Value-added Information Service Using Human-friendly Machine-readable Graphical Symbols for Food Safety and Reliability for Quality of Life

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Abstract: This paper proposes a system for value-added information service using human-friendly machine-readable colorcode pictograms for safety and reliability. The proposed system called Zipic provides the following functions; (1) information infrastructure for food safety, (2) reliable certification for egg quality, and (3) promotion of dietary education for quality of life. The result of the questionnaire survey shows that consumers strongly rely on our Zipic system in shopping to receive value-added egg and dietary information.

Key words: *Pictogram, Information Service, Food Safety and Reliability*

1. Introduction

This Consumer awareness of food safety and reliability has been heightened in recent years by concerns over bird flu viruses and salmonella, among other microbes, and incidents of deceptive labeling of expiration dates. In order to manage the risks and to gain consumer confidence, the egg industry has begun adopting a traceability system that enables the tracking of eggs through the supply chain [1-6].

The existing egg traceability systems rely on identification codes such as alphanumeric characters, linear bar codes, and two-dimensional bar codes, which are read using mobile device cameras, PCs, or other similar devices to access relevant information through the internet. However, visually, the identification codes do not readily convey to the consumers the type of information they represent. A solution to overcome this shortfall and to convey food safety and reliability information in a form that can be intuitively and easily understood by the consumers is to express machine readable codes in designs readily recognizable by humans that could also enable mobile device cameras to extract the code from the captured image. Such a code would be advantageous when coupled with a data portal that provides mobile contents on food safety and reliability and value-added information.

With that in mind, we propose a value-added information service that allows the display of reliability certification using graphic codes expressed in human-friendly and machine-readable graphic symbols that combine the concepts of both identification codes and pictograms. Since such codes can be printed on paper or plastic labels at low cost and the mobile device cameras are in widespread use, the cost of platform building can be reduced.

2. Problems with Egg Traceability Systems

2.1. Problems with Codes that Emphasize Machine-readability

Machine-readable codes that have been used for egg traceability systems are bar codes and two-dimensional codes. IC tags, despite their potential advantages, have not been adopted because of their unit cost of several tens of yens – a sum too high to be cost-effective for an industry that produces a low-cost product. In order for a machine-readable code system to work, it must be a low cost system that can be economically printed on product labels or packaging. Therefore, any applicable system would likely be a bar code that can either be preprinted on labeling materials or printed by printers at the point of packaging and then read by special bar code readers or mobile device camera applications.

Among the codes used in the existing egg traceability systems, the two codes described below can be read from captured images.

Bar codes, information encoded symbols represented by a combination of lines of varying widths and spaces have been globally standardized and widely used. They can be read at high speed by widely available readers and the labeling cost is minimal. However, the application of bar codes has been hampered by their minuscule encoding capacity of only several tens of bytes and their incompatibility of two-byte characters and binary data, among other limitations. The common code used in egg distribution is the numerical 13-digit/8-digit JAN code (Japanese Article Number), which only allows tracking of the producer name and item name.

Two-dimensional codes are embedded with data in both the vertical and horizontal directions and available in several formats. The QR code developed by Denso-Wave is the most popular identification code used by the existing egg traceability systems. Compared with the bar codes, two-dimensional codes take up less space and offer a greater capacity for information embedding, allowing up to 2,953 bytes of binary data (4,296 alphanumeric characters or 1,817 two-byte characters) to be encoded and read at high speed [7-11].

Nevertheless, neither type of code could convey the type of embedded information without the aid of a scanning device directly to humans. In some cases, text has been printed next to the code as supplemental information. But the very narrow space does not allow for any adequate length of text to be printed in human-readable font size and still convey information regarding food safety and reliability. Moreover, since these codes are printed in a single color, they give the impression of an unnatural inorganic look, a quality unsuitable for labeling, which places heavy emphasis on designs.

As discussed above, the existing bar codes and two-dimensional codes are not geared toward consumers because they do not allow a satisfactory integration of the intended information and any graphic design.

2.2. Safety and Reliability of Egg Traceability Systems

2.2.1. Safety and Reliability in Humans

Eggs have been a part of our diet since ancient times. They are fresh food with good quality animal proteins, vitamins, minerals, and other nutrients essential to humans. Although eggs are required by laws to be labeled with an expiration date and the place of origin, consumers still feel the need to select eggs that are fresh and safe because of concerns over the eggs' susceptibility to spoilage due to their fragile shells.

"Safety" established by minimizing the risk of accidents involving eggs may appear to convey a similar meaning to "reliability," which are reflections of consumers' perception. However, they are different. "Safety" is achieved by minimizing hazards through thorough efforts in quality control and information management and daily hard works in accident prevention and cause investigation by those working in the egg industry. "Reliability," on the other hand, is a consumer's perception that safety has been achieved and that concerns over egg quality have been replaced with trust. It is important to bridge the gap between the perception of "safety" on one side and the perception of "reliability" on the other.

2.2.2. Human-friendliness

The existing safety infrastructure systems have made it possible to trace the uninterrupted history of an egg from the farm, grading-packaging center, distribution -processing site, retail store, and all the way to the dinning table.

The producers, however, are the ones who bear the mounting costs of the required equipment and systems, etc. and the growing workload due to the need to record, maintain, and transmit information related to production and distribution histories. In order to prevent human errors and improve worker skills, the egg industry has actively taken measures such as creating manuals and holding training sessions for elderly workers and foreign laborers. Nevertheless, this survey revealed that an unexpectedly large number of individuals in the egg industry are unaware of the egg traceability system that performs the role of a "safety infrastructure system."

It is important that general consumers are informed of the information inherent to eggs that they plan on consuming. But the consumers are even less educated than those in the egg industry about the egg traceability system, showing that the "reliability certification information displaying system" is not performing up to its potential. Furthermore, these alphanumerical characters, bar codes, or two-dimensional codes, printed in a single color next to colorful promotional photos, drawings, or other designs within the tight printable space on egg labels, often are overlooked because they appear to be nothing more than symbols. These codes are in no way human-friendly.

Based on the above, it is clear that in order to provide information on food safety and reliability, it is critical to have a traceability system effective not only in minimizing human errors, but also in providing the reliability certification information display through an intuitively and readily comprehensible visual message.

3. Human-friendly Machine-readable Code

3.1. Adoption of an Eye-catching “Color Code”

Since the existing bar codes or two-dimensional codes are patterns designed to be read by machines, these identification codes alone do not convey the embedded information directly to humans. A color code alone does not indicate the meaning of the encoded information either. But, its colors stand out to signal the presence of the code to those who see it. Thus, it gives the color code a potential to utilize the human cognitive ability to convey the type of encoded information without the need of a scanning device.

The color code system is based on a 5-by-5 grid consisting of 25 squares each in any one of the four colors of red, green, blue, and black to represent the encoded information. It works on either 3-dimensional or 2-dimensional media. Its capacity to incorporate a visually appealing design and high readability even when scanned from a distance, have received high praises, and some businesses have started to adopt the color code system [12].

As shown in Fig. 1, this code system has the advantage of providing easy access to the designated mobile contents because it is a network-based code system and users only need to use a mobile device camera to scan the code, which is then recognized by a special reader application.

Moreover, the capacity for information embedding could be increased by expanding the grid-size to 7x7 or 9x9 in the future. The reader application has already been installed free of charge in more than 180 types of cell phone by all the cell phone companies, allowing the traceability system identification code to be read by consumers using the built-in camera on their existing cell phones.

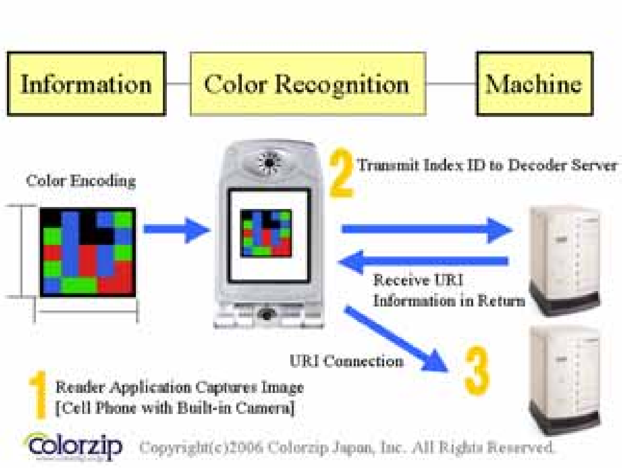


Fig.1 Color code service flow

3.2 Human-friendly Graphic Code

With the aim of devising a “traceability system capable of displaying reliability certification information” that can function in conjunction with the existing “safety infrastructure system,” we are proposing a system based on machine-readable graphic symbols that visually conveys the type of embedded information and has both the features of color codes and pictograms as shown in Fig. 2. We named this system “Zipic Mark,” a term coined from “zip” and “pic (pictogram and picture).”

The omnipresent pictograms are easily comprehensible codes used to indicate emergency exits, traffic signs, lavatories, points of interest on maps, and myriads of other places, events, or information. Because of their pictorial nature, they are readily comprehensible to anyone without any prior knowledge of grammar [13-14]. By giving pictograms the function of a two-dimensional code, we believe human-friendliness, authenticity, and readability can all be achieved at the same time.

The proposed graphic symbols are graphic codes that combine both the features of the intuitively and readily comprehensible pictograms and the color codes used in machine-readable color identification systems. In addition to their expressive power geared toward compact spaces, a large variety of designs is available to convey easily communicable information in an easily comprehensible format. These graphic symbols also allow consumers, through the use of a camera on a mobile device, to connect to a mobile content portal that provides food safety and reliability and value-added information. Table 1 shows how they differ from the existing machine-readable pattern-recognition systems such as bar codes, two-dimensional codes, and the color codes used in machine-readable color identification systems.

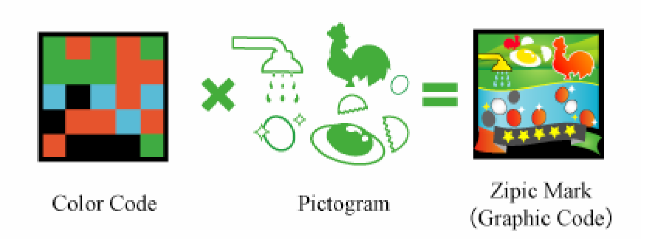
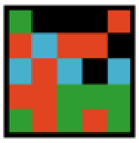
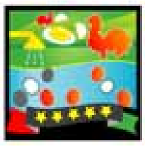


Fig. 2 Zipic Mark concept

Table1.Comparison against other identification codes

		JAN Code QR Code	 Color Code	 Zipic Mark
Mode of Recognition	Human	No		Pictogram
	Machine	Shape Recognition	Color Recognition	
Design		No	Can Incorporate a Design into the Code	

As shown in Fig. 3, the uniqueness of a graphic code can be checked during its designing stage by sending it to a server for immediate verification. This process, unlike the design and trademark verification processes at the Patent Office [15], does not require any human involvement and takes place instantaneously because they are machine-readable codes.

Fig.3 Design reification process
Instant verification of a design's uniqueness

The proposed graphic symbols work in two different ways. The first is to display a single identification code in multiple designs. Although the designs shown in Fig. 4 may appear to be completely different from each other when viewed through human eyes, they are recognized as identical codes when read by a color recognition machine. It is also possible to display multiple identification codes using a single design. Fig. 5 shows an example of what appears to be identical designs to human eyes but recognized as different codes when read by a color recognition machine. In these examples, the color codes are embedded with the producer's name and product number, whereas the design is intended to show the category of information proposed. As demonstrated, these graphic codes can be standardized to serve as graphic symbols that can be shared by all food businesses

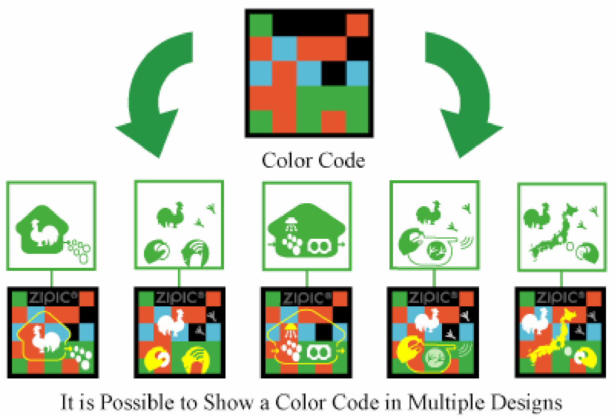


Fig.4 Example 1 of graphic code application

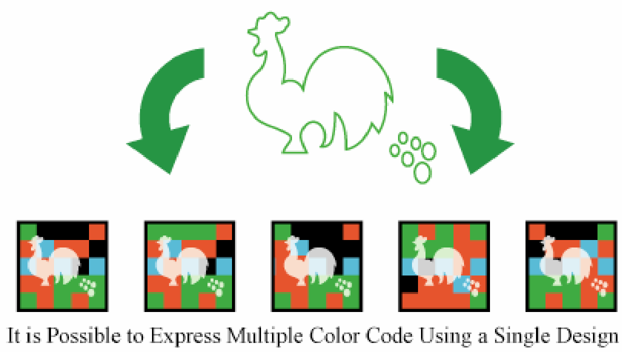


Fig.5 Example 2 of graphic code application

4. Value-Added Information Service Using Graphic Codes

Frequently used identification codes in the existing egg traceability systems include alphanumeric characters-combinations, bar codes, and two-dimensional codes. As a realistic way to achieve the goal of an egg traceability system capable of "displaying the reliability certification information," we propose the following service platform to provide "food safety-reliability and supplemental information" using graphic codes

The functions of graphic codes in an egg traceability system can be roughly divided into three categories.

4.1. Graphic Codes for a Safety Infrastructure

These graphic codes are intended to minimize the risk of accidents and product recalls through the capabilities of tracking the distribution route from the hen farm to the dinning table, and tracing those responsible for quality control. For instance, by capturing the image of the graphic code shown in Fig. 6 with a camera on a mobile device, one may view the footage of eggs in the process of undergoing proper washing at the grading and packaging facility, as well as other data.

Fig.6 An example of using the code to trace egg-washing records

4.2. Graphic Codes for Displaying Reliability Certification Information

These graphic codes are designed for brand identification by building the trust of consumers while reassuring them so as to mitigate anxiety over egg quality. They provide a sense of quality by communicating in an intuitive way to consumers regarding quality control and the fact that safety infrastructure information can be traced easily at any time.

4.3. Graphic Codes for Improving Dietary Quality

These are codes intended to help pass on our culinary culture and practices through promoting a healthy-eating lifestyle, honing the skill for selecting the proper food, and teaching of cooking techniques [16]. Fig. 7 shows a code designed to provide recipes for egg dishes and nutritional information. By scanning the code using a camera on a mobile device, consumers can freely participate at a site to exchange such information as their own original recipes or regional recipes. Such a site can also be used by the egg producers to communicate to the consumers about hearings or risks concerning eggs [17-18].

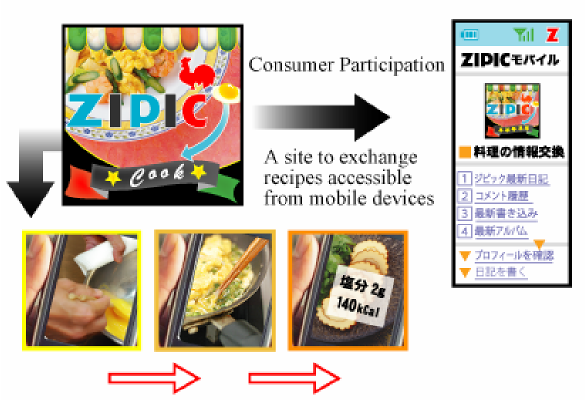


Fig.7 An example of code designed to provide access to a site for recipes and information exchange

Since the proposed code based on the highly expressive pictograms can be economically printed on paper or plastic labels and read by cameras on ubiquitous mobile devices, the cost of building a platform is reduced. Furthermore, although it is possible to assign many meanings to a single graphic symbol, considerations have been given to avoid any potential of undermining the design's capacity to convey intuitive information to humans.

As shown above, graphic codes can accelerate the effort to reform the "safety infrastructure system" within the existing egg traceability systems, and perform the function of a "reliability certification information displaying system" for gaining the trust of consumers. These effects will boost the number of users in the egg industry and among general consumers, and the resulting synergetic effect could create an even greater value, making sustainable use of the codes possible.

5. Validation of Confidence on Safety and Reliability Conveyed Through Graphic Codes

We believe that individuals in the egg industry and general consumers will be more inclined to adopt the code system or purchase the labeled products if they understand how the reliability certification information displaying system works in a color code and graphic code-based egg traceability system. To validate this assumption, a survey was conducted in March 2007. In the survey, both groups were asked about (1) the awareness of egg traceability; (2) the awareness of color codes; (3) the interest in color codes; and (4) the purchase sentiment for graphic code-labeled eggs.

5.1. Overview of the Survey

The subjects gave answers based on a scale of 1 to 5 (with 1 being a great degree and 5 being, not at all). The subjects were surveyed on four issues: (1) the awareness of egg traceability (Do you know . . .?); (2) the awareness of color codes (Do you know . . .?); (3) the interest in color codes (Do you have any interest in . . .?); and (4) the purchase sentiment for graphic code-labeled eggs (Would you purchase . . .?).

5.2. Survey Method

After receiving the survey form, as shown in Fig. 8, survey subjects first provided each of their response to "(1) the awareness of egg traceability." Subsequently, they were informed of how the graphic codes can provide access to safety and reliability information on egg quality, egg brand recognition, and services that provides recipes and other information. The subjects then were asked questions on (2) the awareness of color codes and (3) the interest in color-codes, and at the same time, the impact on the answer to (4) the purchase sentiment for graphic code-labeled eggs was investigated. Furthermore, 21 subjects who worked in the egg industry were provided with a feedback on the results of this survey, and were followed up on whether there was any change to their purchase sentiment for graphic code-labeled eggs.

From the survey results, a mean score was determined for responses to each of the survey questions. Both groups of subjects, "A. egg industry-related parties" and "B. general consumers," showed a corresponding change in attitude after they were informed. When the normal distribution assumption of that difference in the sample parent population is not met, the non-parametric Wilcoxon signed rank sum test was used. "The assessment on (1) the awareness of egg traceability" before the subjects were informed and "the assessment on (4) the purchase sentiment for graphic code-labeled eggs" after the subjects had been informed were analyzed as a data set of paired variables, with the differences assessed by a Wilcoxon signed rank sum test [19].

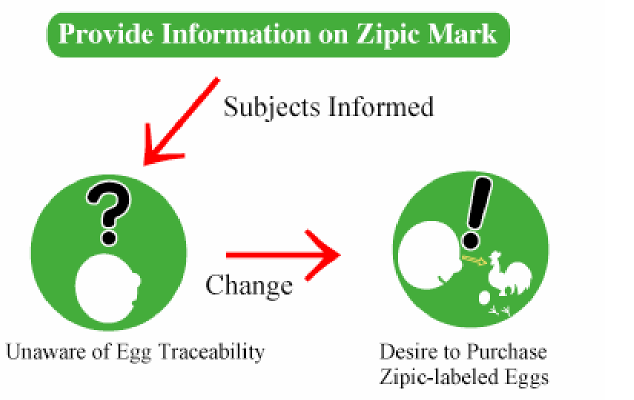


Fig.8 A summary of the survey

5.3. Information Provided to Survey Subjects

Information required in designing the reliability certification information displaying system was defined, and the surveyed subjects were provided with the following three categories of information related to the service based on such a system.

5.3.1. Conveying a Sense of Reliability to Consumers *(Fig. 9 shows the information provided)*

As shown in Fig. 9, in addition to tracking the distribution route of eggs, the graphic code also allows access to information on the quality control performed at every stage of the route from the farm, grading-packaging, to processing-distribution. Besides the easily verifiable reliability certification information, a value-added information service is also available through the Internet after the code is scanned by the camera on a mobile device. Internet sites where the reliability certification information can be verified could also be used to provide the most up-to-date safety information concerning the eggs on a real-time basis, a function that potentially can reduce consumers' anxiety over egg safety, the spread of harmful rumors, and the number of inquiries coming into businesses. By adopting this model of displaying the reliability certification information, the egg industry stands to gain greater trust from consumers over egg safety.

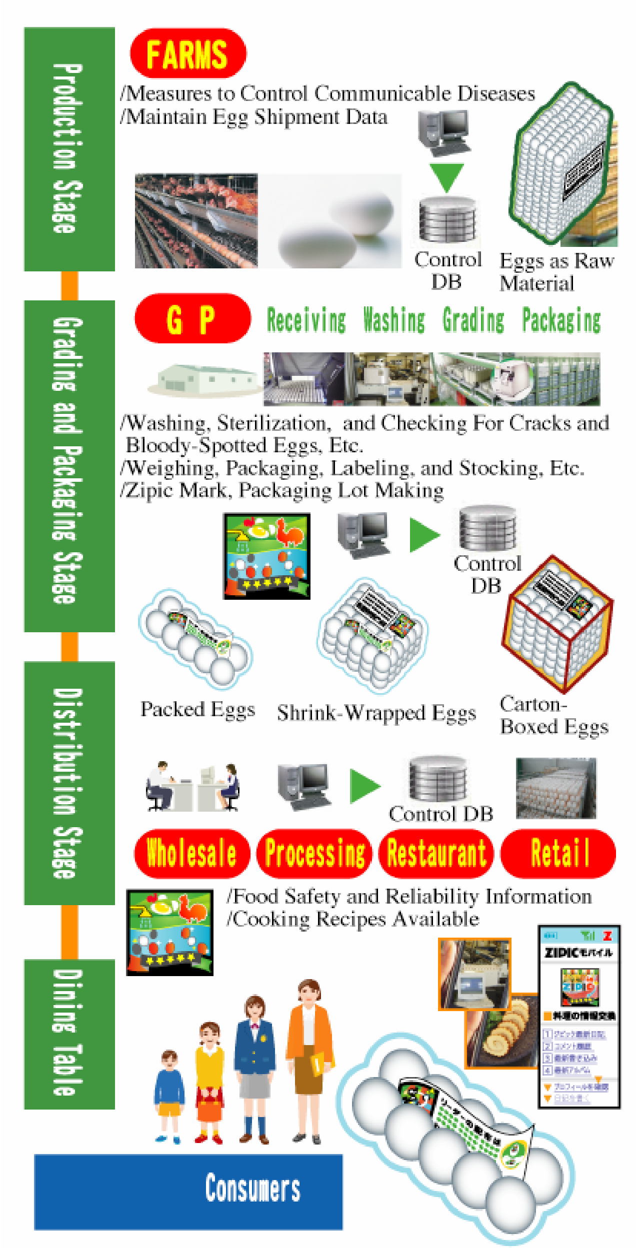


Fig.9 Information aimed to provide a sense of reliability

5.3.2. A Brand Logo that Represents Quality Certification for Eggs (Fig. 10 shows the information provided)

Once this reliability certification information displaying model is adopted, graphic codes will become brand logos that stand for quality certification of eggs, and egg producers and distributors that use this display model will be held responsible for their products. Since egg industry businesses will be required to document and provide all records of production and distribution and to perform quality identification control, improved quality control and efficiency are expected – a result that will lead to enhanced reliability across the entire food chain.

Fig. 10 depicts a sample product with an impact label placed within the egg container. The label is printed with a graphic code designed to visually suggest an image of farm-produced eggs being washed and checked during their distribution process to represent the type of embedded information. The number of stars serves as an index of the value assessment.

Fig.10 An example of egg-brand identification

5.3.3. Table Eggs Education (Fig. 11 shows the information provided)

Dietary education is aimed at passing on our culinary culture and practices through promoting a healthy-eating lifestyle, honing the skills for selecting proper food, and teaching cooking techniques. The reliability certification information displaying model can also be used to provide dietary education-related contents to consumers through cell phones or PCs. For instance, as shown in Fig. 11, egg industry businesses not only can provide recipes free of charge to consumers as a courtesy, but also educate consumers to heighten their understanding of and ability to evaluate eggs. Providing information that foster safety and nutrition-related risk-communication could potentially increase consumption and the value of eggs.

Fig.11 Table egg education-related information

5.4. Surveyed Subjects

Answers were received from 328 subjects who participated in this survey (A. egg industry-related parties: 162; B. general consumers of eggs: 166). "A. Egg industry-related parties" are defined as individuals who work in poultry farming, grading and packaging, food transportation, food wholesale, food processing, food preparation, restaurant, retail, and other related fields as opposed to general consumers. Table 2 provides a breakdown by group, and Table 3 shows a breakdown by age group and gender. The survey subjects had a mean age of 42. The group median age (year) and the number of subjects in each group were used to determine the total age. Those who did not provide their age were assumed to be in the most popular age group of the thirties (35 years). The total age was then divided by the number of subjects (328). The method of calculation is shown in Table 4.

Table2.Cross tabulation of breakdown of subjects by gender and by consumers vs. related workers

	Male	Female	Unknown	Total
A. Egg industry-related parties	99	47	16	162
B. General consumers	60	95	11	166
Total	159	142	27	328

Table3.Cross tabulation of breakdown of subjects by age and gender

Age Group	Male	Female	Unknown	Total
20s or under (20 years)	0	2	0	2
20s (25 years)	18	29	2	49
30s (35 years)	53	42	5	100
40s (45 years)	42	35	2	79
50s (55 years)	34	23	8	65
60s or above (65 years)	11	9	4	24
Age unknown (35 years)	1	2	6	9
Total	159	140	27	328

Table4.Determination of the mean age of subjects

Age Group	Value	Number of Subjects	Group-wise Age Total
20s or under (20 years)	20	2	40
20s (25 years)	25	49	1,225
30s (35 years)	35	100	3,500
40s (45 years)	45	79	3,555
50s (55 years)	55	65	3,575
60s or above (65 years)	65	24	1,560
Age unknown (35 years)	35	9	315
Total		328	13,770
Mean age			42.0

5.5. Survey Results

5.5.1. Assessments Provided by Subjects

Table 5 shows the mean score of the subjects' assessment of each question posed. With respect to (1) the awareness of egg traceability, as expected, "A. egg industry-related parties (2.83)" showed a greater awareness than "B. general consumers (3.68)." Nevertheless, the score given by the egg producers and distributors (2.83) was low, considering the fact that they are the egg suppliers.

Table5.Five-point scale assessments provided by the subjects

Assessment Criteria 1 A great degree 5 Not at all	(1) Do you know about the egg traceability	(2) Do you know about color codes	(3) Do you have any interest in color codes	(4) Would you purchase graphic code-labeled eggs
A. Egg industry-related parties	2.83	4.36	2.48	2.40
(Number of responses)	159	162	160	159
B. General consumers	3.68	4.21	2.60	2.46
(Number of responses)	165	166	166	165
Total	3.26	4.28	2.54	2.44
(Number of responses)	325	328	326	327

5.5.2. Change in Purchase Sentiment after Learning about the Proposal

The presence of any difference between "A. egg industry-related parties" and "B. general consumers" concerning the change in purchase sentiment due to the proposal of graphic code-labeled eggs was assessed using the Wilcoxon signed rank sum test. A significant difference (P<0.01) was detected with respect to both (1) the awareness of egg traceability and (4) the purchase sentiment for graphic code-labeled eggs (refer to Table 8 for further details and the result of the paired t-test).

The result shown in Table 6 suggests a correlation between egg purchases and the knowledge on the workings of an egg traceability system capable of displaying reliability information intended to reassure consumers, and of the various benefits of graphic codes.

Table6.Change in subjects' purchase sentiment for graphic code-labeled eggs

Wilcoxon signed rank sum test

Paired groups of 2 1 A great degree 5 Not at all	Response to (1) Do you know about the egg traceability	Response to (4) Would you purchase graphic code-labeled eggs
A. Egg industry-related parties	Statistic	2.7746
Sample pairs: 159	Significance (P**1%)	0.0055
B. General consumers	Statistic	7.4740
Sample pairs: 165	Significance (P**1%)	0.0000

[Result]

A significant difference was detected in the paired responses (1) and (4).

5.5.3. Change in Purchase Sentiment among Egg Industry-related Parties after Feedback of this Survey Result

In a subsequent follow-up survey of "A. egg industry-related parties (21 people)" who were given feedback of the effectiveness of graphic codes, the change in purchase sentiment due to the proposal of graphic code-labeled eggs was analyzed by the Wilcoxon signed rank sum test, with the result, shown in Table 7, indicating the detection of a significant difference (P<0.01). This suggests that egg industry-related parties could be motivated into adopting the code for commercial use if they are able to ascertain a positive consumer response to the graphic codes.

Table7.Follow-up survey of 21 subjects in an egg industry-related profession

Wilcoxon signed rank sum test

Paired groups 1 A great degree 5 Not at all	Response to (1) Do you about the egg traceability	Response to (4) Would you purchase graphic code-labeled eggs
A. Egg industry-related parties	Statistic	2
Sample pairs: 21	Two-sided test	Significance (P**1%)
*Analysis based on statistical tables		
Normal distribution test	Statistic	3.0400
	Significance (P**1%)	0.0024

[Result]

A significant difference was detected in the paired responses (1) and (4).

6. Summary and Future Tasks

In this study, we proposed a model for food safety and reliability, and a value-added information service platform that can be applied to all food businesses. The model is based on human-friendly, machine-readable graphic codes that combine the features of both color codes and pictograms. As a case for illustration, a survey that included a proposal was conducted on a graphic code-based reliability certification information displaying system for egg traceability.

The results showed that consumers were not aware of the "safety infrastructure" and "reliability certification" with respect to the egg traceability system. Nevertheless, once consumers were informed of the proposal concerning "conveying a sense of reliability to consumers," "a brand logo that represents quality certification for eggs," and "table egg education," and come to understand the functions and workings of this proposal, their purchase sentiment for eggs labeled with a graphic code underwent a marked change. These results suggest that once the benefits of graphic codes became known, increased consumption and an enhanced value of eggs can be expected, and that such codes can be applied to all food businesses.

Moreover, a follow-up survey conducted on egg industry-related parties showed they are more willing to adopt graphic codes after being shown the result of the consumers' purchase sentiment for graphic code-labeled eggs. This proposed system is scheduled for adoption in the near future on eggs for commercial use. As for the tasks that lie ahead, we would like to conduct surveys on a larger population due to concerns over food preferences, health, and other issues, identify targets for safety and reliability education, and verify effectiveness through post-adoption follow-up surveys.

Furthermore, once the code is recognized as a design system to display reliability certification information for egg traceability and seen more frequently at farms, grading, packaging centers, processing centers, distribution centers, retail stores, and dining rooms, it will lead to an active platform for a consumer food safety and reliability information service, making it possible for the graphic codes to be applied to all food, especially perishable food

In addition to establishing a methodology and a guideline for designing Zipic Mark, we plan to develop ways to incorporate photos or images into the graphic codes in hopes of seeing the technology evolve from merely an integrated graphic code of a color code and pictogram to become an even more human-friendly machine-readable code.

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Table8. Analytical results of subjects' responses

A. Analytical results of responses from egg industry-related parties

Wilcoxon signed rank sum test: paired groups of 2

Variable	Assessment on (1) awareness of egg traceability	Assessment on (4) purchase sentiment for Zipic-eggs	
Sample pair	159		
d ≠ 0	113		
d < 0	44	Rank sum	2252
d > 0	69	Rank sum	4189
Analysis based on statistical tables		Normalization test	
Statistic	2252	Statistic: z	2.77460184
Two-sided test		P-value	0.0055**

Test on the difference between two population means: when there is a match

Variable	Assessment on (1) awareness of egg traceability	Assessment on (4) purchase sentiment for Zipic-eggs	Difference
Sample pair	159		
Mean	2.836477987	2.402515723	0.433962264
Unbiased variance	2.4667622	1.583791099	
Sample standard deviation	1.570592946	1.258487624	
T-test			
Statistic: t	3.024893073		
Degree of freedom	158		
2-Sided p-value	0.0029**		
1-Sided p-value	0.0015**		

B. Analytical results of responses from general consumers

Wilcoxon signed rank sum test: paired groups of 2

Variable	Assessment on (1) awareness of egg traceability	Assessment on (4) purchase sentiment for Zipic-eggs	
Sample pair	165		
d ≠ 0	131		
d < 0	23	Rank sum	1069.5
d > 0	108	Rank sum	7576.5
Analysis based on statistical tables		Normalization test	
Statistic	2252	Statistic: z	7.47404906
Two-sided test		P-value	0.00000000**

Test on the difference between two population means: when there is a match

Variable	Assessment on (1) awareness of egg traceability	Assessment on (4) purchase sentiment for Zipic-eggs	Difference
Sample pair	165		
Mean	3.678787879	2.460606061	1.218181818
Unbiased variance	1.987657058	1.310938655	
Sample standard deviation	1.40984292	1.144962294	
T-test			
Statistic: t	9.50853038		
Degree of freedom	164		
2-Sided p-value	0.0000000**		
1-Sided p-value	0.0000000**		