



Adoption of traceability system in Chinese fishery process enterprises: Difficulties, incentives and performance

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Abstract

The paper presents the results of an empirical study on traceability system adoption in Chinese fishery process enterprises, which are based on a survey on 21 tilapia enterprises in Guangdong and Hainan province. The results show that the function of traceability system is recognized by most enterprises, but traceability system is adopted mainly in large enterprises. Inconsistent traceability standard, high costs, lack of necessary conditions and little government support are the main barriers of system adoption for small and medium-sized enterprises. For all the enterprises, the common incentive factors influencing traceability system adoption are improvement of product quality, need of healthy consumption and improvement of management style, also different ownership enterprises have different preference motives. The most notable adoption performance is proved in private enterprises, followed by state-owned enterprises and joint-vent enterprises. Finally, some suggestions are shown for effective adoption of traceability system in Chinese fishery process enterprises.

Key words: Traceability system, fishery process enterprises, food safety.

Introduction

In China, fish industry has made a great contribution to increase of fiscal revenue. In the first half of 2008, the export volume is 1.4 million tons and export value reached 4.75 million dollars. Meanwhile higher income has spurred greater demand for aquatic products ¹. Tilapia is a rising fish industry in China, which is popular because its good taste and quality, also it is more affordable, compared with other high-valued, cultured species. For promoting the sustainable development of tilapia industry, the Ministry of Finance supported 17,000,000 yuan (RMB) for the research of tilapia industry in 2008. However, in the same time the new requirements for quality and safety of aquatic products are on the rise.

In order to ensure the safety of the aquatic products supply chain, many countries issued food traceability policy and encouraged or compelled the fishery enterprises to adopt traceability system, which is becoming a tool to help enterprises manage the flow of inputs and products and improve food safety ². Foods produced or processed by using of the new technologies leads challenging problems ³. The effective adoption of traceability system is dependent on the close cooperation of each stakeholder in the supply chain. The processing enterprise is the core of supply chain, with a wealth of capital, technology and human resources. The incidents of food safety are closely related to the processing enterprises. They are faced with the reality that traceability system is encouraged in the market and must choose, when such opportunity exists, between adopting and not adopting ⁴. That is to say, whether the enterprises adopt traceability system; which are difficulties and incentive factors

and what about the performance of traceability system adoption. These problems are crucial for effective implementation of traceability system in enterprises.

Some results of research have been reported on incentives, costs and benefits, barriers and effects about traceability system adoption based on investigation and empirical study. Whether or not to adopt traceability system is related with the enterprise size, the level of inherent production uncertainty and previous compliance with quality assurance schemes ^{5,6} and depends on a number of factors, such as implementation readiness criteria (IRC), strong management commitment (allocation of resources, investments in hardware and software, training of personnel) and monitoring costs with and without adoption of traceability technologies ⁷. Even though the enterprises have a substantial capacity to establish traceability system, they need to evaluate its costs and benefits and determine the efficient breadth, depth and precision of traceability ², because more reliable traceability systems might induce higher food safety efforts by suppliers ⁸. In addition, effective implementation of traceability system requires an organizational response that addresses the allocations of value, uncertainty and decision rights throughout the supply chain to assure accurate information flows and quality integrity ⁷.

In China, the studies in the field of traceability system adoption mainly focused on discussing the need and importance of traceability system, describing how to implement traceability system and costs and benefits for traceability system adoption ¹⁰⁻¹². Besides that, Yang and Wu ¹³ analyzed the influence factors and mechanisms of traceability system adoption, in which the

depth, breadth and precision of traceability, the coordination level of supply chain enterprises, the existing information technology and the rate of incidence of food safety are considered as main influence factors. However, these researches are still in preliminary stages with placing more emphasis on theoretical analysis, and there is not yet relevant empirical research into the issues of the traceability system adoption in Chinese enterprises. Therefore, the paper investigates and discusses the difficulties, incentives and performance of traceability system adoption in Chinese fishery process enterprises based on an empirical study.

Materials and Methods

The survey and sampling areas: In the research, Guangdong and Hainan province are selected as the sampling areas. Guangdong is the first largest tilapia production and export regions in China. Recently, the output of tilapia is more than 500,000 tons, constituting about 50% of the nation's total output, and the export amount reached 128,000 tons in 2007. Hainan is the second largest tilapia production and export regions. The accumulated export amount of processed tilapia is 51,000 tons from January to July 2008, accounting for 68% of total aquatic products export amount. By the survey, it is expected not only to reflect the status and difficulties of traceability system adoption but also analyze influence involved in import markets.

In addition, a skeleton questionnaire was designed to guide the structured interviews with enterprises' managers and officials managing food safety, the purpose of which is to collect more in-depth knowledge about the enterprises' difficulties and incentives for adopting traceability system and what about the performance after adoption of traceability system or what kind of effects do enterprises look forward to. This is more likely to provide some "why" information to explain their answer in questionnaire.

Conceptual framework: From introduction it can be seen that many factors impact traceability system adoption, in essence, they are linked to enterprises' characteristics, difficulties and incentives. So a questionnaire is selected for this study which consisted of

21 questions, organized into four groups including demographic characteristics of enterprises, the difficulties of traceability system adoption and the incentives factors of traceability system adoption.

As adoption of other food safety assurance systems, many difficulties will be encountered by enterprises in the process of traceability system adoption. Firstly, those are related with basic characteristics of enterprises, such as size, type (ownership) and whether to export (because the decision of export enterprises to adopt traceability system relies heavily on the import countries' food safety requirements). Secondly, by the further discussion with the managers of enterprises, we find that costs of adoption (such as the purchase of computers, software, data acquisition and processing equipment, traceability labels, change of management mode and coordination with other supply chain members) have a significant influence on the decision of enterprises' leaders, who are uneasy about future uncertainty of returns. Also the different traceability standards in the markets impede the effective adoption of traceability system. In addition, the traceability system, which is a new food safety assurance system, whether it is to be accepted by society and consumers, these problems influence the decision of enterprises.

Incentive factors of traceability system adoption vary widely among enterprises. To find the different incentives of enterprises, the paper made a comparative analysis in different ownership enterprises. According to existing research, the incentive factors can fall into four categories: improvement of management level, enhancement of product competitiveness, satisfaction of social demands and other incentives such as encouragement of the government and first adoption of similar enterprises, in which, 11 items related to four groups of factors to effect traceability system adoption are listed, and respondents are required to rate their answers on a five point Likert scale ranging from "very unconsentient" to "very consentient".

Besides that, to make a comprehensive analysis on traceability system adoption, another questionnaire about performance of traceability system adoption was also analyzed. The research team

members made repeated discussions with officials in charge of food safety and managers of enterprises, eventually five questions are selected, which are improvement of product quality and service, improvement of enterprise management standard, expansion of trade volume, improvement of public image and improvement of product competitiveness. From the above analysis, the basic research framework of the paper is showed as Fig. 1.

Statistical methods: In the analysis of basic characteristics of enterprises, difficulties and incentive factors of traceability system adoption, the basic statistical analysis about the mean, percentage, frequency and comparison methods are conducted.

Analytic Hierarchy Process (AHP) is adopted for analyzing the performance of traceability system adoption between state-owned enterprises, private enterprises and

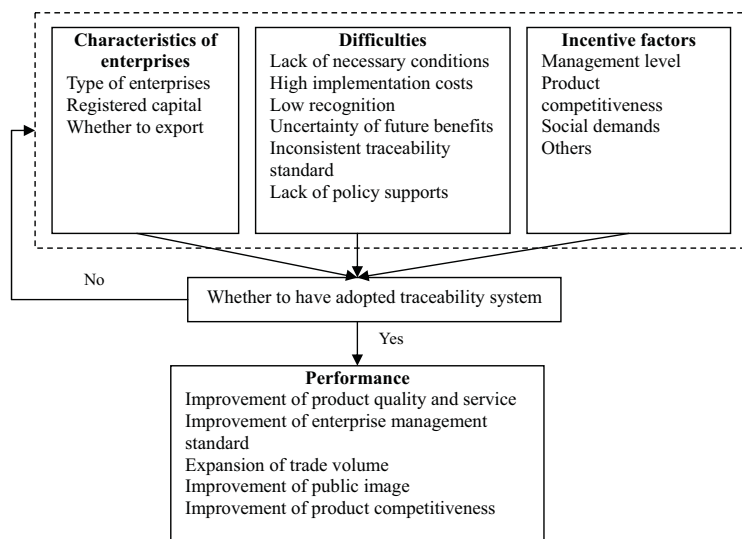


Figure 1. The research framework for traceability system adoption in fishery process enterprises.

joint-vent enterprises. This technique is suited for application to problem evaluations in which qualitative factors dominate. It can be characterized as a multi-criteria decision technique that can combine qualitative and quantitative factors in the overall evaluation of alternatives.

Results and Discussion

A total of 50 questionnaires were distributed and returned. After eliminating those questionnaires with incomplete responses and those that were otherwise unusable, 21 usable questionnaires were obtained for an effective response rate of 42%. The reason why the response rate is low is connected with actual situation of traceability system adoption in China's agricultural enterprises. The government doesn't compel enterprises to adopt traceability system. Although the enterprises have capability of traceability based on paper, in consideration of costs of traceability system adoption, most small and medium-sized enterprises don't plan to establish traceability system. Even export enterprises don't volunteer to adopt traceability system if it is not required to establish traceability system by import countries. In addition, the survey ran into many difficulties, for example, some enterprises declined to be interviewed or the information provided lack credibility.

Characteristics of enterprises: Demographic information related to the characteristics of the enterprises is presented in Table 1. The majority of survey respondents are private enterprises, followed by state-owned enterprises and joint-vent enterprises. The proportion reaches 47.62, 28.57 and 23.81%, respectively. Because the main respondents are along coastal region, export enterprises exist in a great number in the survey. Of enterprises 13 are concerned in export trade, which account for 61.9%. The small and medium-sized enterprises whose registered capital is less than 5,000,000 yuan are more (76.2%). In which, the respondents of registered capital less than 1,000,000 yuan account for 57.15%.

Difficulties of traceability system adoption: The statistical results show that the major barrier is that the standard or criterion of implementation is not consistent in market for agricultural products (76.2%). Actually, there are different implementation standard in different regions and enterprises in China. It's difficult to decide how to implement traceability system for agricultural enterprises. Secondly, the cost of adoption is high (66.7%) and future benefits are uncertain (61.9%). According to the research by Swanson¹⁴, a conversion to a new system is one of the highest risks that an organization can face. As a new investment integrating information

technology with food safety system, the cost of traceability system adoption is higher, including not only explicit costs, such as the purchase of computers, software, data acquisition and processing equipment, traceability labels, but also invisible costs, such as change of management mode and relationship with other supply chain members. It's worrying that the substantial return is not realized if the traceability system is adopted. Thirdly, more than 50% of respondents consider that necessary conditions are still lacking because of skills, funds and human resource and policy supports coming from the government or local authority or other organization are in shortage (52.4%). In China, the state adopts the practice of unified release of food safety support system, and the local government makes relevant policies and measures, specifically according to local conditions. In some regions, the level of economic development is still slow so that the financial support is less. However, the majority of enterprises believes the traceability system is recognized in markets, only 9.5% of respondents express negation. So it can be said that adoption of traceability system is to attend the need of aquatic products market.

Comparative analysis of incentive factors in different ownership enterprises: The mean and percentage of each item are calculated and compared (see Fig. 2). According to the statistical results, the main incentive factors of traceability system adoption for state-owned enterprises are improvement of product quality, need of healthy consumption, improvement of public image, development of domestic market and the government's encouragement; for the private enterprises, that include need of healthy consumption, requirements of clients, expansion of international market and improvement of product quality; for joint-vent enterprises, that is improvement of public image, recognition of enterprise leader, need of healthy consumption, requirements of clients and improvement of product quality.

By contrast, the common incentive factors are improvement of product quality, need of healthy consumption and improvement of management style, and the average score is nearly identical in three ownership enterprises (more than three). Besides that, there are three differences of incentive factors in three ownership enterprises. Firstly, leaders of state-owned enterprises and joint-vent enterprises are more concerned with traceability system than private enterprises; that is related with personal elements of entrepreneur and size of enterprise. Secondly, the joint-vent enterprises grant higher appraisal on development of international market, improvement of public image and product difference than state-owned enterprises and private enterprises. Thirdly, state-owned enterprises set great store by encouragement of government. As compared with state-owned enterprises, requirements of clients are considered as preferable incentives by private enterprises and joint-vent enterprises.

Comparative analysis on performance of traceability system adoption: By extensive interviews with 5 officials responsible for food safety and 10 managers of enterprises, the five evaluation criteria were identified and the relative significance of criteria was scored.

Table 1. Demographic characteristics of the enterprises.

Demographic characteristics	Category	Percent	Frequency
Type of enterprises	State-owned enterprises	28.57	6
	Private enterprises	47.62	10
	Joint-vent enterprises	23.81	5
Registered capital	Less than 100,000 RMB	14.29	3
	From 100,000 to 500,000 RMB	19.05	4
	From 500,000 to 1,000,000 RMB	23.81	5
	From 1,000,000 to 5,000,000 RMB	19.05	4
	From 5,000,000 to 10,000,000 RMB	14.28	3
	More than 10,000,000 RMB	9.52	2
Whether to export	Yes	57.14	12
	No	42.86	9

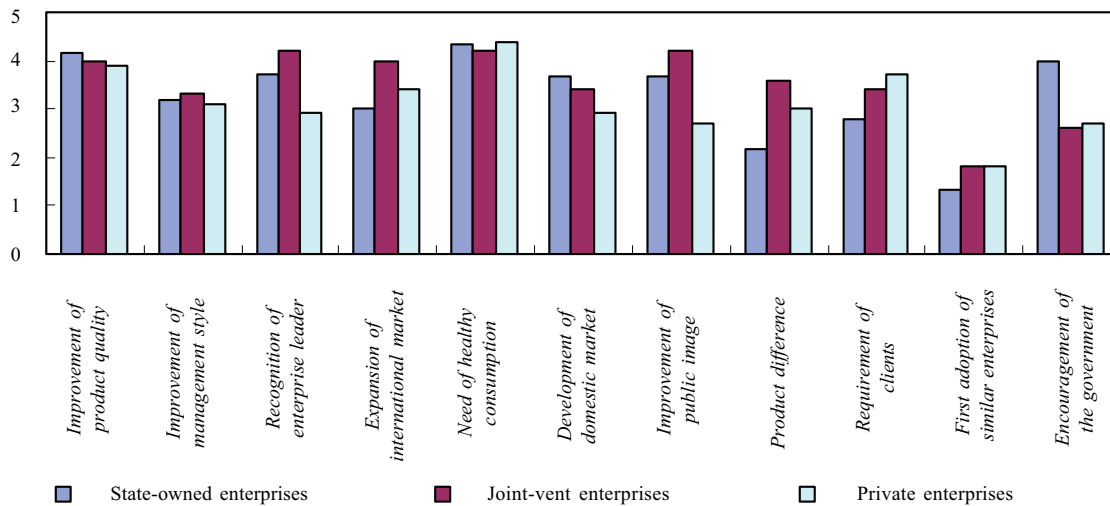


Figure 2. The comparison of three ownership enterprises.

Finally, the hierarchy structure was constructed as Fig. 3. The main results of analysis are shown in Tables 2-4.

In Table 2, the importance of performance criteria is ranked, from which it can be seen that improvement of enterprise management standard is deemed the most important (0.382), which was followed by improvement of product competitiveness, improvement of public image, improvement of product quality and service and expansion of trade volume.

From Table 3 it can be found that traceability system plays different role in three ownership enterprises. In state-owned enterprises, the effect is revealed in three parties, which are expansion of trade volume, enhancement of product competitiveness and improvement of public image. For private enterprises, the effect is manifest in improvement of product quality, service and management standard. In joint-vent enterprises, improvement of product quality and service, expansion of trade volume are the main effect.

The scores of three enterprises are given in Table 4. The private enterprises gain the highest score (0.451), followed state-owned enterprises (0.421) and joint-vent enterprises (0.128). That is to say, after adoption of traceability system the private enterprises achieved most notable effects, next state-owned enterprises and joint-vent enterprises. However, we can see the difference of scores between state-owned enterprises and private enterprises is slight, and their scores are higher than joint-vent enterprises obviously. That indicates adoption of traceability system plays a greater role in Chinese local enterprises. Maybe that is related with the government policy, which is more inclined to be in support of domestic agricultural enterprises. In addition, the length of time the enterprise has implemented traceability system influence the final effect.

Conclusions and Suggestions

From the above results, we can identify important conclusions and further discussion to encourage the adoption of the traceability system in the Chinese fishery process enterprises.

Conclusions: In China, function of traceability system is recognized by the majority of enterprises, but the fishery process

enterprises are of small and medium size generally, and traceability system is adopted mainly in large enterprises. The main barriers that impede the adoption of traceability system in small and medium-sized enterprises are inconsistent traceability standard, high costs, lack of necessary condition and little government support, but 9.5% of respondents with skepticism still exist.

By comparative analysis it can be found that the common incentive factors influencing traceability system adoption are improvement of product quality, need of healthy consumption and improvement of management style, and the difference of evaluation for these factors is slight. In addition, there are some special preferences for three ownership enterprises. For state-owned enterprises, improvement of public image, expansion of domestic market and encouragement of the government are also considered as incentives of traceability system adoption; for private enterprises, they have a preference for requirements of clients and development of international market; for joint-vent enterprises, requirements of clients, development of domestic market and product difference are main preferences.

By analyzing the performance of traceability system adoption in three ownership enterprises using AHP, the result indicates that the effect is the most obvious in private enterprises (0.451), next state-owned enterprises (0.421) and finally joint-vent enterprises (0.128).

Suggestions: Traceability system is an effective tool for food quality assurance and competitiveness improvement of enterprises. With the rising demand for safe aquatic products from domestic market and increasing requirement from import countries, it is potential to increase benefits by adopting traceability system. Parts of enterprises indicate that they don't plan to adopt traceability system recently if there is no compulsory regulation. The most likely reason is that enterprises worry that investments are too much and the significant benefits are not obtained. Therefore, the government departments should strengthen policy publicity and enhance awareness of traceability system establishment.

The main barriers of traceability system adoption are the lack of consistent traceability standard, higher costs, insufficiency of

technology and financial resources for enterprises. China's ability to establish traceability system lags behind the developed countries yet, and relevant laws and regulations served for the traceability system are inadequate. Therefore, it is crucial to make traceability system be put on a standardized and normalized track as early as possible. On the one hand, the government should establish and improve traceability system standard, which will make enterprises recognize the importance of traceability system. On the other hand, the government should provide policy guarantee for adoption of traceability system. Besides that, it is important to set up central government, province and city, prefecture and country level traceability resource centers to provide professional training and consultation services on

traceability system adoption.

Based on the present situation of Chinese fishery process enterprises, it is impracticable to force all the enterprises to implement the traceability system in China, because there exists large numbers of small and medium-sized enterprises, who lack capital, technology and human resources. Therefore, the paper provides two steps to adopt traceability system effectively and comprehensively. Firstly, the government selects sample enterprises with big size and capability taking the consequences to establish traceability system, at the same time gives relevant policy supports and provides adequate cost-benefit information. Secondly, the government is supposed to give enterprises demonstration and stimulation. By a period of time for

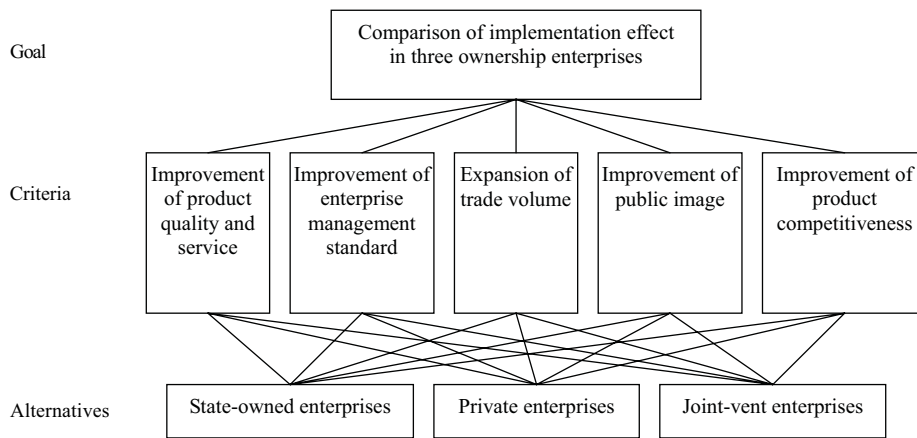


Figure 3. The hierarchy structure for performance comparison of traceability system adoption.

Table 2. The importance of traceability system adoption performance for enterprises.

Performance criteria	Composite priority	Rank
Improvement of product quality and service	0.103	4
Improvement of enterprise management standard	0.382	1
Expansion of trade volume	0.081	5
Improvement of public image	0.172	3
Improvement of product competitiveness	0.262	2

Table 3. The results of pair-wise comparisons (criteria-enterprises) for the importance of performance.

Criteria	State-owned enterprises	Private enterprises	Joint-vent enterprises
Improvement of product quality and service	0.122	0.648	0.230
Improvement of enterprise management standard	0.297	0.594	0.109
Expansion of trade volume	0.681	0.118	0.201
Improvement of public image	0.545	0.370	0.085
Improvement of product competitiveness	0.557	0.320	0.123

Table 4. The results of composite weights for performance of three ownership enterprises.

Alternatives	Composite priority	Rank
State-owned enterprises	0.421	2
Private enterprises	0.451	1
Joint-vent enterprises	0.128	3

implementation, the returns of traceability system will reveal gradually. At that time it's necessary to publicize effects of traceability system adoption and give more policy and financial support to enterprises so as to strengthen their confidence in traceability system adoption.

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