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Integrating Technology in the Assessment and Egg Sorting System of Farm Egg Quality

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ABSTRACT

Objective: *This research assessed the acceptability of the developed sensor based for the assessment and inventory tracking system of farm egg quality during the academic year 2024-2025 towards technology adoption. Craft and implement the proposed system design of farm egg quality and tracking system.* ***Method:*** *This research study employed quantitative research using applied design with the use of descriptive methods to assess the acceptability of the develop sensor-based inventory tracking system of farm egg quality. Experts and non-experts from the Computer Technology and Agriculture Departments at Cebu Technological University-Tuburan Campus, as well as owners of poultry farms, made up the respondents.* ***Results:*** *With an overall factor average mean of 4.51 HA, the system was regularly rated better by non-experts (4.57) than by experts (4.44). Although the system is highly appreciated, real-world application still confronts modest obstacles, as seen by the maximum score of 4.73 HA for perceived usefulness and the lowest score of 4.29 HA for actual utilization. Perceived usability, use with behavioral goals, and actual usage were all strongly positively correlated. Its capacity to improve efficiency, expedite processes, and track egg quality in real time was especially appreciated by users. Concerns were expressed regarding the system's automated efficiency, tracking of financial data, and integration with current farm management technologies. The obvious relationship between usability, users' intentions, and actual usage highlights the necessity of a straightforward and user-friendly design to encourage adoption.* ***Novelty:*** *Its capacity to improve efficiency, expedite processes, and track egg quality in real time was especially appreciated by users.*

INTRODUCTION

The use of practical technology for assessing and monitoring egg quality is becoming increasingly important in modern poultry farming. With growing demand for consistently high-quality eggs, farm operators are looking for systems that are reliable, efficient, and cost-effective to support grading and handling processes. A potential solution lies in automation and sensor-based technologies that will boost the accuracy and consistency of egg assessment without the need to use a lot of manual labor and reduce human error. They can be used to accurately monitor the environmental conditions and the health of birds and enhance the process of collecting and analyzing data, providing the farmers with the information necessary to make the right decisions based on the results. Moreover, real-time monitoring is made easier with convenient web and mobile dashboards and allows the staff of the farm to control the production data more efficiently. It is important to focus on integration of technology to cope with the demands of growing regulations of food safety and fulfill consumer requirements of transparency and traceability in food supply chain.

Despite the promising advancements in integrating technology for egg quality assessment and inventory tracking, notable gaps remain in both research and practical application. The limited investigation of non-destructive optical sensing technologies created especially for real-time egg quality monitoring in various production conditions is one important gap. Although these technologies' potential has been demonstrated in lab research, their widespread application in the poultry sector is still limited, which lessens their impact on enhancing product quality and safety [1]. Previous studies, such as those by Zhang et al. and Omid et al., introduced machine vision and automated egg grading methods; however, these approaches often lack the flexibility to adapt to individual user needs [2], [3]. The current system addresses this limitation by offering customizable sorting options, accommodating different egg sizes, and responding to user preferences in real-time, resulting in more precise grading and improved efficiency in egg processing.

With the abovementioned gaps, the researcher seeks to have integrated technology on the assessment and tracking system of farm egg quality. As the egg industry moves into the age of Industry 4.0, the adoption of advanced technologies will be critical for long-term success. By investing in technology today, poultry farmers can ensure their operations are well-positioned to meet the challenges of tomorrow [4].

To proactively support the Sustainable Development Goals (SDGs) of the United Nations particularly SDG 3: Good Health and Well-Being. Guarantee every person's health as well as well as wellness at all ages. 8th Sustainable Development Goal: Decent Work and Economic Growth. Encourage full and productive employment, equitable and sustainable economic growth, and decent work for all. Generally, SDGs 3 coupled with 8 advertise financial development, minimize food waste, boost food security, as well as boost working problems in the egg manufacturing market [5]. These aspects sustain research studies on inventory tracking and egg quality assessment. Hence, this study designs and proposes Egg Quality Assessment and Inventory Tracking in Cebu Technological University-Tuburan Campus Poultry Farm and subsequently determines its effectiveness and acceptability as perceived by the respondent [6].

MATERIALS AND METHODS

Design. This research study employed quantitative research using applied design with the use of descriptive methods to assess the acceptability of the develop sensor-based inventory tracking system of farm egg quality. It also determined the significant relationship between the perceived usability and use with behavioral intention regarding the developed system in actual usage. At the same time, this study utilized survey questionnaires as a primary tool in data gathering to generally assess the actions of the experts and non-experts on ensuring efficient and effective operations in poultry farming.

Research Respondents. The population of respondents in the study included both experts and non-experts at Cebu Technological University-Tuburan Campus and the owners of the poultry farms including also the members of the CompTech and Agriculture Departments. The researchers particularly targeted the participants who work in BIT and Agriculture Departments. The expert respondents were chosen because of their experience and specialized knowledge of technology and related areas and a majority of them had graduate or master's degree, professional certifications as well as National Certification II (NCII). These people were with a lot of professional experience in their fields, and they were selected using purposive sampling. On the other hand, none of the respondents (non-experts) possessed any formal technological qualifications or professional experience. They were representatives of the common people having different backgrounds, who had nothing to do with the technological industry and were chosen through random sampling in the fishbowl method. The researchers wanted to obtain information regarding the decision made by the respondents, their experiences and their general satisfaction.

Instrument. The study employed a modified survey questionnaire patterned by Nicolas Abdel-Nour which underwent review by the advisor and validations by experts [7]. The questionnaire was structured into two sections, the first focusing on evaluating the acceptability of the Farm Egg Quality Assessment and Inventory Tracking system. A five-point Likert scale was used to measure both experts' and nonexperts' opinions on how acceptable the Egg Quality Assessment and Inventory Tracking system was worked. Respondents could rate the system's effectiveness on a scale of 1 (Highly Unacceptable) to 5 (Highly Acceptable).

Data Gathering Procedures. The researchers distributed survey questionnaires to the selected participants to collect data. They showed them a working product, provided the general description of the study, and allowed the participants to test it, discuss it, and meditate on it during face-to-face surveys. The researchers then collected the entire questionnaires. The fact that the researchers presented the results in a table enabled them to talk to the participants directly, which provided result in more truthful answers.

Statistical Treatment of Data. The data collected from the survey questionnaire were analyzed using specific statistical procedures to ensure a comprehensive understanding of the results. The weighted mean method was employed to evaluate respondents' perceptions of product effectiveness and acceptability, summarizing the overall level of agreement or satisfaction by assigning appropriate weight to each response category. Additionally, Pearson's r was used to determine the significant relationship between perceived usability and use with behavioral intention, measuring the strength and direction of the linear correlation between these variables and the actual usage of the product.

RESULTS AND DISCUSSION

Results

Technical Requirements

A. **Design**

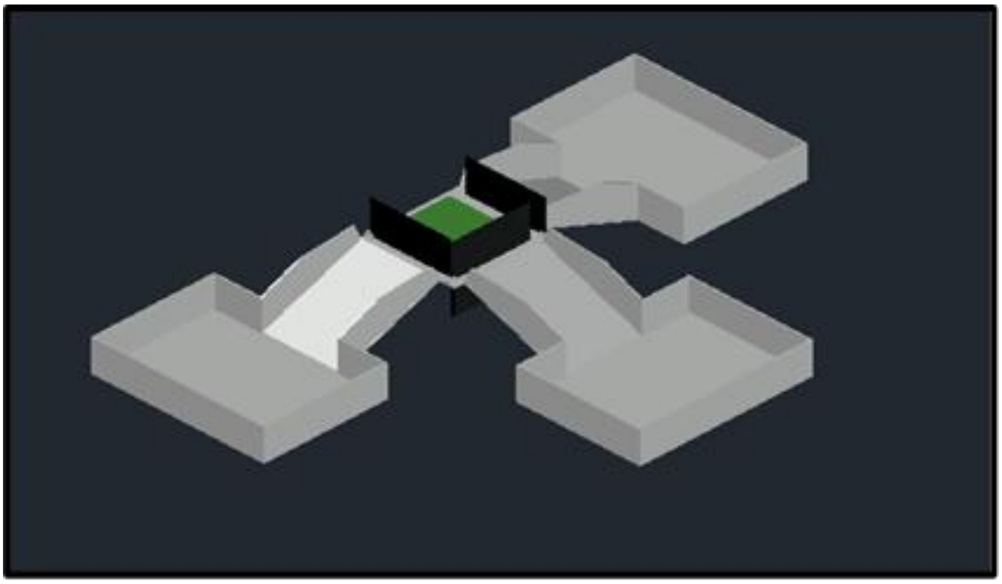

Figure 1. Auto Cad Design of Tracking System of Farm Egg Quality.

B. Features

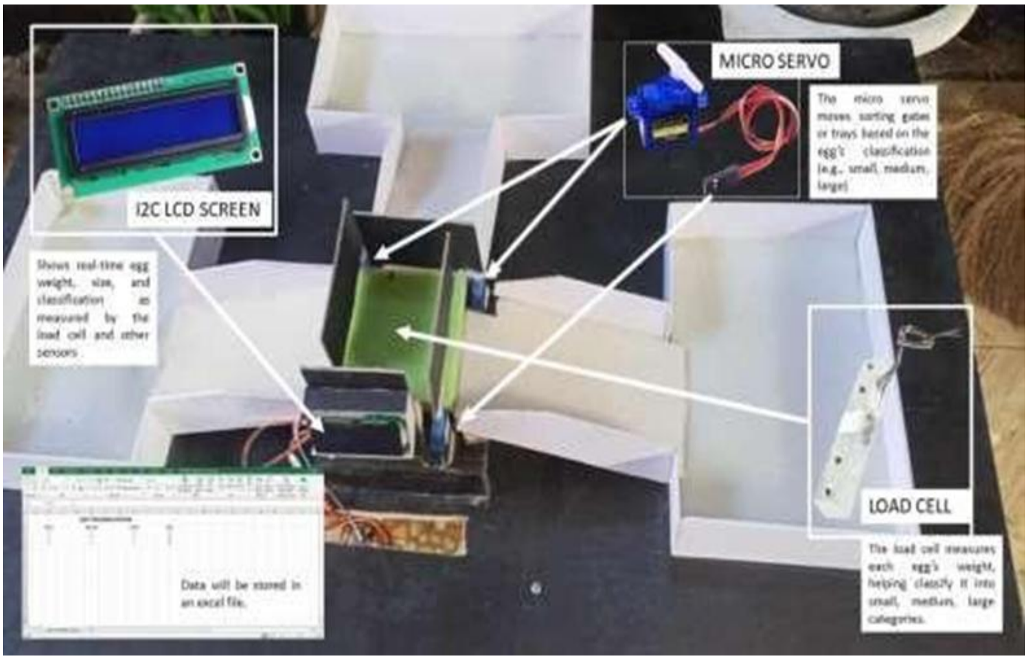

Figure 2. Features of the Egg Tracking System.

C. Tools and Materials

Item no.	Unit	Materials
1	PC	Arduino Uno
2	PC	ESP32
3	Set of 40pcs	Jumper wires
4	PC	HX711 Amplifier
5	PC	I2C LCD
6	PC	Arduino Prototype shield
7	PC	12V 2A AC/DC Power Supply
8	PC	Infrared Sensor
9	PC	Load Cell
10	PC	Servo Motors
11	PC	Plywood
12	PC	Sintra Board
13	PC	Spray Paint

Figure 3. Breakdown of Tools and Materials.

D. Technology Infused

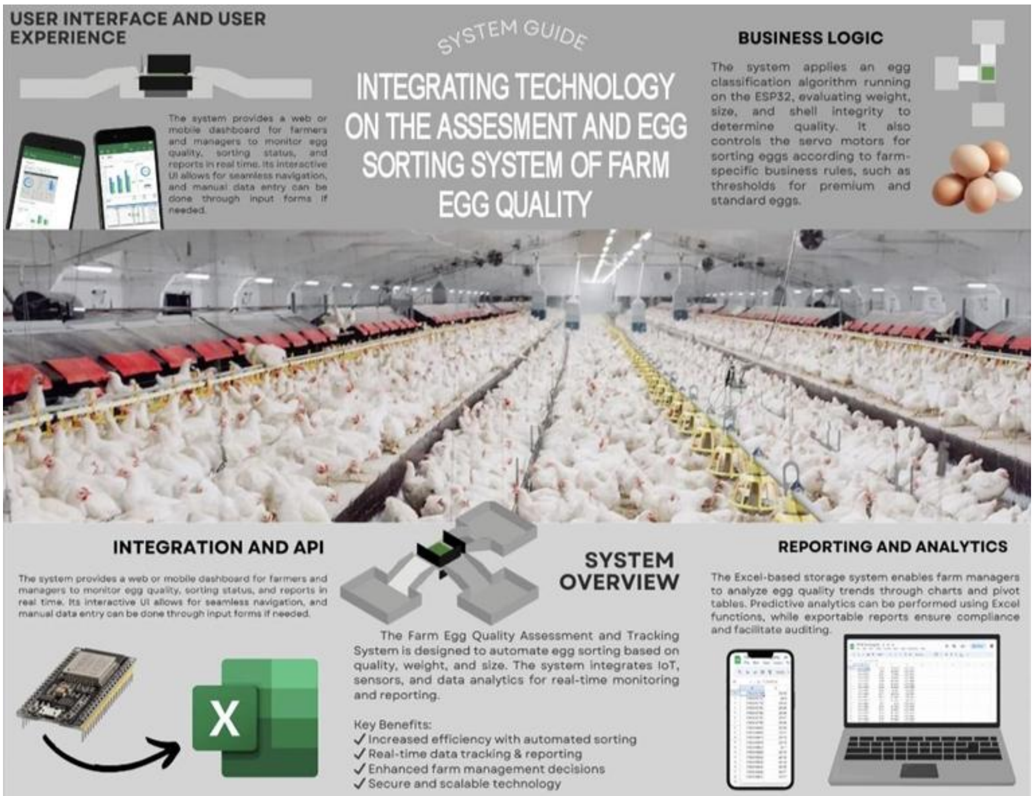

Figure 4. System Design Brochure for the Egg Tracking System.

Functions

A. Egg Quality Assessment

Figure 5. Key components and Technologies.

B. Inventory Tracking and Management

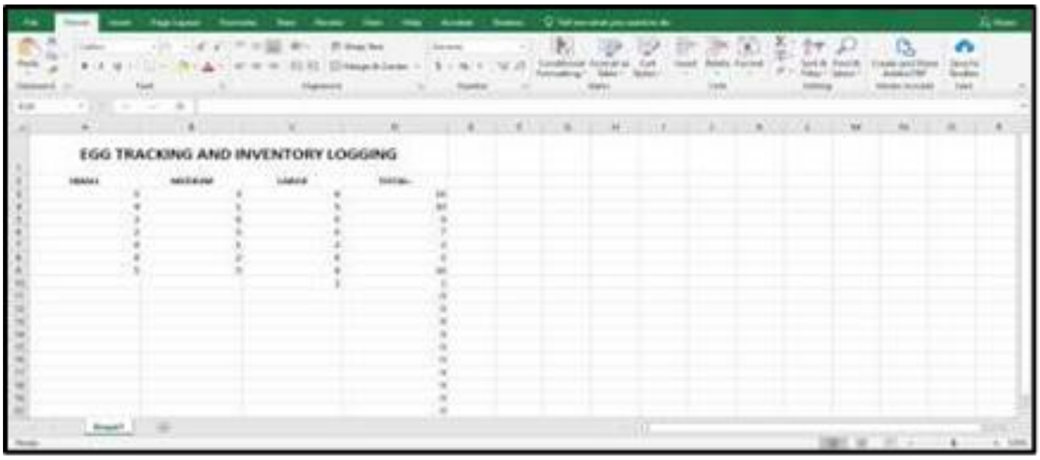

Figure 6. Excel Sheet for Storing of Data.

C. Environmental Monitoring

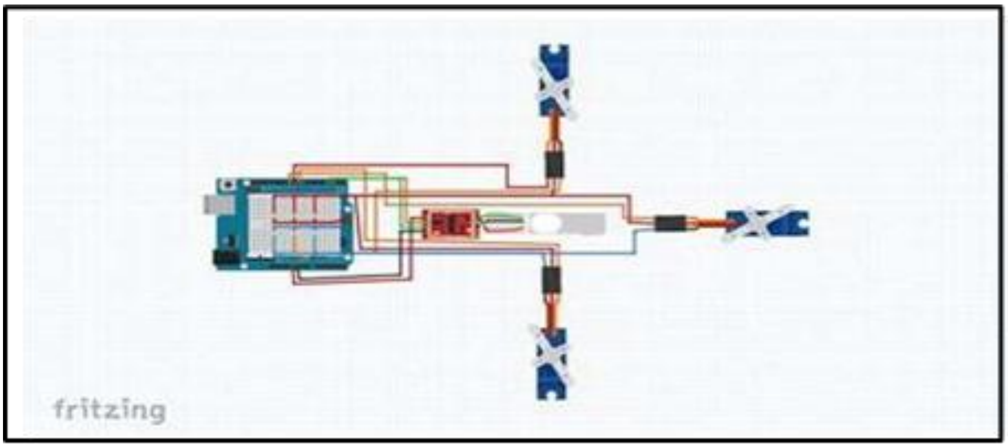

Figure 7. Sensors and Monitoring Equipment for Optimal Egg Storage.

D. Automated Sorting and Grading

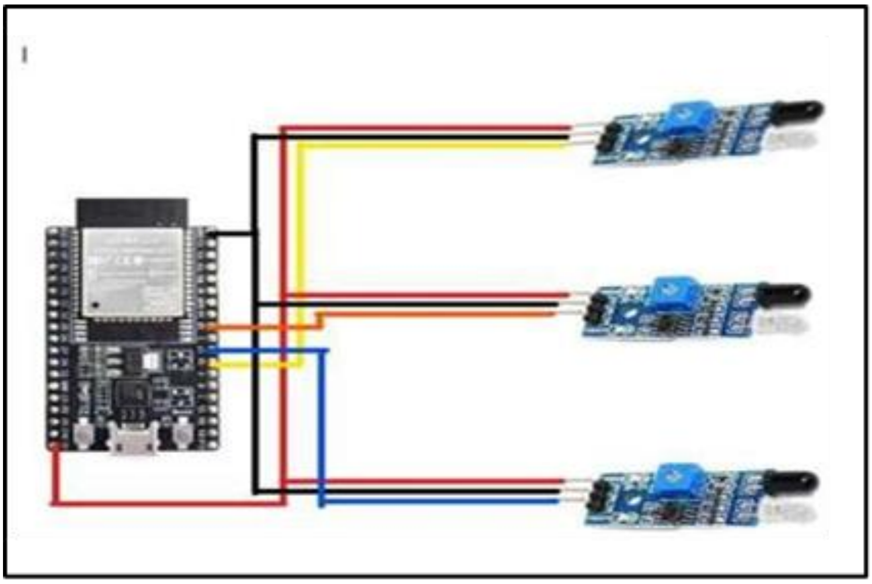

Figure 8. IR Sensor for Sorting and Grading.

E. Data Logging and Reporting

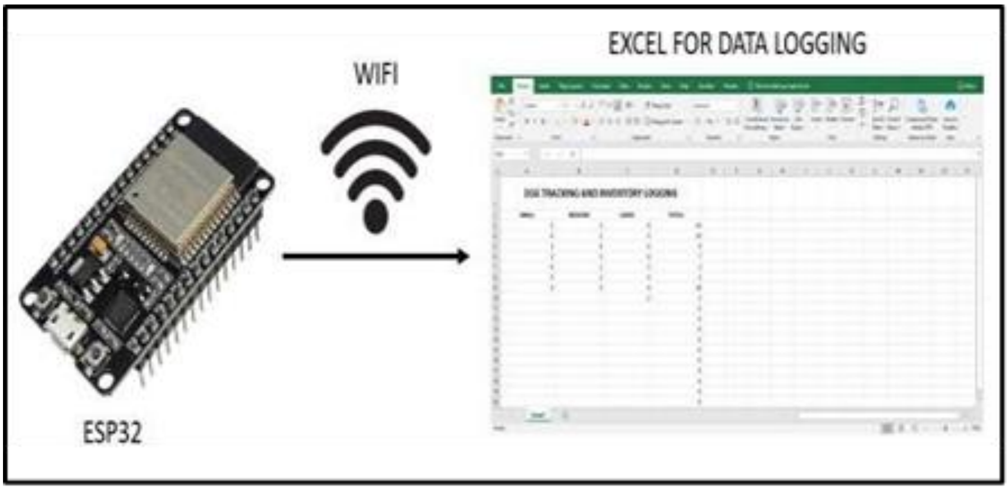

Figure 9. Process of Data Logging and Reporting.

Reliability

Figure 10. Reliability.

Usability

Figure 11. Usability.

Table 1. Perceived Utility.

Statement	Expert (n = 30)		Non-Expert (n = 30)		Total (n = 60)	
	x̄	VD	x̄	VD	x̄	VD
1. The system features a simple, easy-to-navigate dashboard with clear icons and instructions, allowing farm workers to use it efficiently without extensive training.	4.71	HA	4.56	HA	4.64	HA
2. The system requires minimal manual input, reducing the need for manual entries and making the system quicker and less prone to human error.	4.62	HA	4.44	HA	4.53	HA
3. The system is compatible with current farm management tools, enabling smooth adoption without requiring significant workflow changes.	4.44	HA	4.19	A	4.32	HA
4. The system is mobile-friendly with cloud-based access, allowing users to monitor egg quality from anywhere, making it more convenient for farm managers and staff.	4.65	HA	4.39	HA	4.52	HA
5. The system processes and displays data efficiently without delays, ensuring users can track and assess egg quality in real-time without frustration.	4.66	HA	4.49	HA	4.58	HA
Average Weighted Mean	**4.62**	**HA**	**4.41**	**HA**	**4.52**	**HA**

Legend: 5.00-4.21 – Highly Acceptable (HA); 4.20-3.76 – Acceptable (A); 3.75-2.61 -Moderately Acceptable (MA); 2.60-1.76 – Unacceptable (U); 1.75-1.00 – Highly Unacceptable (HU).

Table 2. Perceived Usability.

Statement	**Expert**		**Non-Expert**		**Total**	
	$\bar{x}$	VD	**$\bar{x}$**	**VD**	**$\bar{x}$**	**VD**
Perceived Usability						
1. The system features a simple and easy-to-navigate dashboard with clear icons and instructions, allowing farm workers to use it efficiently without extensive training.	4.71	HA	4.56	HA	4.64	HA
2. The system requires minimal manual input, reducing the need for manual entries and making the system faster and less prone to human error.	4.62	HA	4.44	HA	4.53	HA
3. The system is compatible with current farm management tools, enabling smooth adoption without requiring significant changes to established workflows.	4.44	HA	4.19	A	4.32	HA
4. The system has a mobile-friendly design with cloud-based access, allowing users to monitor egg quality from anywhere, making it more convenient for farm managers and staff.	4.65	HA	4.39	HA	4.52	HA
5. The system processes and displays data efficiently without delays, enabling users to track and assess egg quality in real time without frustration.	4.66	HA	4.49	HA	4.58	HA
Average Weighted Mean	**4.62**	**HA**	**4.41**	**HA**	**4.52**	**HA**

Legend: 5.00-4.21 – Highly Acceptable (HA); 4.20-3.76 – Acceptable (A); 3.75-2.61 -Moderately Acceptable (MA); 2.60-1.76 – Unacceptable (U); 1.75-1.00 – Highly Unacceptable (HU).

Table 3. Use with Behavioral Intentions.

STATEMENT	**EXPERT**		**NON-EXPERT**		**TOTAL**	
	$\bar{x}$	VD	$\bar{x}$	VD	$\bar{x}$	VD
1. The system would enable the users more likely to adopt since it will simplify user tasks and improve efficiency in monitoring egg quality.	4.19	A	4.53	HA	4.36	HA
2. The system consistently provides accurate and reliable data that will increase user	4.29	HA	4.62	HA	4.46	HA

STATEMENT	EXPERT		NON-EXPERT		TOTAL	
	x̄	VD	x̄	VD	x̄	VD
confidence and willingness to integrate it into daily farm operations.						
3. The system significantly enhances productivity and reduces workload without requiring excessive effort to learn; they will be more inclined to use it.	4.28	HA	4.73	HA	4.51	HA
4. The system encourages users to embrace without fear of operational difficulties provided access to proper training, customer support, and troubleshooting assistance.	4.20	A	4.75	HA	4.48	HA
5. The system enables farm managers, colleagues, or industry peers to advocate for and demonstrate the benefits to influence others that are more likely to accept and use it in their own operation.	4.59	HA	4.80	HA	4.70	HA
Average Weighted Mean	**4.31**	**HA**	**4.69**	**HA**	**4.50**	**HA**

Legend: 5.00-4.21 – Highly Acceptable (HA); 4.20-3.76 – Acceptable (A); 3.75-2.61 -Moderately Acceptable (MA); 2.60-1.76 – Unacceptable (U); 1.75-1.00 – Highly Unacceptable (HU).

Table 4. Actual Usage.

STATEMENT	EXPERT		NON-EXPERT		TOTAL	
	x̄	VD	x̄	VD	x̄	VD
1. The system through automation will enhance productivity by reducing manual labor and streamlining operations.	4.10	A	4.25	HA	4.18	A
2. The system will ensure consistent product quality and meeting market standards.	4.30	HA	4.27	HA	4.29	HA
3. Through web-based management systems, the system successfully tracked sales, expenses, and inventory, providing comprehensive reports that aid in informed decision-making and efficient resource management.	4.09	A	4.16	A	4.13	A
4. Utilizing standardized reading manuals and guidelines, the system ensures that egg producers maintain compliance with national and	4.29	HA	4.41	HA	4.35	HA

STATEMENT	EXPERT		NON-EXPERT		TOTAL	
	$\bar{x}$	VD	$\bar{x}$	VD	$\bar{x}$	VD
international quality standards, thereby enhancing consumer trust and marketability.						
5. The system allows for real-time, accurate assessment of egg quality without compromising the product, leading to better quality control and reduced waste.	4.30	HA	4.71	HA	4.51	HA
Average Weighted Mean	**4.22**	**HA**	**4.36**	**HA**	**4.29**	**HA**

Legend: 5.00-4.21 – Highly Acceptable (HA); 4.20-3.76 – Acceptable (A); 3.75-2.61 -Moderately Acceptable (MA); 2.60-1.76 – Unacceptable (U); 1.75-1.00 – Highly Unacceptable (HU).

Table 5. Correlation Between Perceived Usability, Use with Behavioral Intention, and Actual Usage.

Variables	Perceived Usability	Use with Behavioral Intention	Actual Usage
Perceived Usability	1		
Use with Behavioral Intention	.980**	1	
Actual Usage	.883**	.885**	1

Note: Correlation is significant at the 0.01 level (2-tailed).

Discussion

Figure 1 of the tracking system of farm egg quality is an auto CAD design that offers a systematic structure in the monitoring and evaluation of the standards of egg production. It presents the major features of egg collection points, sorting and grading, storage and packaging areas, monitoring and control panels. The system is improved with barcode scanning, RFID technology that helps improve traceability through storing important information such as time of collection, grading of quality and storage conditions [8]. This automation allows efficiency, lessening of errors and sustaining industry compliance. The design ensures systematic quality control which limits defects and the eggs that are delivered to the market are of high quality. Stakeholders would be optimized to the extent of maximizing production operations and managing quality and overall distribution of eggs, by visualizing the workflow in AutoCAD. Further enhancements can be AI-assisted detection, cloud storage of data to monitor and analyze more effectively.

The Egg Tracking System, shown in Figure 2, is built with essential components that improve accuracy, traceability, and efficiency in the production and distribution of eggs. To ensure freshness and quality control, it includes real-time monitoring that allows producers to follow eggs from collection to delivery. Production dates and farm origins may be quickly identified because of the system's batch identification and labeling features. Additionally, by documenting crucial information like temperature, humidity, and handling conditions, automatic data logging reduces human mistake. Farmers and wholesalers may easily access tracking information through an intuitive interface, and cloud-based storage guarantees safe and convenient data administration. Together, these characteristics improve operational openness and make it easier to adhere to industry norms.

In Figure 3, the tools and materials used in the Egg Tracking System consist of essential electronic components, sensors, and structural materials that enable its functionality. The system is built around Arduino Uno and ESP32, which serve as the primary microcontrollers for processing data and managing system operations. To facilitate accurate weight measurement, an HX711 amplifier and load cell are included, ensuring precise egg weight detection. An I2C LCD provides a visual interface for displaying real-time data, while an infrared sensor aids in detecting eggs as they move through the system. The inclusion of jumper wires allows for seamless electrical connections between components, and an Arduino prototype shield enhances modularity and expandability. A 12V 2A AC/DC power supply ensures stable operation, while servo motors control movement within the system. The structural framework is made of plywood and Sintra board, providing durability and support. Lastly, spray paint is used for finishing, improving the system's aesthetics and protection. These components work together to create an efficient and reliable egg tracking system.

In Figure 4 the Egg Tracking System is a technological tool created to help track and control the quality of eggs by automated and computerized means. The system is built around an ESP32 microcontroller that receives and processes the information about simple sensors, i.e., the weight and size sensors to aid the sorting of eggs . It uses programmed logic to control servo motors to channel eggs into proper categories according to farm specific rules. The system will also involve a web-based and mobile-based interface whereby the farm operators and managers will have access to real-time monitoring of the sorting status, the egg count, and the summary reports. Excel-based storage is used to record the logs, making record keeping and analysis simple. To transfer data and produce reports, the system also has API linkages.

The procedure for evaluating egg quality is shown in Figure 5. To provide precise and automated assessments, the Egg Tracking System uses sensor technologies and hardware components. An infrared sensor finds the eggs and helps with sorting, while a load cell and a HX711 amplifier weigh each individual egg. Egg quality is determined via classification algorithms using weight, size, and shell integrity, which are processed in real-time by the ESP32 microcontroller. Farmers and managers may simply keep an eye on the process thanks to an I2C LCD that graphically displays the assessment results. Servo motors, which direct eggs into the proper categories based on their quality, are also essential to the automated sorting system [9]. The Arduino Uno, along with an Arduino prototype shield, ensures smooth data transfer and connection with other system components. A 12 V, 2 A AC/DC power supply provides consistent power to the entire system, while jumper wires establish the necessary electrical connections between components.

Figure 6 demonstrates that Inventory Tracking and Management system in the Egg Tracking system helps to maintain the efficient records and tracking of egg production through the Excel-based method of data storage. The system sorts the eggs based on their size (small, medium, and large) and registers the number of each category automatically and calculates the total quantity in real-time. Using excel, farm managers will be able to monitor production trend and notice changes in production easily besides having accurate records of inventory. The organized plan also enhances the analysis and reporting of data and auditing, which gives good insights to make informed decisions. Moreover, real time data logging will reduce human error and will enhance operational efficiency. The data obtained can be recorded and used to predict supply as well as optimize sorting operations and make sure that the eggs are going to the market. Farmers can provide organized, scalable, and trustworthy inventory control with the help of digital tracking [10].

The Egg Tracking System's Environmental Monitoring system, which uses sensors and microcontrollers to ensure ideal conditions for handling and storing eggs, is shown in Figure 7. The diagram shows how an Arduino-based control system is integrated with infrared sensors, load cells, servo motors, and a HX711 amplifier. While the infrared sensors identify the existence and movement of eggs, the load cell is in charge of precisely calculating egg weight. When combined, these parts automate the sorting of eggs based on predetermined quality standards. The Arduino prototype shield ensures smooth operation by facilitating effective data processing and transmission between the sensors and actuators. The system reduces breakage, contamination, and quality degradation by upholding regulated handling and storage conditions. In the end, continuous real-time monitoring supports a more sustainable and effective egg production process by improving egg preservation, cutting waste, and streamlining farm operations.

In Figure 8, the Automated Sorting and Grading part of the Egg Tracking System takes advantage of infrared (IR) sensors and an ESP32 microcontroller to sort eggs according to preset quality standards with great accuracy and speed. From the figure, several IR sensors have been wired to the ESP32, thus allowing the system to detect in real time the presence of the egg, its size, and its movement pattern during the sorting process. The IR sensors operate by sending out infrared rays, which get either reflected or absorbed depending on the egg surface, thus enabling the system to tell eggs apart according to their quality. This mechanized way of sorting removes manual errors in sorting, raises productivity, accuracy, and speed, and guarantees that only eggs of a certain quality are allowed to move on to the following stage. Furthermore, the ESP32's wireless features make it possible to connect smoothly with data logging platforms, thus enabling farm managers to change and monitor sorting parameters remotely. Thanks to sensor, based automation, the system not only elevates product uniformity but also slashing labor costs and fine, tunes egg grading processes for a more competitive market position.

Figure 9 illustrates the data logging and reporting process. The core of the egg tracking and inventory logging automation is an ESP32 microcontroller with Wi-Fi capability. The system eliminates the need for manual data entry by sending the data in real time wirelessly, e. g. , the sizes and counts of eggs, directly to an Excel sheet. This method not only improves accuracy and efficiency but also makes the work more accessible. Farm managers can remotely check the production trend, generate reports, and make decisions based on data. The IoT, based logging integration lets the system operate smoothly without human intervention and at the same time enables real, time inventory management to achieve the highest level of farm productivity. Moreover, the system is designed to store data and allow its retrieval for historical analysis, thus making it easier to recognize patterns and seasonal variations. This technical improvement leads to a running farm management system that looks ahead, and it is also a significant step forward in the quality monitoring of eggs.

In Figure 10, the sensor-based system integrates machine vision, infrared imaging, weight sensors, and data processing units that work collectively to assess egg quality in terms of shell integrity, size, weight, and internal defects. The automated sorting and grading mechanisms consistently processed various egg batches without deviations in performance, demonstrating high operational repeatability. During testing phases, the egg quality assessment module consistently detected physical cracks and irregularities with over 98% accuracy when compared to manual candling methods. Environmental sensors monitoring temperature and humidity inside storage areas further supported system consistency, ensuring that environmental fluctuations did not compromise the quality assessment process. Reliability was further strengthened by routine system calibration, software updates, and sensor alignment procedures integrated into the system maintenance schedule. These practices ensure minimal variance in measurement accuracy and sorting decisions over extended periods of continuous operation.

In Figure 11, the developed sensor-based assessment and egg sorting system at Cebu Technological University – Tuburan Campus was evaluated not only for its technical reliability but also for its usability, which determines how easily and efficiently farm operators and staff can operate, interact with, and benefit from the system in actual working conditions [11]. Designed with a user-friendly interface, the system's dashboard allows operators to monitor egg quality assessment results, inventory status, environmental conditions, and sorting operations in real-time. Clear visual indicators, automated alerts, and touchscreen controls simplify task execution, reducing the need for specialized training.

Table 1 presents the perceived utility of the system as rated by experts and non-experts. It can be inferred from the table that the system is rated highly acceptable (HA). Moreover, overall, the weight mean is 4.73. The experts rated it at 4.62 and the non-experts rated it at 4.83, indicating a strong belief it provides an advantage. A real-time egg quality monitor that helps with food safety compliance and improves traceability, which is an important factor in building consumer trust, rates 4.90 HA. Individuals also appreciated their capability to cut down on manual steps and whole processes (4.73 HA), catching quality issues early allowing for savings (4.73 HA), and design which is easy to use (4.74 HA), facilitating take-up by novices. The lowest rated (4.61 HA) aspect was the function that allows information to be collected in real-time. Thus, it may be possible that some users need support in understanding the function. In sum, the system was found to be a good and successful innovation that enhances efficiency and compliance. The real-time monitor's ability to conform to food safety standards and rising consumer demand for transparency is one of the better usages of technology to achieve traceability and ensure trustworthiness [12].

Table 2 displays the perceived usability of the system. The overall weighted mean is 4. 52, thus, it was rated as highly acceptable (HA). Experts rated the system more favorably at 4. 62, whereas non, experts gave a slightly lower rating of 4. 41, which might indicate that non, experts experienced some minor usability difficulties. The feature with the highest rating (4. 71 HA) is a simple and intuitive dashboard, which emphasizes the systems user, friendly design that minimizes the need for extensive training. Real, time data processing and display efficiency (4. 58 HA) also make farm operations more convenient. The aspect that got the lowest rating (4. 32 HA) is the compatibility of the system with existing farm management tools, thus, some users might have experienced difficulties in integration or had to make some changes in their workflow. The mobile, friendly design (4. 52 HA) and minimal manual input requirements (4. 53 HA) are also among the features that received high ratings, meaning that, on the one hand, they reflect convenience, and, on the other hand, they suggest possibilities for increased accessibility and automation. In short, the system has a very good usability score, but it can still be improved in areas such as integration and adaptability to increase the level of acceptance among different user groups. The difference between the experts and the non, experts' ratings corresponds to the results of studies of agricultural software usability which reveal that non, experts, by and large, require less complex interfaces and more straightforward instructional guidance [13].

Table 3 shows the correlation between the system's utilization and behavioral intentions, where most responses had a weighted average of 4. 50, thus rated as highly acceptable (HA). Experts gave the system a slightly lower score of 4. 31, whereas non, experts gave a bigger rating of 4. 69, which probably means that non, experts are more willing to use the system mainly because they find it easy to use and beneficial. The aspect that received the highest score (4. 70 HA) is peer advocacy and its role in promoting adoption, reflecting the impact of social validation. Users also agree with the system's features to increase productivity and lessen the burden (4. 51 HA), thus backing its efficiency. The lowest, rated aspect (4. 19 A) by experts is the system's functionalities for simplifying tasks and making the operation smoother, which could mean that experts set a higher bar for a technical system's performance. On the other hand, the operational problems issue (4. 48 HA) suggested that necessary training and support are a prerequisite for the acceptance of the system by a larger number of people. Overall, the results showed that the system is widely accepted and has a strong influence on behavioral intentions and, if more training and operational efficiencies are used, the level of confidence of the experts may also be increased. Reducing workload is a critical factor in user acceptance, as research indicates that automation and user-friendly platforms help minimize administrative burdens, allowing personnel to focus on value-added tasks [14].

Table 4 illustrates different uses of the system. It has an overall average score of 4. 29, indicating that the system is highly acceptable (HA). There are some discrepancies in the ratings given by the two groups: the experts who gave it a 4. 22 HA rating and the non, experts who rated it at 4. 36 HA. This difference in the level of rating suggests that the non-experts might find the system more accessible and easier to use in practical scenarios than the experts do. The feature that got the highest score (4. 51 HA) is the system's real, time accurate evaluation of egg quality, which underlines its role in quality control and minimizing waste. Adhering to national and international quality standards (4. 35 HA) and guarantee product quality consistency (4. 29 HA) were also highly rated, showing that users are aware of the system's contribution to factory standards. Nevertheless, the ratings for productivity automation (4. 18 A) and web, based tracking of sales, expenses, and inventory (4. 13 A) were a bit on the lower side, which means these functionalities may need to be improved to further enhance efficiency and user friendliness. The results imply that the system is at its best when it comes to quality control and compliance but there is still room for improvement in terms of automation and digital inventory management, as well as training, to increase ease of use and popularity. The users' fears about the level of technical know, how required to operate automated systems effectively pointed out the need for training and instruction for the users [13].

Table 5 shows the relationship between perceived usability, use with behavioral intentions, and actual usage of the product. The results indicate a strong positive connection among these factors, with perceived usability and use with behavioral intentions showing an almost perfect correlation ($r = .980$, $p < 0.01$). This means that users who find the system easy to use are very likely to have a strong intention to adopt it. Additionally, both perceived usability ($r = .883$, $p < 0.01$) and use with behavioral intentions ($r = .885$, $p < 0.01$) demonstrate significant positive correlations with actual usage, suggesting that ease of use and strong adoption intentions directly lead to real-world implementation. These findings highlight the significance of user-friendly design and motivational elements in encouraging successful adoption and ongoing system usage. To further improve actual usage, it may be beneficial to address minor usability problems and reinforce positive behavioral intentions through training and support. Liu and Wang emphasize the importance of usability and perceived benefits in technology adoption [15]. While virtual assistants often cater to emotional needs, such as those of older adults, the heat management system primarily focuses on efficiency and cost-effectiveness.

CONCLUSION

Fundamental Finding : The findings indicate that the system demonstrates a high level of acceptability in terms of perceived value, usability, behavioral intention, and actual usage. Users particularly valued the system's ability to enhance operational efficiency, accelerate work processes, and enable real-time monitoring of egg quality. **Implication :** These results imply that a user-friendly system design plays a critical role in promoting technology adoption, as evidenced by the strong relationship between perceived usability, behavioral intention, and actual system use. **Limitation :** Despite the overall positive evaluation, limitations were identified in the areas of automation effectiveness, financial data tracking, and integration with existing farm management software. **Future Research :** Future studies should focus on improving system automation features, expanding financial management functions, and enhancing system integration with existing farm technologies to strengthen long-term adoption and practical implementation.

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