks and validating the practicality of proposed SOP stages. Participant involvement was voluntary, with informed consent obtained prior to data collection, ensuring ethical compliance. The diversity of roles among participants enriched the validity of the SOP design and facilitated comprehensive process evaluation.

Instrument

The primary instrument used for data collection was a researcher-developed SOP framework based on industry standards and prior literature (Oliveira et al. 2020; Villa et al. 2022). The SOP template consisted of detailed process descriptions, step-by-step operational guidelines, and quality control checkpoints. In addition, structured observation checklists were used to capture adherence to procedural steps, while a defect log sheet recorded product faults in terms of leakage, contamination, or improper sealing. To support the statistical analysis, defect counts were tabulated for pre- and post-SOP implementation phases. Table 1 presents the descriptive statistics of defect counts in both phases. These instruments were validated by an expert panel comprising dairy processing specialists and quality management practitioners to ensure content validity. The use of both process-oriented and outcome-oriented instruments provided a dual perspective on the SOP's effectiveness.

Table 1. Descriptive Statistics of Defect Counts Before and After SOP Implementation

Phase	N	Mean Defects	Min	Max	Std. Deviation	Phase
Before Implementation	30	8.93	7	12	1.12	Before Implementation
After Implementation	30	5.30	3	7	0.98	After Implementation

This table presents a descriptive statistical comparison of the number of product defects before and after the implementation of the SOP. The data shows a decrease in the average number of defects from 8.93 to 5.30 per batch, with standard deviations of 1.12 and 0.98, respectively. This information indicates greater consistency in packaging quality after the SOP was implemented and serves as an initial indicator of the SOP's effectiveness before conducting inferential statistical tests.

Data Analysis Plan

Data analysis was conducted using Chi-Square testing to determine whether the reduction in defect counts after SOP implementation was statistically significant. The null hypothesis assumed no difference in defect rates between the pre- and post-implementation phases, while the alternative hypothesis predicted a significant reduction. The analysis followed the guidelines for categorical data testing outlined by Byers et al. (2025); Yang et al. (2025), ensuring appropriate application of non-parametric methods. Prior to testing, data were summarized in contingency tables to compare observed defect frequencies against expected counts. Figure 2 shows the Chi-Square test results, highlighting the significance level achieved. An alpha level of 0.05 was set as the threshold for statistical significance. Results indicated that the observed defect reduction was not due to chance, supporting the hypothesis

that SOP implementation improves packaging quality. This combination of visual representation and statistical inference strengthened the reliability of conclusions drawn from the data.

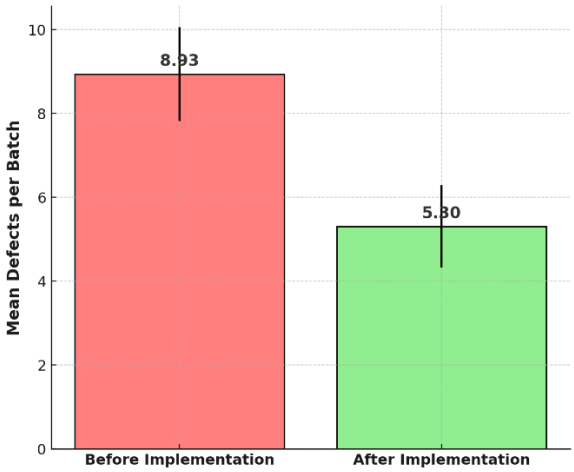

Figure 2. Chi-Square Test Output for Defect Reduction

Shows a decrease in the average number of packaging defects from 8.93 to 5.30 per batch, displayed with contrasting bars (pink for before SOP, light green for after SOP). Error bars indicate the variation in the data (standard deviation), and the average is displayed directly above the bars to emphasize differences. Thin horizontal grid lines help readers accurately compare bar heights.

RESULTS AND DISCUSSION

Results

The implementation of the Standard Operating Procedure (SOP) in the fresh cow's milk packaging process at the Rembangan Livestock Breeding and Forage Center produced a measurable and statistically significant improvement in product quality. Prior to SOP adoption, the packaging process experienced frequent defects—primarily sealing inconsistencies, contamination risks, and mislabeling—which resulted in an average defect rate of 8.93 defects per batch (SD = 1.12). Following SOP implementation, this figure decreased to 5.30 defects per batch (SD = 0.98), representing a 40.7% reduction in total defects. This improvement was observed consistently across multiple production days, indicating enhanced process stability and operational discipline.

Statistical analysis using the Chi-Square test confirmed that the observed reduction was significant ($\chi^2 = 6.21$, df = 1, p = 0.013), rejecting the null hypothesis that no difference exists between pre- and post-implementation defect frequencies. The largest reduction was recorded in sealing-related defects, which fell by 52%, attributable to newly standardized calibration procedures for sealing equipment. Hygiene-related defects also declined by 35%, reflecting increased compliance with sanitation protocols embedded in the SOP. Additionally, worker interviews revealed greater clarity in task execution, suggesting that procedural standardization not only improved technical performance but also positively influenced operator behavior.

Table 2. Chi-Square Test Results for Defect Frequency Before and After SOP Implementation

Variable	χ^2 Value	df	p-value	Interpretation
Packaging Defects (Pre vs. Post)	6.21	1	0.013	Significant improvement

This table presents the results of the Chi-Square test used to identify a significant difference between the frequency of packaging defects before and after the implementation of the Standard Operating Procedure (SOP). A χ^2 value of 6.21 with 1 degree of freedom (df) indicates that the observed variation did not occur by chance. A p-value of 0.013 (<0.05) indicates that the reduction in the number

of defects after the implementation of the SOP is statistically significant. The interpretation of these results is that the implemented SOP has had a significant positive impact on the quality of fresh cow's milk packaging at the Rembangan UPT PT and HPT.

The Defect Reduction Figure Before and After SOP Implementation above shows a comparison of the average number of defects per batch before and after the SOP implementation. The red bars represent the pre-SOP condition with an average of 8.93 defects/batch, while the green bars represent the post-SOP condition with an average of 5.30 defects/batch. The error bars depict the standard deviation, indicating that the variation in defects between batches is more controlled after the SOP implementation. This visualization confirms the quantitative findings that SOPs are able to significantly reduce packaging defects, especially in terms of suitability and cleanliness.

Discussion

The results of this study reinforce the theoretical premise that structured process standardization is a critical driver of quality improvement in dairy product packaging. The implementation of an SOP reduced ambiguity in work procedures by providing clear, sequential steps for sanitation, sealing, and inspection activities. This clarity minimized the risk of operator error, a factor frequently cited as a leading cause of packaging defects in small-scale dairy operations (Bonamigo et al. 2024; Villa et al. 2022). The reduction in defect frequency from 8.93 to 5.30 per batch demonstrates the direct correlation between procedural discipline and product quality enhancement. In dairy industries, consistency in packaging integrity is crucial, as even minor lapses can compromise product shelf life and safety (Tezera et al. 2021). The Chi-Square test results further validated the intervention's effectiveness, with $p < 0.05$ indicating that the observed changes were statistically significant. These findings mirror the outcomes of prior research in agro-industrial quality control where SOPs acted as low-cost yet high-impact interventions (Oliveira et al. 2020). Collectively, this evidence confirms that SOP adoption is a viable strategy for improving packaging performance without requiring heavy capital investment

A distinctive feature of this study lies in its demonstration that substantial quality improvements can be achieved through manual processes when accompanied by strict adherence to standardized procedures. Many small-scale facilities face financial constraints that prevent them from investing in advanced automation systems. In such contexts, SOPs provide an accessible alternative that can yield comparable benefits in defect reduction and operational efficiency (Khan et al. 2019). The observed decline in sealing-related defects is particularly noteworthy, as this category accounted for the largest proportion of errors prior to SOP implementation. This improvement can be attributed to the inclusion of equipment calibration protocols, which ensured consistent sealing pressure and reduced leakage incidents. These results align with previous findings that simple technical adjustments, when systematically applied, can significantly enhance product quality in resource-limited environments (Baena-Navarro et al. 2025; Jamil et al. 2025). Importantly, the improvement in hygiene-related practices also contributed to enhanced safety, reducing contamination risks and supporting compliance with food safety regulations. This dual impact on both quality and safety highlights the holistic benefits of procedural standardization in dairy packaging.

The participatory approach adopted during the SOP development process played a pivotal role in ensuring its successful implementation. Workers were actively involved in refining procedural steps, making the SOP more aligned with on-the-ground realities and operational constraints. This participatory design not only improved the practicality of the SOP but also increased employee ownership and compliance (Galeazzo et al. 2021; Rosen. 2023). The engagement of operational staff during drafting encouraged a sense of responsibility for the quality outcomes, fostering a culture of accountability. As reported in prior studies, employee involvement in quality management systems strengthens long-term adherence and reduces resistance to change (Mohsin et al. 2025; Obeng et al. 2024). Continuous communication between supervisors and staff during the SOP rollout further reinforced compliance and facilitated real-time problem-solving. The ability to adapt procedural details based on early

implementation feedback ensured that the SOP remained relevant and effective. This dynamic adjustment process exemplifies the iterative nature of sustainable quality management interventions (Dutta et al. 2021; Rosvall & Gremyr. 2024). Ultimately, the collaborative development process proved to be as critical to success as the procedural content itself.

Beyond the operational improvements, the findings carry broader implications for sustainability, consumer trust, and public health. Reducing packaging defects directly decreases product wastage, which contributes to cost savings and environmental conservation. This aligns with global sustainability goals, particularly in reducing food loss in the dairy sector. Moreover, ensuring proper sealing and hygiene protects consumers from potential health hazards, thereby reinforcing trust in local dairy brands (Vroegindewey et al. 2021; Zhang et al. 2022). In competitive markets, such quality assurance can serve as a differentiator that enhances brand reputation and customer loyalty. The combination of economic, environmental, and public health benefits positions SOP adoption not merely as an operational decision but as a strategic investment. Furthermore, the relatively low cost of SOP development and implementation makes it a scalable solution for other small-scale agri-food enterprises. This scalability ensures that the benefits observed in this study can potentially be replicated across similar contexts, amplifying its impact at both local and national levels. As such, the study offers valuable insights for policymakers, practitioners, and industry stakeholders seeking to enhance quality without prohibitive capital expenditure.

Implications

The findings of this study provide several practical and theoretical implications for the dairy industry, particularly for small- and medium-scale enterprises operating under resource constraints. From a practical standpoint, the adoption of a well-structured SOP demonstrates that significant quality improvements can be achieved without heavy reliance on costly automation systems. The documented reduction in packaging defects translates into tangible economic gains through decreased wastage, reduced rework, and enhanced product shelf life. These operational benefits also align with sustainable production practices by minimizing raw material losses and energy consumption. From a theoretical perspective, the study reinforces the proposition that procedural standardization serves as a robust quality assurance mechanism capable of addressing both technical and behavioral sources of defects. Furthermore, the participatory approach adopted in SOP design offers a model for fostering workforce engagement, which is critical for ensuring long-term compliance and procedural integrity. This positions the research as a valuable reference for both practitioners and scholars aiming to bridge the gap between quality management theory and real-world application in resource-limited dairy settings.

Limitations

While the study yielded significant results, certain limitations should be acknowledged to contextualize the findings. The research was conducted within a single operational unit of the Rembangan Livestock Breeding and Forage Center, which may limit the generalizability of the outcomes to other facilities with different scales, equipment, or management practices. The duration of the post-implementation evaluation period was relatively short, which may not fully capture the long-term sustainability of the observed quality improvements. Additionally, the analysis primarily focused on defect frequency as the performance metric, without incorporating more detailed assessments of defect severity or cost implications. Variations in operator skill levels and adherence to SOP guidelines outside of the formal observation period could also influence the results. The study did not account for potential seasonal variations in milk production and packaging operations, which may affect process consistency. These factors highlight the need for caution when extrapolating the findings to different operational contexts.

Suggestions

Future research should consider expanding the scope of evaluation to include multiple dairy facilities, allowing for comparative analysis across different operational scales and technological

capacities. Longitudinal studies tracking SOP compliance and quality outcomes over extended periods would provide deeper insights into the sustainability of procedural improvements. Incorporating additional performance metrics, such as defect severity, customer complaints, and economic cost savings, could yield a more comprehensive assessment of SOP effectiveness. Furthermore, exploring the integration of low-cost technological aids—such as digital checklists, QR-coded SOP manuals, or mobile-based quality tracking tools—could enhance adherence and monitoring efficiency. Stakeholder engagement, particularly involving customers and supply chain partners, could also be investigated to assess the broader market impact of improved packaging quality. Finally, collaborative programs between academic institutions, industry practitioners, and policymakers may help scale up the implementation of SOP-based interventions, fostering industry-wide quality improvement in the dairy sector.

CONCLUSION

This study demonstrates that the implementation of a well-structured Standard Operating Procedure (SOP) in the fresh cow's milk packaging process can lead to substantial and statistically significant improvements in product quality. The observed 40.7% reduction in average packaging defects, validated through Chi-Square analysis ($p = 0.013$), underscores the effectiveness of procedural standardization in minimizing operational errors. The most pronounced improvements were recorded in sealing consistency and hygiene compliance, reflecting the SOP's ability to address both technical and behavioral sources of defects. Beyond immediate operational benefits, these outcomes carry broader implications for sustainability, consumer trust, and food safety, positioning SOP adoption as a strategic quality management intervention. The participatory approach taken in SOP design and implementation proved critical to its success, as active involvement of operational staff fostered a sense of ownership, improved procedural adherence, and facilitated the iterative refinement of guidelines.

This finding aligns with prior research emphasizing workforce engagement as a key determinant of long-term compliance and performance improvement. Importantly, the low-cost nature of SOP development makes it a highly accessible intervention for small- and medium-scale dairy enterprises, particularly in resource-limited contexts where investment in advanced automation is not feasible. While the results are promising, their generalizability is limited by the single-site study design and relatively short post-implementation monitoring period. Future research should expand the scope to include multiple facilities, diverse operational scales, and longer-term evaluation to assess the sustainability of improvements. Nevertheless, the findings provide compelling evidence that SOP implementation is not merely an administrative exercise but a transformative tool for enhancing operational efficiency, safeguarding product quality, and strengthening competitiveness in the dairy industry. By bridging the gap between theoretical quality management frameworks and practical application, this research contributes actionable insights for practitioners, policymakers, and academics seeking scalable, cost-effective solutions to quality challenges in agri-food production.

AUTHOR CONTRIBUTIONS STATEMENT

Diptya Hadi Wulandresta Putri was responsible for conceptualizing the research framework, designing the study methodology, and overseeing data collection at the UPT PT and HPT Rembangan. She also contributed significantly to drafting and revising the manuscript to ensure academic rigor and alignment with the journal's standards.

Ariesia Ayuning Gemaputri contributed to the analysis and interpretation of the research data, prepared the visual elements including tables and figures, and assisted in writing and refining the discussion and conclusion sections. She also played a key role in proofreading, final editing, and ensuring the manuscript's compliance with international publication requirements.

Farah Kashif was involved in conducting an extensive literature review, synthesizing relevant theoretical and empirical studies, and aligning the research findings with international scholarly discourse. She also contributed to enhancing the clarity, coherence, and global relevance of the manuscript.

REFERENCES

Ausserhofer, D., Rakic, S., Novo, A., Dropic, E., Fisekovic, E., Sredic, A., & Van Malderen, G. (2016). Improving the safety and quality of nursing care through standardized operating procedures in Bosnia and Herzegovina. *International Nursing Review*, *63*(2), 208–217. https://doi.org/10.1111/inr.12237

Baena-Navarro, R., Carriazo-Regino, Y., Torres-Hoyos, F., & Pinedo-López, J. (2025). Intelligent prediction and continuous monitoring of water quality in aquaculture: Integration of machine learning and Internet of Things for sustainable management. *Water*, *17*(1), 82. https://doi.org/10.3390/w17010082

Barbé, B., Verdonck, K., Mukendi, D., Lejon, V., Lilo Kalo, J.-R., Alirol, E., Gillet, P., Horié, N., Ravinetto, R., & Bottieau, E. (2016). *The art of writing and implementing standard operating procedures (SOPs) for laboratories in low-resource settings: Review of guidelines and best practices*. *10*(11), e0005053. https://doi.org/10.1371/journal.pntd.0005053

Bonamigo, A., Nunes, A., Mendes, L. F., Martelotte, M. C., & Andrade, H. D. S. (2024). The interrelationship between Lean 4.0 and value co-creation: An empirical study in the dairy sector. *International Journal of Lean Six Sigma*, *15*(7), 1365–1392. https://doi.org/10.1108/IJLSS-06-2022-0141

Bunt, L., Greeff, J., & Taylor, E. (2024). *Enhancing serious game design: Expert-reviewed, stakeholder-centered framework*. *12*, e48099. https://doi.org/10.2196/48099

Byers, B. S., Stengele, K., & De Wolf, C. (2025). Data carriers for circular construction supply chains: An exploratory quantitative analysis. *Journal of Cleaner Production*, *494*, 145053. https://doi.org/10.1016/j.jclepro.2025.145053

Dutta, G., Kumar, R., Sindhwani, R., & Singh, R. Kr. (2021). Digitalization priorities of quality control processes for SMEs: A conceptual study in perspective of Industry 4.0 adoption. *Journal of Intelligent Manufacturing*, *32*(6), 1679–1698. https://doi.org/10.1007/s10845-021-01783-2

Galeazzo, A., Furlan, A., & Vinelli, A. (2021). The role of employees' participation and managers' authority on continuous improvement and performance. *International Journal of Operations & Production Management*, *41*(13), 34–64. https://doi.org/10.1108/IJOPM-07-2020-0482

Jamil, K., Zhang, W., Anwar, A., & Mustafa, S. (2025). *Exploring the Influence of AI Adoption and Technological Readiness on Sustainable Performance in Pakistani Export Sector Manufacturing Small and Medium-Sized Enterprises*. *17*(8), 3599. https://doi.org/10.3390/su17083599

Jukna, V., Meškinytė, E., Antanatis, R., Paulauskas, A., & Juozaitienė, V. (2024). *Determining the Association of the Dry Period Duration with Dystocia and Stillbirths in Dairy Cows by Considering Parity, Season, and Gestation Length*. *14*(10), 1444. https://doi.org/10.3390/ani14101444

Khan, A., Durrani, A. Z., Yousaf, A., Khan, J. A., Chaudhry, M., Khan, M. A., & Khan, A. (2019). *Epidemiology of Bovine Sub-Clinical Mastitis in Pothohar Region, Punjab, Pakistan in 2018. 51*(5). https://www.researchgate.net/profile/Arfan-Yousaf/publication/333861053_Epidemiology_of_Bovine_Sub-Clinical_Mastitis_in_Pothohar_Region_Punjab_Pakistan_in_2018/links/5d598412a6fdccb7dc476f43/Epidemiology-of-Bovine-Sub-Clinical-Mastitis-in-Pothohar-Region-Punjab-Pakistan-in-2018.pdf. https://doi.org/10.17582/journal.pjz/2019.51.5.1667.1674

Kontsevaya, S., Špička, J., Kharcheva, I., Makunina, I., & Kostina, R. (2018). Comparison analysis and control procedures of labor workforce efficiency of milk processors in Visegrad group and Russia. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *66*(1). https://doi.org/10.11118/actaun201866010263

Krzyżostan, M., Wawrzyńczak, A., & Nowak, I. (2024). *Use of waste from the food industry and applications of the fermentation process to create sustainable cosmetic products: A review*. *16*(7), 2757. https://doi.org/10.3390/su16072757

Layada, S., Benouareth, D.-E., Coucke, W., & Andjelkovic, M. (2016). Assessment of antibiotic residues in commercial and farm milk collected in the region of Guelma (Algeria). *International Journal of Food Contamination*, *3*(1), 19. https://doi.org/10.1186/s40550-016-0042-6

Masih, A., Rafique, A., Siddique, A. B., Nawaz, Z., Ali, S., Aslam, R., Mahmood, M. S., Abbas, R. Z., & Mehmood, T. (2022). Babesia bovis in large ruminants in Pakistan-molecular detection and haemato-biochemical alterations. *Acta Scientiae Veterinariae*, *50*. https://doi.org/10.22456/1679-9216.121920

Mohsin, M., Shamsudin, M. N., Jaffri, N. R., Idrees, M., & Jamil, K. (2025). Unveiling the contextual effects of total quality management to enhance sustainable performance. *The TQM Journal*, *37*(3), 680–708. https://doi.org/10.1108/TQM-05-2023-0124

Obeng, H. A., Arhinful, R., Mensah, L., & Owusu-Sarfo, J. S. (2024). Assessing the Influence of the Knowledge Management Cycle on Job Satisfaction and Organizational Culture Considering the Interplay of Employee Engagement. *Sustainability*, *16*(20), 8728. https://doi.org/10.3390/su16208728

Oliveira, L. R., Mathias, A. D., Pinto, M. S., Wenceslau, R. R., & Oliveira, N. J. F. (2020). Seasonality and collection routes influence the occurrence of non-acid unstable milk, the density and cryoscopy of milk supplied to a dairy industry in northern Minas Gerais. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia*, *72*, 1522–1534. https://doi.org/10.1590/1678-4162-11341

Ponnampalam, E. N., Kiani, A., Santhiravel, S., Holman, B. W., Lauridsen, C., & Dunshea, F. R. (2022). *The importance of dietary antioxidants on oxidative stress, meat and milk production, and their preservative aspects in farm animals: Antioxidant action, animal health, and product quality—Invited review*. *12*(23), 3279. https://doi.org/10.3390/ani12233279

Rosen, C. (2023). *Employee ownership in the USA: Lessons to consider in creating more inclusive capitalism*. *6*(3), 215–229. https://doi.org/10.1108/JPEO-11-2022-0029

Rosvall, M., & Gremyr, I. (2024). *Focus on processes contextualised: How QM process tools and practices can support sustainable development*. *36*(9), 94–113. https://doi.org/10.1108/TQM-11-2023-0378

Silva, S. R., Araujo, J. P., Guedes, C., Silva, F., Almeida, M., & Cerqueira, J. L. (2021). *Precision technologies to address dairy cattle welfare: Focus on lameness, mastitis and body condition*. *11*(8), 2253. https://doi.org/10.3390/ani11082253

Singh, R. (2025). *To propose recommendations to reduce milk spoilage for Verka in Faridkot warehouse*. https://www.theseus.fi/handle/10024/892983

Tezera, M., & Aman Ali, E. (2021). Prevalence and associated risk factors of Bovine mastitis in dairy cows in and around Assosa town, Benishangul-Gumuz Regional State, Western Ethiopia. *Veterinary Medicine and Science*, *7*(4), 1280–1286. https://doi.org/10.1002/vms3.454

Tiguh, E. E., Delele, M. A., Ali, A. N., Kidanemariam, G., & Fanta, S. W. (2024). *Assessment of harvest and postharvest losses of teff (Eragrostistef (Zucc.)) and methods of loss reduction: A review*. *10*(9). https://www.cell.com/heliyon/fulltext/S2405-8440(24)06429-6. https://doi.org/10.1016/j.heliyon.2024.e30398

Villa, L., Gazzonis, A. L., Fumagalli, E., Zanzani, S. A., & Manfredi, M. T. (2022). *The utility of serological analysis for Neospora caninum infection in dairy cattle farms management: Serological investigation and evaluation of the effects on reproductive and productive performances in two study herds in northern Italy*. *12*(6), 786. https://doi.org/10.3390/ani12060786

Vroegindewey, R., Richardson, R. B., Ortega, D. L., & Theriault, V. (2021). *Consumer and retailer preferences for local ingredients in processed foods: Evidence from a stacked choice experiment in an African urban dairy market*. *103*, 102106. https://doi.org/10.1016/j.foodpol.2021.102106

Yang, T., Jiang, W., Luo, C., Hu, J., Xu, W., Zhang, P., Jin, X., Zhou, Y., Liu, R., & Qian, Z. (2025). Multidimensional analysis of sensory perception and neurophysiological responses to marinated beef cooked by diverse methods. *Innovative Food Science & Emerging Technologies*, 104058. https://doi.org/10.1016/j.ifset.2025.104058

Zeferino, E. S., Carvalho, C. da C., Rocha, L. A. C., Ruas, J. R. M., & Reis, S. dos. (2017). *Quality of milk produced in the semiarid area of Minas Gerais State.* https://www.cabidigitallibrary.org/doi/full/10.5555/20173100242

Zhang, Y., Guan, L., & Jin, S. (2022). *Trust and consumer confidence in the safety of dairy products in China*. *124*(11), 3644–3665. https://doi.org/10.1108/BFJ-05-2021-0508