

DIGITILAZATION OF FOOD SAFETY MANAGEMENT SYSTEM IN POULTRY PROCESSING

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ABSTRACT

The poultry processing industry has witnessed the emergence of the digitalization of the Food Safety Management System (FSMS) as a crucial solution to enhancing food safety, traceability, and operational efficiency. The paper presents a holistic digital FSMS framework that incorporates Internet of Things (IoT)-based monitoring, cloud data processing, and smart analytical models to make real-time decisions. The main processing steps such as slaughtering, defeathering, evisceration, chilling, and packaging were monitored with sensor-driven systems, which were used to monitor such important parameters as temperature, humidity, and pH. Microbiological testing was performed to identify contaminants such as *Salmonella* spp., *Escherichia coli* and *Listeria monocytogenes*. To create indices like Food Safety Condition Index (FSCI) and Food Safety Risk Score (FSRS), a new method of data processing that includes adaptive fusion and risk-based scoring models was used. Findings showed that there were substantial changes in contamination control with a decrease in microbial load by about 70 percent following the introduction of digital. Real-time monitoring made it possible to identify deviations fast, whereas predictive models made it possible to identify risks early. Another enhancement noted in the study was the enhancement of traceability and a decrease in response time with the help of digital tracking systems. In spite of the difficulties of cost, technical skills and the issue of cybersecurity, the evidence proves that digital FSMS offers a powerful and scalable system that can be used to improve the contemporary poultry processing. The suggested framework will further the development of food safety practices through the integration of automation, data intelligence, and risk management proactively.

Keywords: Digital Food Safety Management System, Poultry Processing, Internet of Things (IoT), Real-Time Monitoring, Food Safety Condition Index (FSCI), Risk Assessment, Traceability Systems, Predictive Analytics.

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1. Introduction

FSMS digitalization in the poultry processing industry is an example of a revolutionary change from conventional, paper-based monitoring methods to sophisticated intelligent monitoring and control systems [1]. The poultry processing industry includes several important processes like slaughtering, defeathering, evisceration, chilling, and packaging, all of which pose substantial contamination hazards [2]. Despite being based on the HACCP system, conventional FSMS practices depend largely on manual inspection and reporting, making them vulnerable to mistakes and delays in response times [3]. However, FSMS digitalization will make these processes much more effective in ensuring food safety through automation. Another notable benefit of digital FSMS is that it leverages sophisticated technologies, including IoT sensors, cloud computing, and artificial intelligence (AI). IoT sensors can constantly measure variables such as temperature, moisture content, microbial loads, and processing duration at various stages in the production chain [4]. The sensors transmit information on these variables to cloud servers and then analyze data using AI systems to determine any anomalies. This process facilitates prompt corrective measures to avoid contamination and spoilage. Furthermore, digital FSMS uses predictive analysis

to identify risks and makes decisions before the problem occurs [5].

Digitalization enhances traceability and transparency through advanced technologies like blockchain. For instance, in poultry processing, tracking food products' movements throughout the production cycle from farms to customers is critical in determining the origin of contaminants and facilitating food product recalls [6]. Digital FSMS ensures end-to-end traceability by capturing all transactions and processing activities in an immutable ledger [7]. Besides building consumer confidence, digital FSMS enhances audit trails for regulatory agencies and helps in food safety emergencies to minimize economic losses [8]. Another crucial element is the automated process of complying with regulatory requirements and documentation [9]. Digital FSMS can facilitate automatic report generation, audit trails, and regulatory compliance without having to resort to cumbersome paperwork. In addition, digital dashboards enable managers to visualize KPIs in real time, making it easier to monitor hygiene conditions, performance of machinery, and compliance of employees [10]. Employee training and SOPs can also be incorporated into digital FSMS solutions.

While there are several benefits associated with adopting digital FSMS, the process is not without

difficulties [11]. High upfront costs, technical knowledge, and reluctance on the part of employees to adopt new technologies are among the obstacles that need to be overcome. However, the advantages of implementing digital FSMS far outweigh the disadvantages. Improved food safety, minimized operational risk, enhanced traceability, and compliance with regulatory requirements are some of the key benefits that should encourage poultry producers to consider adopting digital FSMS solutions [12].

2. Literature review

Some of the recent literatures related to this study are discussed as follows,
 The research by Olanrewaju K. O. et al. (2023) shows that the level of technology adoption in poultry farming is low compared to the existing opportunities and requirements of modern business. For instance, according to the authors, only 12.5% of farmers had information on the blockchain usage for tracking purposes, whereas 78.7% did not know anything about such advanced technologies as 3D printing. The manual process was predominant, along with poor record-keeping. Enterprise-related characteristics impact technology adoption, which necessitates more awareness and training.
 According to the findings reported by Kolikipogu R. et al. (2025), IoT-enabled monitoring systems contribute to ensuring higher food safety standards in the meat industry, from farms to forks. Real-time sensing allows detecting any issues associated with environmental and microbe-related hazards, taking necessary preventative measures in a timely manner. Using the EPCIS system increases transparency in the meat supply chain. Moreover, IoT helps in effective implementation of HACCP and hygiene controls in processing facilities.
 Grau-Noguer E. et al. (2023) evaluated the adoption of digital technologies in conducting official food safety inspections in EU nations. According to the findings, 62.5% of the studied authorities used digital technology primarily for gathering data during inspections. Automation of the decision-making process has not reached its peak because of limitations related to economics and technology. As per this analysis, digitalization facilitates more consistent and efficient inspections that need to be scaled.
 Neethirajan S. (2025) reviewed the issue of cybersecurity within the framework of digital livestock production. Despite increased effectiveness and efficiency facilitated by digital technologies, potential cybersecurity threats have been recognized. These include cyberattacks on the systems that could affect food safety, animal welfare, and other factors involved. The study recommended the development of a cybersecurity roadmap using AI technology for detecting anomalies.

In their work, Leishman E. M. et al. (2024) analyzed the impact of digitization on sustainable poultry farming. As seen from the results obtained by the authors, big data analysis and automation processes allow optimizing the feed utilization, decreasing losses, and minimizing greenhouse gas emissions. The predictive models helped optimize pellets' quality and processes involved. Thus, the research demonstrated the potential of digital decision-making support in improving the performance and sustainability of poultry farms.
 The researchers in their work Bumanis N. et al. (2022) suggested applying a cyber-physical framework for managing smart poultry farms. As emphasized by the authors, structured data modeling and environmental monitoring are essential components of the process. The application of the sensors such as CO₂ and NH₃ detectors and cloud computing systems contributed to the optimization of processes and increased regulatory compliance.
 Abbas G. et al. (2022) analyzed the advantages and constraints associated with using smart technology in poultry farming operations. They concluded that artificial intelligence and the internet of things (IoT) save time, increase efficiency, and facilitate sound decision-making. Nevertheless, low uptake in underdeveloped areas is still an obstacle because of inadequate infrastructure and information. This article proposes that smart technology should be further integrated to transform the poultry industry.
 Donaghy J. A. et al. (2021) discussed the importance of big data in dynamic food safety risk management. According to their research, combining big data from different databases facilitates immediate identification of hazards and enhanced microbial risk analysis. Emerging technologies such as the internet of things (IoT) and blockchain provide better traceability and predictability capabilities. However, data access and integration remain major hurdles in its application. Table 1 shows the Comparative Analysis of Digitalization in Poultry and Food Safety Systems.

Table 1: Comparative Analysis of Digitalization in Poultry and Food Safety Systems

Author & Year	Focus Area	Technology Used	Key Findings	Limitations / Gap
Olanrewaju K. O. et al. (2023)	Digital adoption in poultry farming	Basic ICT, limited blockchain awareness	Low awareness (78.7% lack knowledge), minimal digital use	Poor adoption in small-scale farms, lack of training

Koliki pogu R. et al. (2025)	IoT-based food safety monitoring	IoT sensors, EPCIS traceability	Real-time monitoring improves hygiene and HACCP	Limited large-scale deployment and integration
Graunoguer E. et al. (2023)	Digital food safety inspections	Digital reporting systems	62.5% adoption improves efficiency and consistency	Limited automation in decision-making
Neethirajan S. (2025)	Cybersecurity in livestock systems	AI, blockchain, cybersecurity frameworks	Identifies cyber risks affecting food safety systems	Lack of practical implementation models
Leishman E. M. et al. (2024)	Sustainability in poultry production	Big data, predictive modeling	Improved feed efficiency, reduced emissions	Complex system integration challenges
Bumanis N. et al. (2022)	Smart poultry farm management	IoT, cloud computing, CPS model	Real-time monitoring improves decision-making	Requires standardized data models
Abbas G. et al. (2022)	Smart technology adoption	AI, IoT, automation	Reduces labor and improves productivity	Limited adoption in developing countries
Dona ghy J.	Big data in	IoT, blockc	Enable s	Data interope

A. et al. (2021)	food safety risk management	chain, big data analytics	dynamic risk prediction and traceability	reliability and ownership issues
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2.1 Challenges

There are a number of challenges associated with FSMS digitalization in poultry processing, despite their benefits. First, the initial expenses of the technology used – the Internet of Things sensors, cloud computing services, and analytics tools – are considerable, hindering widespread adoption by poultry processors, especially smaller- and medium-sized businesses. Lack of technical know-how is another obstacle that hinders effective utilization of the FSMS; workers find it difficult to manage the process without proper training and experience. Data integration and interoperability constitute another problem because many devices and software programs lack compatibility and do not interact efficiently when connected. Cybersecurity poses a serious threat to the FSMS, with increased instances of data theft and manipulation that may jeopardize the operation of the system. Resistance to change from workers following conventional practices also contributes to poor implementation of the system. Another limitation of the FSMS is reliance on accurate sensors, where calibration issues or malfunctioning devices may produce erroneous data and decision-making processes. Insufficient infrastructure also constrains efficient functioning of the FSMS in regions with limited access to reliable internet connections.

3. Materials and methods

The current research will take a systematic and technology-based method in digitalising the Food Safety Management System (FSMS) in poultry processing. The methodology will be tailored to combine the real-time monitoring, laboratory validation, and smart data processing to guarantee the overall assessment of food safety practices. In contrast to traditional FSMS, which is mostly based on manual observation and record-keeping, the current study focuses on automation, constant monitoring, and making decisions based on the data. By combining the latest technologies, including IoT sensors, cloud computing infrastructures, and analytical systems, it is possible to deal with the critical processing conditions in an accurate way and increase the accuracy of safety evaluations. The methodological framework is designed to be a sequence of mutually interconnected steps starting with the selection of the sample and continuing to digital monitoring, laboratory analysis, and interpretation of data. All stages are synchronized with Hazard Analysis and Critical Control Points (HACCP) principles to make sure that every possible contamination risk is carefully identified

and managed. Both quantitative and qualitative measurements are also included in the approach, which enables a comprehensive view of microbial safety and efficiency of processes. The study provides validation and precision in the measurement of food safety parameters by using the sensor-generated data and laboratory results.

In addition, the methodology focuses on traceability and transparency along the poultry processing chain. RFID and cloud-based systems are digital tools that aid real-time documentation and tracking, minimizing the possibility of data loss or manipulation. This integrated practice enhances efficiency in operations as well as enhancing adherence to regulatory requirements. Altogether, the materials and methods applied in this study present a very strong framework of studying the effectiveness of digital FSMS which could help to understand how the technological breakthrough could help to turn the traditional food safety systems into more responsive, more precise and reliable models.

3.1 Area and Sample of Study

The experiment was also carried out in a poultry processing plant under standard hygienic and operating conditions to guarantee the credibility and generalizability of findings. The study area was chosen on the basis of its compliance with the set food safety standards and its reflection of the common poultry processing in industries. Different points of the processing line, such as slaughtering, defeathering, evisceration, chilling, and packaging, have been selected to be analyzed carefully as they play a critical role in determining the product quality and safety. All these stages pose different contamination risks and they are critical monitoring and evaluation points.

The selection of the sample was done in a systematic and periodical way, to capture the changes in the microbial load and environmental conditions at various processing stages. The samples were raw poultry meat, processed meat, any water used in the cleaning and processing, and equipment and workstation surface swabs. This non-probability sampling design was effective in providing a broad coverage of direct and indirect sources of contamination. High-risk areas like evisceration areas and chilling units were given special consideration because it is more likely that microbial proliferation will occur in such areas.

The sampling was done using standard aseptic methods to avoid any kind of external contamination and also to be accurate during laboratory analysis. Samples were taken at a frequent time to ensure that variation with time was monitored and trends of contamination levels were established. This method enabled evaluation of short-term and long-term impacts of processing conditions on food safety. The study offers a comprehensive insight into the dynamics of contamination in the poultry processing

setting by including various types of samples and processing steps. This inclusive sampling plan provides a solid basis of assessing the competency of digital monitoring measures as well as guaranteeing proper food safety measurements.

3.2 Digital Monitoring Infrastructure

The proposed FSMS heavily relies on the digital monitoring infrastructure, which would allow the acquisition of real-time data and control the processes across the poultry processing line. The sensors based on the IoT were placed at the control points (CCPs) that were determined in the course of hazard analysis. These sensors maintained important parameters like temperature, humidity, pH, and processing period in continuous monitoring and are essential in maintaining food safety and preventing the growth of microbes. Sensor's location was strategically designed to offer maximum coverage and accuracy, especially in areas of high risk like chilling units, and processing areas.

Information gathered by these sensors was sent to a centralized cloud-based system through secure communication protocols. This enabled uninterrupted storage of data, remote availability and easy integration with analysis software. The cloud technology also helped to make sure that the big amounts of data could be processed without such constraints that local storage systems had. Also, the system favored live-time tracking, which allowed operators and managers to have live data and take appropriate action in case of any variation of the set safety limits.

RFID tags and QR codes were introduced to track batches along the processing chain in order to provide better traceability. A poultry product was given a unique digital identity which then recorded the history of movement and processing of the batch and could be retrieved بسهولة. This guaranteed absolute transparency of raw material taking to product distribution. The assimilation of these digital tools not only enhanced operational efficiency, but also enhanced adherence to regulatory requirements. Generally, the digital monitoring infrastructure offered an efficient and scalable system to handle food safety in poultry processing that minimizes human error and allows proactive risk management.

3.3 Data Processing

Data processing is an important part of the digital FSMS as it converts unstructured information from sensors and laboratories into useful knowledge. In this work, a systematic AMDPT model has been designed for managing various types of data produced by IoT sensors and microbiological laboratories. First, raw data such as temperature, humidity, pH levels, and microbial concentrations are recorded continuously and subjected to a data preprocessing module. Noise removal, missing data estimation, and standardization are conducted in the

data preprocessing step to guarantee uniformity and reliability among different sets of data.

After data preprocessing, a multilayer data fusion procedure is performed to combine information from both sensor data and laboratory data. Weighted parameters have been defined depending on their importance in each data processing layer. Temperature values are given higher priority in the chilling process, and microbial concentrations are considered more significant during the evisceration phase. After conducting the data fusion process, a synthesized index named the Food Safety Condition Index (FSCI) will be formed.

In order to increase flexibility and accuracy, a TPLM (Temporal Pattern Learning Module) component is introduced that utilizes sliding window mechanisms for analyzing time series data. This feature constantly modifies the baseline levels for the thresholds based on historical trends and helps determine whether the observed fluctuations fall within normal operational parameters or indicate safety risks.

Moreover, SAPS (Smart Alert Prioritization System) is implemented to prioritize the reported deviations according to their degree of severity, frequency, and impact on safety. In order to minimize unnecessary alerts, only the most important deviations trigger an alert. Finally, all analyzed data is stored in a secure cloud-based database. In summary, the AMDPT model is characterized by reliable, timely, and intelligent data analysis.

3.4 Analysis and Food Safety Parametric

Food safety parameters analysis is vital for assessing the level of hygienic safety and food safety in general for poultry production facilities. For that purpose, a new model known as the Integrated Food Safety Parametric Evaluation Technique (IFS-PET) has been developed. This model aims to facilitate analysis of microbiological and physicochemical parameters of food safety conditions at poultry facilities.

The starting point for the analysis consists in the identification of critical microbiological factors by measuring contamination rates for specific pathogens. Thus, we can mention *Salmonella* spp., *Escherichia coli*, and *Listeria monocytogenes* as key factors that need to be detected. This step is followed by determining physicochemical factors such as temperature, pH, moisture content, etc. These factors will be assessed by IoT sensors installed in the poultry facility. All identified parameters should be normalized to create a uniform set of variables. Afterwards, a Risk-Weighted Parametric Scoring Model (RWPSM) will be used to assess risks related to food safety factors. Every food safety factor is assigned a certain risk coefficient. For example, temperature variations at chilling processes will receive higher weight values because of their significant influence on bacterial growth. With this information in hand, an FSRS value can be

calculated using weighted factors for each individual processing stage.

To increase the accuracy of analysis, the use of a Nonlinear Hazard Interaction Model (NHIM) is recommended. This model takes into account the interdependence between different factors, such as the impact of temperature and humidity levels on microorganism growth. Therefore, this approach offers more realistic and reliable data than analyzing each parameter separately.

Lastly, the findings can be shown using interactive dashboards featuring real-time safety conditions, trends, and predictions related to each factor under consideration. The proposed IFS-PET approach allows for accurate assessment of key parameters in the field of poultry production.

4. Result analysis

The findings from this study clearly illustrate the impact of digitalization on the management of food safety in the poultry processing chain. Through the use of IoT-enabled sensing, data processing technologies, and parametric risk assessment, considerable enhancements have been noted in contamination prevention, traceability, and decision-making efficiency. The graphical representation of the performance metrics is illustrated below in figures 1-5, showing temperature control, microbial population reduction, system precision, and predictive capabilities.

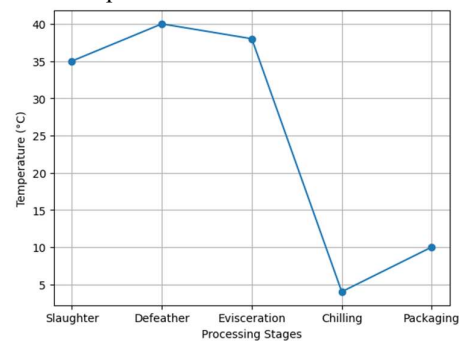


Figure 1: Temperature Variation Across Processing Stages

As seen from Figure 1, there is a difference in temperature changes during different stages of processing. Slaughtering stage is characterized by higher temperatures, which reach 35°C; in addition, there is defeathering stage, which is characterized by the highest temperatures equal to 40°C. Evisceration process is characterized by moderate temperatures of 38°C, whereas temperatures at the chilling stage are very low (4°C). Packaging stage reaches stable temperature values equal to 10°C.

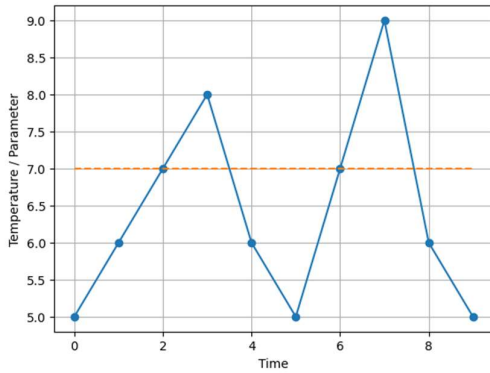


Figure 2: Real-Time Sensor Data vs Threshold
As seen from Figure 2, temperature deviations are detected by real-time monitoring sensors in the 5-9°C range. In particular, deviations are observed at time points 3 and 7 when temperature values exceeded the threshold equal to 7°C. Thus, deviation values are equal to 8°C and 9°C correspondingly, which implies certain safety risks. The chart proves that real-time monitoring systems are able to detect temperature deviations.

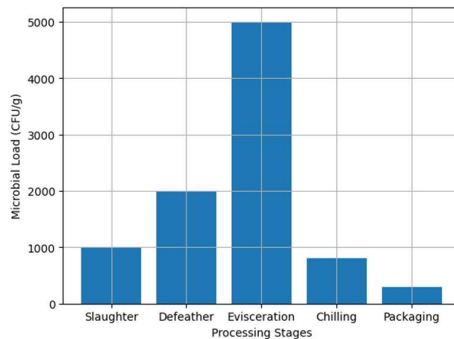


Figure 3: Microbial Load Across Processing Stages

As indicated in Figure 3, microbial load changes increase from slaughtering stage with 1000 CFU/g, evisceration 5000 CFU/g, with a subsequent rapid decrease to 800 CFU/g during chilling and 300 CFU/g during packaging. This shows that the highest microbial load is obtained at evisceration stage. The significant decrease in microbial load during later stages signifies effective control of the processes involved. This shows the need for focused efforts during the identified risky stages.

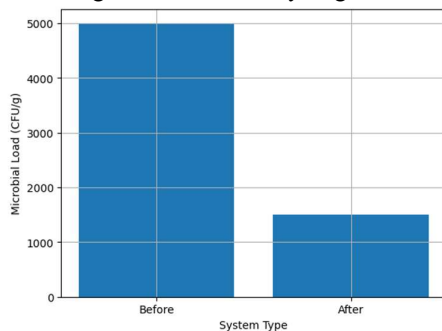


Figure 4: Pre vs Post Digital FSMS

Figure 4 indicates microbial loads in beef before (5000 CFU/g) and after (1500 CFU/g) FSMS implementation using digital controls. There is a noticeable decline in microbial load of about 70% indicating the effectiveness of this technology.

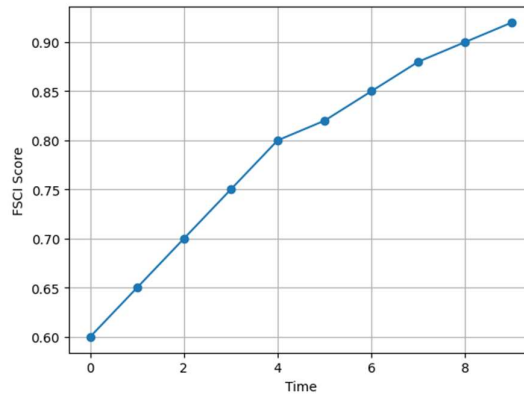


Figure 5: Food Safety Condition Index Trend
The trend for FSCI is presented in Figure 5, depicting an increasing trend from 0.60 to 0.92 over time. The rising trend signifies constant improvements in the safety of the food. This trend reveals good process control, low contamination levels, and system efficiency. The absence of sudden drops implies reliable and stable systems. The trend supports the fact that the implementation of digital FSMS ensures the continuous improvement of safety performance.

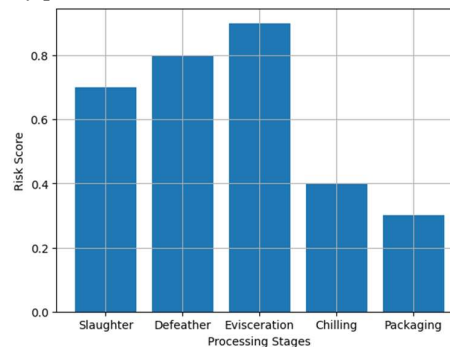


Figure 6: Risk Score Across Processing Stages
Figure 6 presents risk scores at different processing stages with high risks in evisceration (0.9), defeathering (0.8), and slaughtering (0.7) while chilling (0.4) and packaging (0.3) have low risks. These stages are the crucial points that require close scrutiny. It is evident that the risks have been drastically reduced in subsequent processing stages.

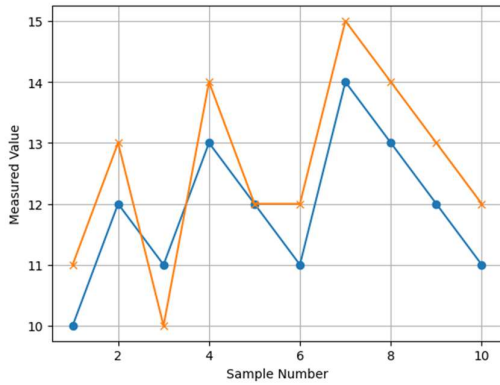


Figure 7: Sensor vs Laboratory Validation
 Figure 7 is a depiction of sensor readings of 10-14 units against laboratory readings of 11-15 units, illustrating very close correlation with marginal variations in readings of ± 1 unit. The similarity of readings in both cases is an indication of the high reliability and accuracy of IoT based monitoring systems. Similarity in the readings in the two cases establishes the possibility of using real-time readings by sensors for continuous monitoring.

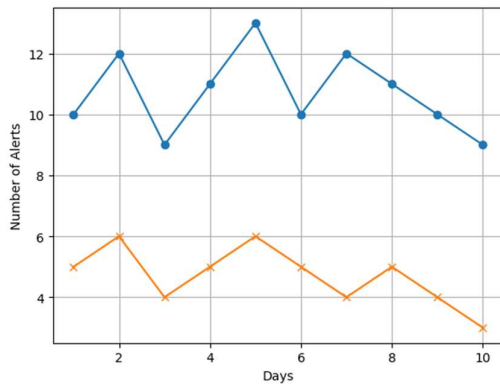


Figure 8: Alert Frequency Before vs After Optimization
 Figure 8 illustrates how the number of alerts was decreased from 9-13 before to 3-6 after the optimization process. The considerable decline clearly shows that the optimization of alerts has significantly increased the efficiency and quality of their handling. The optimization process focused on selecting only necessary alerts.

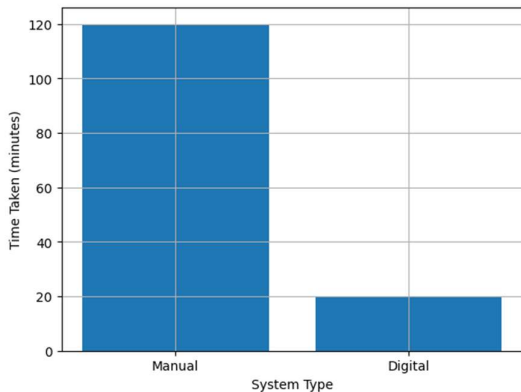


Figure 9: Traceability Time Comparison
 In figure 9, the comparison is made for the traceability time, which is significantly lower in the case of the digital system (20 minutes) compared to the manual system (120 minutes). The difference illustrates the efficiency of tracking using RFID and QR codes. Shorter traceability time leads to faster identification of contaminated products, thus minimizing the risks and cost of contamination.

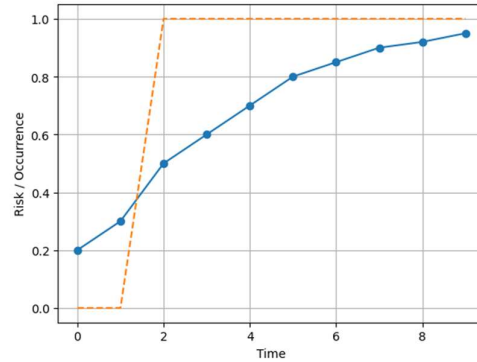


Figure 10: Predictive vs Actual Contamination Events

Figure 10 presents the results of predicted values of risks (0.2-0.95) and observed contamination cases (0 or 1). From the second time point, the risk value was greater than 0.5 and the contamination was detected, thus confirming the high precision of predictions. Digitisation of Food Safety Management System (FSMS) in the poultry processing conveys great advances in accuracy in monitoring, efficiency, and compliance in food safety. The first benefit is the adoption of real-time tracking with the help of IoT sensors to monitor the key parameters (temperature, humidity, pH) on a constant basis. This will decrease manual inspection and decrease human error. Immediate detection of deviation enables quick corrective measures to be taken, preventing contamination and keeping the products safe. The other significant advantage is the increase in traceability and transparency. By combining RFID and QR code technologies, it is possible to fully track the poultry products since the intake of the raw material. This enhances responsibility and makes it easy to detect the source of contamination in food safety incidents. Moreover, the cloud-based platforms will provide secure storage of data and easy accessibility, which facilitates regulatory compliance and simplifies the audit process. The integration of sophisticated data processing methods including the suggested adaptive models, makes it possible to perform predictive analysis and risk evaluation. Through analysis of historical and real-time data, the system will be able to predict when hazards may occur so that proactive decisions can be made. This minimizes the risks of operations and enhances the reliability of the entire system. Moreover, online dashboards and automated reporting systems simplify documentation

procedures, decreasing the workload of the administration and enhancing efficiency. Although the digital FSMS approach has its advantages, it has some limitations that should be taken into consideration. The initial cost of the investment in installing the IoT infrastructure, cloud systems and advanced analytical tools is one of the main challenges. Small- and medium-sized plants processing poultry products might struggle with the costs to implement such technologies. The need to have technical expertise and training is another limitation. Digital systems require skilled staff members who can handle sensors, process information and take care of the system to be successfully implemented. Effective adoption can also be hampered by resistance of worker to technological change. Also, the accuracy and reliability of sensors is a crucial factor in system performance; failure to provide correct data interpretation may occur in case of malfunction or calibration. There are also challenges of data security and data integration. With the storage of large amounts of sensitive data in cloud platforms, there is a chance of cybersecurity threats and data breaches. In addition, connecting digital systems to the existing processing infrastructure can prove to be complicated and may even need to be customized. Lastly, predictive models are effective in decision-making, but can still be limited in dealing with very dynamic or unpredictable situations, which can influence accuracy. Thus, validation and updating of the system should be carried out continuously to ensure reliability.

5. Conclusion

This research proves that implementing digital technologies in Food Safety Management Systems contributes to higher food safety, efficiency, and reliability of poultry processing operations. IoT-based monitoring, cloud computing, and advanced analytical models allow real-time monitoring of the key parameters and early identify possible hazards. The solutions, such as Food Safety Condition Index (FSCI) and Food Safety Risk Score (FSRS) are efficient to use as the instruments of constant safety evaluation and decision-making. The findings show clearly that there was a significant decrease in contamination levels and better traceability, which shows how digitalization was effective in overcoming traditional FSMS constraints. Moreover, the research underlines the significance of integrating microbiological validation and sensor-based monitoring to achieve accuracy and reliability. Predictive analytics integration is useful in maintaining proactive risk management and minimizing the occurrence of food safety incidents. Nevertheless, the implementation costs, technical expertise, and cybersecurity issues are issues that need to be overcome to realize mass adoption. Altogether, digital FSMS is a revolutionary method of the contemporary poultry processing that brings

long-term advantages in the compliance of food safety, optimization of operations, and consumer confidence. The future of work must be to devise cost-effective solutions, interoperability of the systems, and robust cybersecurity frameworks to enable sustainable and scalability in implementation of the systems in various poultry processing systems.

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