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Consumer Preferences for Information on Taiwan's Pork Traceability System

[1]Yan-Kwang Chen, [1]Te-Chen Wang, [2]Chien-Yue Chen, [3]Yueh-Chuen Huang and [4]Cheng-Yi Wang
[1]Department of Distribution Management, National Taichung University of Science and Technology, 129 Sanmin Road, Sec. 3, Taichung, Taiwan
[2]Department of Electronic Engineering, National Yunlin University of Science and Technolgy, 123, Sec. 3, University Rd., Douliu, Yunlin, Taiwan
[3]Department of Business Administration, National Taichung University of Science and Technology,
[4]Institute of Technology Management, National Chung Hsing University, 250 Kuo Kuang Road, Taichung, Taiwan

Abstract: Traceability systems can provide detailed information about the origin, processing, transfer and distribution of a food item. The information reported on the labels can be considered as an instrument to improve consumer trust and perception of food safety and quality. However, if too much information is provided, information overloads may occur, causing consumers to spend too much time on information processing. Thus, it is important to understand which kind of information that consumers are really interested in. Based on three criteria, namely food safety, food quality and food trust, this study investigates consumer preferences for information on traceability systems used in Taiwan's pork sector. Since there is interdependence among the three criteria. This study adopts a hybrid of Analytic Network Process (ANP) and Interpretive Structural Modeling (ISM) method to conduct the multi-criteria evaluation. This study first extracts 17 attributes of traceability information from previous literature and then measures the relative weights (consumer preferences) of the attributes using a system of pairwise comparison. Results indicate that national certification, certification marks, retailer, date of slaughter and date of packaging are attributes of traceability information that consumers are more concerned about when purchasing pork products. The findings of this research can be a reference for the government and related industries on how to strengthen the usefulness of the current pork traceability system.

Key words: Traceability, food safety, food quality, food trust, ISM, ANP

INTRODUCTION

Traceability systems play an important role in protection of food safety and food quality. Implementation of traceability systems can not only increase cooperation between members in the food chain but also align the management of food suppliers and retailers to consumer expectations (Issanchou, 1996; Banterle *et al*., 2006; Ojinnaka, 2011; Onay *et al*., 2011). Loureiro and Umberger (2007) point out that consumers are paying increasing attention to food safety and food quality and endorsement of traceability systems has gradually become a dominant factor affecting consumers' choice of food products. Besides, through disclosure of detailed food information, including source of raw materials, origin, feed and medication used, market information can be more transparent and seller opportunism can be effectively reduced (Choe *et al*., 2008). Therefore, food traceability systems have been introduced in many countries to provide information on the entire food process from farm to table for safety, quality and consumer trust of the food (Choe *et al*., 2008). Information disclosed on a food traceability system can be classified into mandatory information and voluntary information. The main difference between the two types of information is that the former type is required by the government and the latter is optional. To meet consumers' expectation of the information to be disclosed on the label of food products, selecting proper types of information to be recorded on the food traceability system becomes particularly important (Stranieri and Banterle, 2009). According to Verbeke and Ward (2006), providing excessive information causes information overloads which make the information hard to understand, unhelpful for decision making and generate more fears of information. Only through effective disclosure of important

Corresponding Author: Yan-Kwang Chen, Department of Distribution Management, National Taichung University of Science and Technology, 129 Sanmin Road, Sec. 3, Taichung, Taiwan

information can information asymmetry be mitigated and risks of information overloading avoided (Verbeke and Viaene, 1999).

So far, some scholars have investigated consumers' preferences for information recorded on food traceability systems. For instance, Stranieri and Banterle (2009) used logit model to assess consumer interest in some mandatory and voluntary information cues through a telephone survey conducted in Lombardy, Italy. Their findings provide a direction for improving information recorded on food labels. Van Rijswijk *et al.* (2008) use means-end-chain to investigate consumers' perception of the benefits associated with traceability related attributes through a questionnaire administered to 163 respondents residing in Germany, France, Italy and Spain. By exploring consumers' perception of the benefits of traceability systems, they attempt to improve the functions of traceability systems and boost consumer confidence. Bernues *et al.* (2003) identify the attributes of information demanded by consumers living in England, France, Italy and Scotland on beef and lamb labeling and analyze the relationship between such demand and motives. Through cluster analysis, they also examine the importance of information cues for people from different nations to improve the lack of consumer-oriented information in the existing traceability systems.

Most of the above studies collect consumer preferences for traceability information and identify information cues expected or demanded by the market through a questionnaire survey. In these studies, respondents are required to select a few items they pay more attention to form a large number of information attributes. As human brains have a limited capacity for processing information, it is hard for respondents to conduct a comparison between information cues involving more than seven different attributes (Miller, 1956). Therefore, it is not easy to arrive at a conclusion that one information attribute is more important than the other, especially when compromises have to be made in a multi-objective problem. To simply the complexity of the above-mentioned decision, Saaty (1980) proposed Analytic Hierarchy Process (AHP) in 1980. AHP is a method that simplifies a complicated decision through breaking down the problem into several layers. It allows decision-makers to decompose a large and complicated decision into multiple sub-problems and weight each element to find an optimal decision that entails the minimum risk. This study was conducted to apply AHP to analyze consumer preferences for information from the perspectives of food safety, food quality and food trust.

Food safety is related to food-born hazards. Potentially harmful substances contained in food (including mycotoxins, dioxins, chemicals and drug residuals) all pose hazards to the health of human beings (Tent, 1999; Biswas *et al.*, 2010). These hazards can be generally classified into biological, physical and chemical hazards (Codex Alimentarius Commission). Food quality consists of characteristics of a food including its production process, organization and system, overall performance and conditions that determine its compliance with legal requirements of quality assurance, safety and environmental protection (Deutsches Institut für Normung). Food quality can also be defined from the perspectives of suppliers and consumers. (1) From the perspective of suppliers, food quality is the sum of a food's characteristics that can be maintained at a level satisfactory to consumers while the food is produced in an economic manner. These characteristics include external factors such as flavor, freshness and appearance as well as internal factors such as composition, nutrition, amount of microbial biomass, maximum period of storage and safety. (2) From the perspective of consumers, food quality refers to the evident characteristics of a food, including flavor, freshness, appearance, nutrition, hygiene and safety that are acceptable to existing or potential customers. In terms of the food chain, food trust implies that risks are involved in information communication (Luhmann, 1988). Communication of both subjective and objective information affects consumers' trust of a food's safety and quality. Subjective information refers to the information provided by food manufacturers or suppliers to various consumer groups, while objective information refer to the information provided on labels, traceability systems and quality control systems as an instrument to increase consumers' trust of a food and reduce the uncertainty of the food's safety (Grunert, 2005). Thus, if a food's information cannot be effectively conveyed to consumers, problems of information asymmetry between its supplier and consumers may occur and reduce consumers' trust of the food (Frewer *et al.*, 2005).

To sum up, food safety and food quality are closely correlated. High quality implies high safety (Van Rijswijk *et al.*, 2008). Besides, falsification of information or attributes regarding a food's safety and quality also affects consumers' trust of the food (Hobbs, 2004). Therefore, adoption of traceability systems ensures reliability of food sources and is also viewed by consumers as an important criterion for judging the safety and quality of an agricultural product (Halawany *et al.*, 2007).

If AHP is applied to explore the relationship among food safety, food quality and food trust, the required assumption of independence of criterion may lead to oversimplification of the problem and generate biased results. Thus, this paper applied Interpretive Structure Modeling (ISM) to examine the relationship among the three elements and then used Analytic Network Process (ANP) to assess consumers' preferences for information cues to ultimately help food suppliers increase consumers' purchase intention. Because pork was one of the dominant meat consumed in Taiwan and the government has prioritized pork products in the implementation of food traceability systems after the outbreak of foot-and-mouth disease caused a tremendous agricultural loss in 1997, this study used the traceability system adopted in the pork sector as an example to analyze consumers' preference for information provided by the traceability system.

Interpretive structural modeling and analytic network process

Interpretive structural modeling: Understanding the relationships among ill-defined elements in a complex system can improve the quality of rational decision-making. However, it is not easy for human beings to grasp complex systems. Several researchers (Harary, 1969; Simon, 1969; Warfield, 1976) have pioneered the development of think-tools to help sharpening perceptions of the complex system.

Interpretive structural modeling (ISM) is a think-tool developed by Warfield (1976) to understand and comprehend the complex interrelationships between elements. This tool aims at developing an arrangement, in which a set of elements related directly and indirectly are structured into a model, through a systematic analysis of the complex relationship among them based on priority, cause and effect or categorization (Gorvett and Liu, 2006). The steps of ISM include: (1) Identify the elements that could be related to each other in a system (2) Identify the direct and indirect relationships between these elements; (3) Convert the relationships into a matrix that is finally structured into a model through a hierarchical configuration; and (4) Arrive at a multi-level structure of elements with a graphical representation of their networks and relationships based on priority, cause and effect or categorization.

ISM has been extensively applied since introduced. For instance, executives of multinational companies usually may suffer from poor management efficiency resulting from employees' differences in gender, race, nationality and social factors. Broome *et al.* (2002) thus apply ISM to clarify the relationship among the above-mentioned factors to help corporate managers reduce barriers in management and enhance employees' work efficiency and skills. Besides, different departments of a company (i.e., production, sales, human resource, R and D and financial departments) may hold different views regarding the same problem and thus arrive at different conclusions through group decision making. Bolanos *et al.* (2005) use ISM to clarify the difference and correlation between different views to help small-and-medium enterprises improve their group decisions and make decisions beneficial to both the firms and consumers. Promotion and implementation of education principles are complicated and profoundly influential policies which affect education quality and appraisal of stakeholders. Sahney *et al.* (2010) take the higher educational system in India as an example and apply ISM to examine factors critical to quality management in education, hoping that education quality can also be improved with the rapid growth of India's economy.

Analytic network process: Both the Analytic Hierarchy Process (AHP) and the Analytic Network Process (ANP) are method proposed by Saaty (1980, 1996). AHP is a Multiple Criteria Decision Making (MCDM) tool that decomposes a decision-making problem into several levels, forming a hierarchy with unidirectional hierarchical relationships between levels. The ultimate goal of the decision problem is placed at the top level of the hierarchy. The next lower levels are formed by the tangible/intangible criteria (or elements) that contribute to the goal. Decision makers can weight the elements at each level using Saaty's rating scale from 1 to 9 and then calculate the global weights at the bottom level using pairwise comparison. AHP can help decision makers find best suits their goals and their understanding of the problems. Due to the benefits of AHP, it has been widely applied in decision analysis problems (Amiri *et al*., 2008; Asikhia, 2009; Khurana *et al*., 2011; Wang *et al*., 2011; Zorriassatine and Bagherpour, 2009).

AHP is theoretically easy to use. However, independence among the criteria must be satisfied before users can proceed to decision making. Hence, its applicability to many problems in reality is limited. As a solution, Saaty (1996) proposed the ANP the general form of the AHP. The structural difference between AHP and ANP is shown in Fig. 1. As can be seen from Fig. 1, ANP presents a decision-making problem as a network of criteria (or elements) grouped into clusters. The network can incorporate feedbacks and interdependence relationships within/between clusters, so it provides a more accurate modeling of complexity in many real world problems.

Since introduced, ANP has been applied in a variety of fields. For instance, Meade and Presley (2002) use it for selection of R and D Projects; Chung *et al.* (2005) use it for product mix planning in semiconductor fabricator;

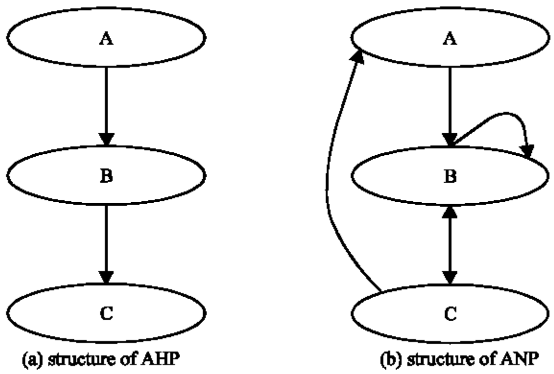

Fig. 1: Structures of AHP and ANP

Partovi (2006) uses it for locating facilities strategically; Gencer and Gurpinar (2007) use it for supplier selection in an electronic firm; Aragones-Beltran *et al.* (2008) use it for assessment of urban industrial lands. Etaati *et al.* (2011) use it for software selection of E-Learning systems.

Proposed approach: Based on the framework consisting of food safety, food quality and food trust, this study applied ANP to analyze consumers' preferences for information cues on the pork traceability system. The analysis consists of three phases, including (1) Build up a network framework (2) Calculate the relative weight for each criterion and attribute of traceability information and (3) calculate the steady-state supermatrix for the priority of attributes of traceability information. A brief explanation of each phase is provided as follows:

Phase I. Build a network framework: Aiming to analyze consumers' preferences for traceability information, we built a network framework that could "capture consumers' preferences for attributes of traceability information under each criterion". To verify the correlation between criteria and induce the attributes associated with each criterion, we applied Delphi method to collect expert opinions through the following steps:

- **Step 1: Form a panel of experts:** Since implementation of the pork traceability system through collaboration between the government and private sectors in 2004, a sound system of operating and channel management processes has been established in the pork sector. To obtain sufficient information from a wide spectrum of opinions and ensure the completeness of the evaluation model, we limited the subjects to scholars and practitioners in this field
- **Step 2: Conduct an expert survey and analyze the results:** Two questionnaires were used in the expert survey. One was intended to evaluate and find the interrelationship between criteria and the other was used to induce attributes of traceability information associated with each criterion for obtaining the relative importance of derived attributes

Survey the correlation between criteria: The selected experts were required to answer the questionnaire in two rounds. The questionnaire used in the first round was designed according to ISM. This questionnaire was administered through field interviews and open discussion and explanation of the questionnaire were allowed during the survey to ensure that the experts understood all the questions before they answered them. The experts were asked to evaluate whether each criterion listed on the left ($C_1, C_2,..., C_n$) affects the criteria listed on the top ($C_1, C_2,..., C_n$), respectively. 1 denotes positive and 0 denotes otherwise. Finally, based on the experts' answers, we could create a binary matrix B as follows:

$$B = \begin{matrix} & c_1 & c_2 & \cdots & c_n \\ c_1 & c_{11} & c_{12} & \cdots & c_{1n} \\ c_2 & c_{21} & c_{22} & \cdots & c_{2n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ c_n & c_{n1} & c_{n2} & \cdots & c_{nn} \end{matrix} \quad (1)$$

Note that all diagonal elements in matrix B are marked 0.

In the second round of the survey, the experts' answers were instantly computed and compared with the results they provided in the first round. If total numbers of votes for the same question in the two rounds were different, they were asked to contemplate on the question again or modify their answers until convergence of their answers. This process was intended to lead the experts to reach a consensus over each question and facilitate convergence of their opinions.

Analyze the correlation between criteria: We then combined the binary matrix B obtained in (1) and the identity matrix I to get the correlation matrix R. Then, successive self-multiplication of R was performed using Boolean algebras (Warfield, 1976) to obtain the reachability matrix N when convergence was reached:

$$N = R^K = R^{K+1}, k>1 \quad (2)$$

Survey the association of traceability information with the criteria: This survey was also carried out in two rounds. In the first round, the experts were asked to evaluate the association of each attribute listed on the left of Table 1 with the criteria listed on the top of the table. They were allowed to check one criterion that each attribute was most correlated with.

Table 1: Association between attributes of traceability information and evaluation criteria

		Criteria			
Item	Traceability information	C_1	C_2	...	C_n
1	X_1				
2	X_2				
3	X_3				
⋮	⋮				
m	X_m				

Before conducting the second round of the survey, we computed the results obtained from the previous round and examined if any item was associated with multiple criteria. The experts were asked to view the results obtained in the first round as they answered the questionnaire in the second round. They had to review their answers until steady convergence of their opinions was reached.

The above expert survey was designed based on the spirits of the Delphi method. The main characteristics of this survey include: (1) independence of thinking: anonymity of the respondents was maintained during collection of the opinions, so all respondents could feel free to express their opinions without being affected by other members in the group (2) instant feedbacks: the results of the survey were instantly computed and fed back to experts as a reference for them to modify their opinions and (3) convergence: through iterative modification of opinions, biases could be excluded and congruent results could be obtained. Although obtaining convergent opinions through this process is more costly and time-consuming, the consensus reached by a large population of experts also has a higher degree of validity (Sharma *et al*., 1994).

Phase II. Calculate the relative weight for each criterion and attribute of traceability information

- **Step 1: Conduct the survey on consumers:** The 1-9 scale developed by Saaty for AHP was used for the survey on consumers and comparison of criteria or attributes of traceability information under each criterion in pairs were made to build pairwise comparison matrices. As the subjective preference of every decision-maker will be different and the judgments made will not be completely identical, Saaty (1996) suggests an integration of decision makers' preferences with the geometric mean by establishing a pairwise comparison matrix for each component which needs to conform to the characteristic of positive reciprocal matrix
- **Step 2: Calculate the maximum eigenvalue and eigenvector for each pairwise comparison matrix:** Let $A = (a_{ij})$ denote a pairwise comparison matrix of elements $e_1, e_2, ..., e_n$ in which a_{ij} represents the relative significance of e_i to e_j and the elements here can be the criteria or the attributes of traceability information under each criterion. Then, by using the row vector average normalization proposed by Saaty (1996) we could calculate the maximum eigenvector $W = (w_1, w_2, ..., w_n)$ of the pairwise comparison matrix A by:

$$w_i = \frac{1}{n}\sum_{j=1}^{n}\frac{a_{ij}}{\sum_{j=1}^{n} a_{ij}}, \ \forall i = 1, 2, \cdots, n \tag{3}$$

where, w_i is called the relative weight of e_i. Moreover, we could obtain the maximum eigenvalue λ_{max}:

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n}\frac{\sum_j a_{ij} w_j}{w_i} \tag{4}$$

- **Step 3: Consistency test:** The consistency test of ANP is designed to ensure the consistency of judgments by decision makers throughout the decision making process. In this paper, we defined the consistency index (C.I.) of matrix A as:

$$\text{C.I.} = \frac{\lambda_{max} - n}{n - 1} \tag{5}$$

According to Saaty (1980), if the consistency ratio (C.R.) of the pairwise comparison matrix A, defined as Eq. 6, is less than 0.1, the consistency level of the pairwise comparison matrix is acceptable. If C.R. is greater than 0.1, the results of the decision process are not consistent. For such situation, Saaty (1980) suggests that the decision maker performs the pairwise comparison again:

$$\text{C.R.} = \frac{\text{C.I.}}{\text{R.I.}} \tag{6}$$

where, R.I. can be obtained from Table 2.

Phase III. Calculate the steady-state supermatrix for the priority of attributes of traceability information: ANP uses a supermatrix to present the relationship of feedback and interdependence among the criteria or attributes of traceability information. We constructed the supermatrix according to the network framework built in phase I. The structure of the supermatrix is shown in Eq. 7:

$$M' = \begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} W_{11} & W_{12} & \cdots & W_{1n} \\ W_{21} & W_{22} & \cdots & W_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ W_{n1} & W_{n2} & \cdots & W_{nn} \end{bmatrix} \end{array} \tag{7}$$

Table 2: Random Index (R.I.)

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
R.I.	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

If no interdependent relationship exists between the criteria C_i and C_j, the pairwise comparison submatrix W_{ij} would be 0. Otherwise, if an interdependent and feedback relationship exists among the criteria, such submatrix would no longer be 0. For example, $W_{21} \neq 0$ implies that criterion 2 depends on criterion 1. Each column of a submatrix is either a normalized eigenvector on the attribute of traceability information from phase II or its entire block entries being zero.

If the supermatrix does not comply with the rule of column stochastic, the decision-maker can weight the matrix to make it comply with the rule of column stochastic. The weights are taken from the normalized eigenvector on criteria. Then the unweighted supermatrix is multiplied by the weight to yield the weighted supermatrix M. Finally, the weighted supermatrix M will be steady-state by multiplying the weighted supermatrix by itself until convergence of the interdependent relationship to obtain the accurate relative weights among the attributes of traceability information:

$$M^* = \lim_{k \to \infty} M^K \tag{8}$$

EMPIRICAL VALIDATION

The pig farming industry is one of the backbones of Taiwan's agricultural industry. However, since the foot-and-mouth disease claimed a huge economic loss in 1997 and the ban on pig import was lifted in 2002 after our nation's entry into WTO, the number of domestic pig farms has decreased by 1,802, from 12,931 in 2002 to 11,129 in 2008 and the total number of pigs has also decreased by 477,452 from 6,920,763 to 6,443,311. Therefore, enhancing the production and sales environment and expanding the domestic market are the primary tasks that the government and the industry must address. In recent years, our government has launched a program of introducing the food traceability system to the pork sector. Through this program, the government expects to help the domestic pork sector not only meet international demands but also increase its market competitiveness and ensure consumer benefits. This paper used the traceability system adopted in Taiwan's pork sector as an example to examine consumers' preference for traceability information.

First of all, a Delphi survey was conducted on a panel of five experts. Of these experts, two have expertise in agriculture and farming and are ones of the scholars involved in the planning of Taiwan's food traceability systems, one is a researcher from Food Industry Research and Development Institute (FIRDI) and the remaining two are senior managers of two chain supermarkets which are also model stores for demonstrating application of food traceability systems. This study used food safety (C_1), food quality (C_2) and food trust (C_3) as criteria for evaluating consumers' preferences for traceability information. Through two rounds of survey on correlation between criteria, we obtained the result as shown in Table 3.

Table 3: Correlation between criteria

Criteria	Food safety	Food quality	Food trust
Food safety	0	1	0
Food quality	1	0	0
Food trust	0	1	0

1: The criterion on the left affects the criterion on the top and 0: Otherwise

Based on the experts' answers, we built a binary matrix B:

$$B = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \end{array} \begin{array}{c} \begin{array}{ccc} C_1 & C_2 & C_3 \end{array} \\ \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \end{array}$$

To further identify the interrelationship among the three criteria, we added the identify matrix I to the binary matrix B and performed self-multiplication of R (= I+B) iteratively to obtain the reachability matrix N which revealed the relationship of the three criteria (Fig. 2):

$$N = \begin{array}{c} \\ C_1 \\ C_2 \\ C_3 \end{array} \begin{array}{c} \begin{array}{ccc} C_1 & C_2 & C_3 \end{array} \\ \begin{bmatrix} 1 & 1 & 0 \\ 1 & 1 & 0 \\ 1 & 1 & 1 \end{bmatrix} \end{array}$$

The relationship shown in Fig. 2 suggests that food safety and food quality are interdependent and higher food safety or higher food quality leads to higher food trust. As mentioned in the literature review, there is interdependence among the three criteria. Therefore, applying ANP to evaluation of preference for traceability information could help us obtain objective and reasonable results that cover multiple factors and can be used to increase consumers' purchase intention.

After utilizing ISM to identify the relationship of the three criteria, we conducted a survey on associations

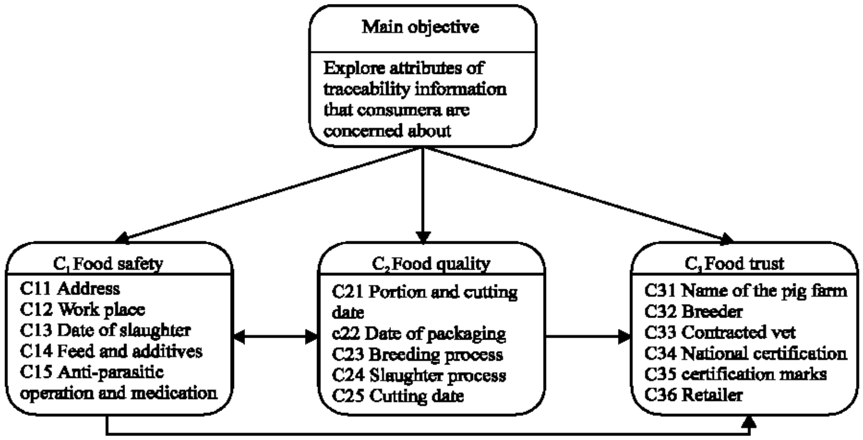

Fig. 2: The framework for evaluating consumer preference of pork traceability information

Table 4: Attributes of traceability information and explanation of each attribute

Attributes of traceability information	Explanation of the attribute
1. Address	The registered address can be verified with the address of the pig farm that supplies the pork
2. Workplace	This information allows consumers to understand the environment where the food is produced and can increase their trust of the food
3. Feed and additives	This information allows consumers to understand which kind of fodder is used to feed the animal and the safety of its source
4. Vaccination	This information allows consumers to understand medical treatruent and vaccination of the animal
5. Anti-parasitic operation and medication	This information allows consumers to understand that the animal has been properly medicated according to guidelines and which medication has been administered
6. Breeding process	This information allows consumers to understand how pigs are bred, the facilities used to breed them and enviroument of the pig farm
7. Date of slaughter	Exposure of date of slaughter increases the visibility of the operating process
8. Slaughter process	This information allows consumers to understand the measures taken and guidelines followed to prevent and control epidemics before and after slaughter of pigs
9. Cutting process	This information allows consumers to understand the processes of cutting and packaging the meat
10.Portion and cutting date	This information increases the visibility of the operating process
11.Date of packaging	This information helps consumers judge the freshness of the meat product
12.Name of the pig farm	Data of registered pig farms allow consumers to understand the source of the meat
13.Breeder	Responsibility can be easily clarified if the breeder has a legal license for operating a pig farm
14.Contracted veterinarian	Diseases can be effectively prevented if the pig farm has a professional and certified veterinarian responsible for epidemic prevention and control
15.National certification	Agricultural products that have passed related standards of the nation will be given a mark of certification, CAS which stands for compliance with the highest quality standards of the nation
16.Certification marks	Certification marks shown on the products indicate that the food has been thoroughly examined in the production process to find potential biological, physical and chemical hazards and proper measures have been taken to control or cope with identified hazards to ensure the safety of the food
17.Retailer	The perceived safety and quality of the food can be higher if it is sold by a well-known retailer

between the attributes of traceability information and the three criteria so that a network framework could be built. From Pork-Taiwan Good Agriculture Practice (P-TGAP), we extracted 17 attributes of traceability information as shown in Table 4. These attributes are norms that the government encouraged the pork industry to follow when introducing a traceability system to their industry and also the cues that consumers can trace or refer to when making a buying decision or dealing with a product-related problem. Based on the attributes and explanations provided in Table 4, we also collected expert opinions using the Delphi method and constructed a network framework for ANP as shown in Fig. 2.

In the survey of consumer preferences, we selected one well-known chain supermarket in central Taiwan. This supermarket has 15 stores in Taichung City and is the only supermarket that owns three certifications, including ISO9002, HACCP and CAS. Because the survey process required by ANP is more complicated, Khorramshahgol and Moustakis (1988) suggest that the number of respondents should not be too large and preferably fall between 5~15. However, for a realistic and reliable model to be obtained we selected 10 stores at random to distribute the questionnaire (Fig. 3). The questionnaire was distributed to consumers who have purchased products carrying labels of food traceability systems. A total of 200 consumer responses were obtained. Based on these responses, we built pairwise comparison matrices of criteria and attributes under each criterion and computed the maximum eigenvalue and eigenvector of each matrix (Step 2 of Phase II). The consistency test result (Step 1) showed that all the pairwise comparison matrices complied with the consistency requirement (C.R.$\leq$0.1), suggesting that the responses collected from consumers were consistent.

Then, we input the eigenvector (i.e., relative weight) of each attribute into the supermatrix to obtain an unweighted supermatrix M'(Table 5). In this table, 0 denotes no dependence between criteria. Because the values in M' do not comply with the rule of column

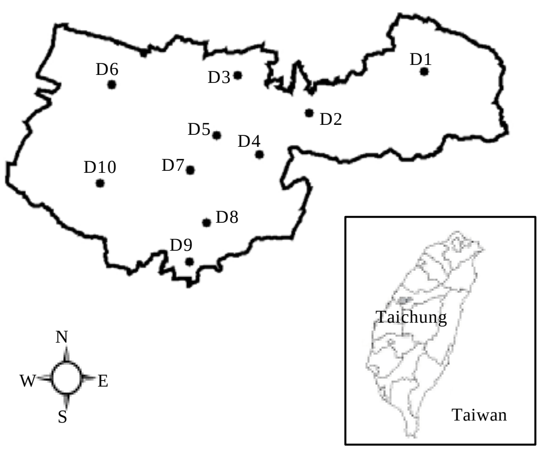

Fig. 3: Distribution of the stores selected for conducting the survey, D1: Dongshan, D2: Dalien, D3: Tienjing, D4: Sanmin, D5: Chienhsing, D6: Chinghai, D7: Dadun, D8: Chungming, D9: Daching, D10: Nantun

stochastic (the sum of values in each column is not equal to 1), they should be adjusted through weighting to make the sum equal to 1. This process would yield a weighted supermatrix M as shown in Table 6.

To ensure that the final result is consistent and at a steady state, we multiplied the weighted supermatrix by itself until convergence of the weighted values of the interdependent relationship to obtain a limit supermatrix M* as shown in Table 7.

By sorting the attributes in Table 7 by weight, we could understand consumers' preferences for attributes of traceability information, as shown in Table 8. Because food safety, food quality and food trust are the goals of traceability systems, all the information attributes used in traceability systems are derived from these three criteria. In terms of the importance of traceability information, among the top six attributes, three are associated with food trust (national certification (0.297), certification mark (0.170), retailer (0.076)), one is associated with food safety (date of slaughter (0.054)) and two are associated with food quality (portion and cutting date (0.055) and date of packaging (0.052). The above finding suggests that consumers are most concerned about whether the product has passed national certification, does it carry other certification marks and where it is sold when purchasing pork products. As there are numerous dishonest traders selling fake or defective products in the market, whether the government or private sectors can provide a trustworthy certification for reliable food products affects consumers' purchase intention. Besides, product display environment, product management and service quality also influence the reliability of a food product.

Date of slaughter is an important cue that can be used to trace the source of a food problem. Through a database of meat products, consumers can easily identify

Table 5: The unweighted supermatrix M'

		C_1						C_2					C_3					
		C11	C12	C13	C14	C15	C16	C21	C22	C23	C24	C25	C31	C32	C33	C34	C35	C36
C_1	C11	0	0	0	0	0	0	0.037	0.037	0.037	0.037	0.037	0	0	0	0	0	0
	C12	0	0	0	0	0	0	0.124	0.124	0.124	0.124	0.124	0	0	0	0	0	0
	C13	0	0	0	0	0	0	0.325	0.325	0.325	0.325	0.325	0	0	0	0	0	0
	C14	0	0	0	0	0	0	0.244	0.244	0.244	0.244	0.244	0	0	0	0	0	0
	C15	0	0	0	0	0	0	0.148	0.148	0.148	0.148	0.148	0	0	0	0	0	0
	C16	0	0	0	0	0	0	0.123	0.123	0.123	0.123	0.123	0	0	0	0	0	0
C_2	C21	0.327	0.327	0.327	0.327	0.327	0.327	0	0	0	0	0	0	0	0	0	0	0
	C22	0.311	0.311	0.311	0.311	0.311	0.311	0	0	0	0	0	0	0	0	0	0	0
	C23	0.140	0.140	0.140	0.140	0.140	0.140	0	0	0	0	0	0	0	0	0	0	0
	C24	0.101	0.101	0.101	0.101	0.101	0.101	0	0	0	0	0	0	0	0	0	0	0
	C25	0.121	0.121	0.121	0.121	0.121	0.121	0	0	0	0	0	0	0	0	0	0	0
C_3	C31	0.073	0.073	0.073	0.073	0.073	0.073	0.062	0.062	0.062	0.062	0.062	0	0	0	0	0	0
	C32	0.061	0.061	0.061	0.061	0.061	0.061	0.051	0.051	0.051	0.051	0.051	0	0	0	0	0	0
	C33	0.065	0.065	0.065	0.065	0.065	0.065	0.056	0.056	0.056	0.056	0.056	0	0	0	0	0	0
	C34	0.437	0.437	0.437	0.437	0.437	0.437	0.455	0.455	0.455	0.455	0.455	0	0	0	0	0	0
	C35	0.248	0.248	0.248	0.248	0.248	0.248	0.262	0.262	0.262	0.262	0.262	0	0	0	0	0	0
	C36	0.116	0.116	0.116	0.116	0.116	0.116	0.113	0.113	0.113	0.113	0.113	0	0	0	0	0	0

Table 6: The weighted supermatrix M

		C_1						C_2					C_3					
		C11	C12	C13	C14	C15	C16	C21	C22	C23	C24	C25	C31	C32	C33	C34	C35	C36
C_1	C11	0	0	0	0	0	0	0.018	0.018	0.018	0.018	0.018	0	0	0	0	0	0
	C12	0	0	0	0	0	0	0.062	0.062	0.062	0.062	0.062	0	0	0	0	0	0
	C13	0	0	0	0	0	0	0.162	0.162	0.162	0.162	0.162	0	0	0	0	0	0
	C14	0	0	0	0	0	0	0.122	0.122	0.122	0.122	0.122	0	0	0	0	0	0
	C15	0	0	0	0	0	0	0.074	0.074	0.074	0.074	0.074	0	0	0	0	0	0
	C16	0	0	0	0	0	0	0.061	0.061	0.061	0.061	0.061	0	0	0	0	0	0
C_2	C21	0.163	0.163	0.163	0.163	0.163	0.163	0	0	0	0	0	0	0	0	0	0	0
	C22	0.156	0.156	0.156	0.156	0.156	0.156	0	0	0	0	0	0	0	0	0	0	0
	C23	0.070	0.070	0.070	0.070	0.070	0.070	0	0	0	0	0	0	0	0	0	0	0
	C24	0.051	0.051	0.051	0.051	0.051	0.051	0	0	0	0	0	0	0	0	0	0	0
	C25	0.061	0.061	0.061	0.061	0.061	0.061	0	0	0	0	0	0	0	0	0	0	0
C_3	C31	0.037	0.037	0.037	0.037	0.037	0.037	0.031	0.031	0.031	0.031	0.031	0	0	0	0	0	0
	C32	0.031	0.031	0.031	0.031	0.031	0.031	0.026	0.026	0.026	0.026	0.026	0	0	0	0	0	0
	C33	0.033	0.033	0.033	0.033	0.033	0.033	0.028	0.028	0.028	0.028	0.028	0	0	0	0	0	0
	C34	0.219	0.219	0.219	0.219	0.219	0.219	0.228	0.228	0.228	0.228	0.228	0	0	0	0	0	0
	C35	0.124	0.124	0.124	0.124	0.124	0.124	0.131	0.131	0.131	0.131	0.131	0	0	0	0	0	0
	C36	0.058	0.058	0.058	0.058	0.058	0.058	0.057	0.057	0.057	0.057	0.057	0	0	0	0	0	0

Table 7: The limit supermatrix M*

		C_1						C_2					C_3					
		C11	C12	C13	C14	C15	C16	C21	C22	C23	C24	C25	C31	C32	C33	C34	C35	C36
C_1	C11	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
	C12	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021
	C13	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054	0.054
	C14	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041	0.041
	C15	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
	C16	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
C_2	C21	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055	0.055
	C22	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	C23	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
	C24	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017	0.017
	C25	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020
C_3	C31	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045	0.045
	C32	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037	0.037
	C33	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040	0.040
	C34	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297	0.297
	C35	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170	0.170
	C36	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076	0.076

Table 8: Analysis of the attributes by weight

Criteria	Traceability information	Weight	Rank
C_1 Food safety	C11. Address	0.006	16
	C12. Workplace	0.021	13
	C13. Date of slaughter	0.054	5
	C14. Vaccination	0.041	8
	C15. Feed and additives	0.025	11
	C16. Anti-parasitic operation and medication	0.020	14
C_2 Food quality	C21. Portion and cutting date	0.055	4
	C22. Date of packaging	0.052	6
	C23. Breeding process	0.023	12
	C24. Slaughter process	0.017	15
	C25. Cutting process	0.020	14
C_3 Food trust	C31. Name of the pig farm	0.045	7
	C32. Breeder	0.037	10
	C33. Contracted veterinarian	0.040	9
	C34. National certification	0.297	1
	C35. Certification marks	0.170	2
	C36. Retailer	0.076	3

and trace the source of the products they purchase. As domestic people buy and eat almost all portions of a pig, the cutting date, portion of the cut and date of packaging are very important. These information cues represent whether standard operating procedures have been strictly followed in the slaughter process. From them, consumers can also judge whether there is a significant difference in the cutting time of different portions of a pig. While some dishonest vendors may mix sick or dead pigs with healthy ones or process the meat of dead pigs to produce various products, such information is particularly important. Besides, packaging and freezing pork immediately after cut and preventing growth of microorganisms in meat are critical processes that ensure hygiene and quality of meat products. Therefore, information of a pork product from breeding, slaughter, cutting, packaging, vending to retailing should all be recorded in the traceability system. The realization of this goal will require proactive promotion of the government and more importantly, support of the industry and consumers.

These findings are consistent with Gellynck *et al.* (2008) in the sense that quality label (portion and cutting date and date of packing) ranks higher in terms of importance as compared to the cues of product origin and slaughter date. Nevertheless, some previous meat studies, e.g., Stranieri and Banterle (2009), Giraud and Halawany (2006) and Bernues *et al.* (2003), showed product origin was the first thing that came to consumers' minds when questioned about their definition of traceability which is contrary to our results. It is well known that people from different cultural background have different perceptions and experiences related to food and that they have different priorities regarding food (Lennernas *et al.*, 1997; Houghton *et al.*, 2008). It is believed that some cultures are more oriented towards food quality, whereas for others food safety is their main concern (Askegaard, 1995).

Other authors have pointed out that, consumers are not interested in cues directly related to traceability and identification while they pay more attention to other cues like readily interpretable search information cues such as expiry date, meat type, weight and price (Verbeke and Ward, 2006; Verbeke *et al.*, 2002). Nevertheless, these information cues are ignored in this study because these are mandatory standard information regarding food in Taiwan.

CONCLUSIONS

Traceability systems are one of the main instruments that many nations have adopted to enhance food safety. The main benefit of traceability systems is that detailed information about all levels of operations involved in food production is disclosed to consumers. Although systems and guidelines used in traceability systems may differ from nation to nation, all of them are intended to effectively combat untraceable food products sold by dishonest suppliers, increase the responsibility and obligations of food suppliers and provide consumers a high-quality environment where they are assured of food safety and quality.

This study used the pork sector as an example mainly because pork has always been one of the major sources of protein for domestic people. In addition to domestic people's dietary habit, the outbreak of the foot-and-mouth disease in early years is also one of the factors that made the pork sector the first to implement a traceability system. The goal of implementing a traceability system is to enhance food safety, food quality and food trust. As the conventional AHP requires the assumption of independence of each criterion, using it to evaluate consumers' preferences for traceability information may yield biased results. Considering the interdependence of the three criteria, we integrated ISM and ANP to build our evaluation model.

Present findings suggest that in addition to identifying the main attributes that consumers are more concerned about, the government and the industry can present information of these attributes along with information of related regulations on traceability labels to not only increase the reliability of the product but also save the time consumers spend on information seeking and increase the prevalence of products using traceability systems.

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