Critical Success Factors for Implementing Traceability Systems in Chinese Food Enterprises

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***Abstract*—Food safety has always been the focus of worldwide attention. However, the implementation of traceability system (TS) in China faces many challenges which are creating major barriers to the traceability system implementation success. Research reported in this paper aims to identify critical success factors (CSF) for implementing TS in Chinese food enterprises. To achieve the research objectives, this research adopted both qualitative and quantitative approaches. Extensive literature review was conducted to establish initial understanding of TS implementation success and associated critical success factors. Semi-structured interviews were carried out with managers to establish a set of TS implementation success measures in the context of Chinese food enterprises. Survey questionnaires were designed to identify the critical success factors influencing TS implementation success. Exploratory factor analysis technique was used for the development of the CSF framework.**

Keywords- Critical Success Factors (CSF); System Implementation Success; Traceability System (TS); Food Enterprise; exploratory factor analysis

I. INTRODUCTION

Food safety has always been the focus of worldwide attention. Chinese Government has promulgated a series of initiatives, laws and regulations to implement the traceability since 2004. However, the implementation of traceability system (TS) in China faces many challenges which are creating major barriers to the traceability system implementation success. Traceability is the ability to trace the history, application or location of an entity by means of recorded information (ISO 8402:1994). This broad definition of traceability has been applied in the food as well as in the non-food sector. In 2004, Food traceability/product tracing is defined by the Codex Alimentarius Commission (CAC) as: *"the ability to follow the movement of a food through specified stage(s) of production, processing and distribution"*. Traceability System (TS) is the modern information system technology and bar code technology applied in food quality and safety management. The establishment of TS for the entire food supply chain can identify product attributes, process attributes, environmental conditions and participant attribute effectively in order to achieve top-down track of raw materials, processing, packaging, storage, transportation, and marketing in food supply chain. It can also trace information from the bottom up when food safety problems occur, quickly identify problem areas [1].

This research aims to identify critical success factors (CSF) for implementing TS in Chinese food enterprises. More specifically, the study attempts to develop a set of criteria of TS implementation success from theoretical and practical point of views and identify and propose a framework of critical success factors for TS implementation success. The research adopted both qualitative and quantitative approaches. To achieve the research objectives, this research adopted both qualitative and quantitative approaches. Extensive literature review was conducted to establish initial understanding of TS implementation success and associated critical success factors. Semi-structured interviews were carried out with managers to establish a set of TS implementation success measures in the context of Chinese food enterprises. Survey questionnaires were designed to identify the critical success factors influencing TS implementation success. Exploratory factor analysis was adopted to analyse the survey data and generate the CSF framework. A six dimensional framework is developed to illustrate the six CSF. The outcomes of this research can have great significance for research and

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management in implementing TS and offering implications for policy makers and other stakeholders in the future.

II. TS IMPLEMENTATION IN CHINA

The implementation of TS in China is still non-mandatory, but TS implementation has covered more than twenty provinces and cities. The research on TS in China mostly focuses on vegetables, aquatic products, meats and tea area. For example, Tao discussed TS applications in vegetables, aquatic products areas in Beijing[2]. Li, Fu et al. designed and implemented a web based Vegetable Traceability System [3]. Yang, Sun et al. built a Fishery Product Quality Traceability System [4]. Xie, Lu et al used different technologies to develop Safe Pork Traceability Systems [5-6]. Yang, Luo et al. combined farming and slaughtering areas, designed and built a complete Pork Traceability System[7-8]. Zan, Zhen et al. developed Beef quality tracking and tracing system [9]. China Meat Research Center and a company has jointly conducted a RFID Traceability System for meat products [10]. Wu, Lu et al. introduced traceability system to tea industry[11].

In China, implementing TS in food enterprises faces a series of difficulties and challenges. These include:

- The complexity involved in system integration because the system should be able to collect information covering the entire supply chain [12].
- The difficulties in collecting large amount of information accurately and ensuring the data quality because of lower educational level of employees and lack of the sense of the responsibility of the inspector or manager[13-16].
- Making the Information collected useful not only for consumers, but also for supporting business and management decision making by company managers[14].
- High cost of the implementation Due to the lack of adequate traceability equipment in China, many companies have to use imported technologies and equipments for traceability implementation. As a result, it is expensive to implement TS [13, 15-17].
- Inadequate national regulations and laws related to traceability [16].

These difficulties and challenges can create major barriers to the traceability system application. Therefore, it is imperative to understand the critical success factors affecting the TS implementation.

III. RESEARCH METHODS

Based on the research objectives and the review on the appropriateness of different research strategies and their use in information systems research, semi-structured interview and questionnaire survey were adopted in this study. The interview can help collect managers' views on TS implementation success and obtain success measures in the context of TS implementation. Questionnaire surveys can help extract CSF through exploratory factor analysis, and data analysis results will be used for proposing CSF framework.

A. Semi-structured Interviews

The purpose of the interview was mainly to collect opinions of managers and experts who have been involved in TS implementation. Six interviewees in four typical food companies in China were contacted and accepted for interviews. The interviews were carried out using face to face and telephone. All the companies which the interviewees work have implemented TS in recent years and the systems are offered by vendors. The traceable products cover vegetables, fruits, meats and aquatic products. The target markets of the products are domestic and international markets.

B. Questionnaire Survey

The instrument adopted is a self-administered questionnaire which has three parts. The first part is a cover letter. The second part of the questionnaire is a list of 32 factors based on the literature review and the results of semi-structured interviews. The respondents are asked to indicate their opinions on the importance of the factors provided in the survey using a 5-point Likert-scales (1= non important to 5= extremely important). The third part collects respondent profile such as their personal and organisational information.

The selected population in this study was people who have participated in the implementation of traceability system in food enterprises. About 400 survey questionnaires were distributed to the sampled subjects, and the respondents were asked to provide feedback via email or online transmission tool such as QQ within two weeks. A total of 129 questionnaires were collected and 124 of them are valid responses representing a 31% valid response rate.

IV. DATA ANALYSIS AND RESULTS

A. Interviews

Interview results suggested that the following criteria can be used for measuring the TS implementation success in food enterprises: *Brand and reputation improved, profit increase, Food safety and well evaluated by consumers, Products are more trusted by consumers, Information satisfy users' need, consumers can simply, quickly and accurately obtain the information they need, Information credibility, Data accuracy, Information automatically collected and transmitted, System user satisfaction, Complete tracing and tracking.*

According to the research by DeLone and McLean [18] about the measures of IS success, the choice of where the impacts should be measured will depend on the system or systems being evaluated and their purposes. Therefore, based on literature review (e.g. D&M Model) and results of the interview, the measures of TS implementation success in Chinese food enterprises are "system users' (e.g. employees in the company) satisfaction, information users' (e.g. consumers) satisfaction, improved food quality and safety, and enhanced brand and enterprise reputation."

B. Survey Analysis

A summary of the demographic characteristics of the sample is shown in Table Ⅰ.

TABLE I. **RESPONDENTS PROFILE**

	Frequency (n=124)	Percent
Position		
General manager	13	10.5
Department manager	17	13.7
Project manager	13	10.5
Manager assistant	19	15.3
Expert	19	15.3
System implementation commissioner	22	17.7
System operator	21	16.9
Implementation Experience		
1 year or less	14	11.3
2-3 years	69	55.6
4-6 years	30	24.2
over 7 years	11	8.9
Education Background		
Junior high school and lower	2	1.6
High School	9	7.3
Junior college	26	21.0
Undergraduate and higher	87	70.2

Factor analysis addresses the problem of analysing the structure of the interrelationships (correlations) among a large number of variables (e.g. questionnaire responses) by defining a set of common underlying dimensions [19]. A large number of variables have been identified in the literature affecting the IS implementation success, but no previous research has investigated the CSF in the context of food traceability system implementation in Chinese food industry. This study attempted to understand the underlying dimensions contributing to TS implementation success. Factor analysis was chosen to help categorise the indentified CSF into a set of uncorrelated dimensions with a minimum loss of information. Exploratory Factor Analysis (EFA) is often recommended when researchers have no hypotheses about the nature of the underlying factor structure of the variables.

In the first Exploratory Factor Analysis (EFA), the initial solution contained 8 factors with eigenvalues of above 1.0, and the proportion of the variance explained by the 8 factors was 73.93%. The results show among the loadings of 32 variables. 28 variables of them are greater than 0.5, which indicate the variables are very significant. Therefore, four variables which are lower than 0.5 were removed. 28 variables were left for second EFA. The results of second EFA shows the loading of one variable is lower than 0.5 which is removed. Therefore, the remaining 27 variables were used for the final EFA.

The final EFA showed that the factor patterns remained constant and six dimensional critical success factors explained 70.62% of the total variance among the remaining 27 variables. Table Ⅱ summarizes the results of the factor analysis.

Six dimensional factors were extracted from EFA analysis and are named based on the area of the variables within each dimension. The six dimensional CSF are categorized as:

TABLE II. RESULTS OF FINAL EFA

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
V1	**.739**	.123	.068	-.043	.332	.137
V2	**.740**	.070	.044	.142	.144	.371
V3	**.554**	-.061	.341	.403	.102	.297
V6	-.082	**.674**	.290	-.113	.329	.140
V7	.175	**.840**	.077	.219	.041	.126
V8	.269	.242	**.730**	.176	-.087	.117
V9	.098	.040	**.806**	.206	.165	-.042
V10	-.317	.103	**.576**	.382	.313	.080
V11	.220	-.003	.254	**.684**	-.078	.168
V12	.072	.109	.098	**.737**	.224	.093
V13	-.212	.004	.157	**.663**	.098	.444
V16	.158	.091	.230	**.601**	.340	-.200
V18	-.038	.200	.510	**.528**	.244	.283
V19	-.083	.260	.300	.506	**.587**	-.019
V20	.042	.304	.167	.013	**.731**	.274
V21	-.061	.226	.410	.168	**.589**	.217
V22	.188	-.139	.354	.357	**.556**	.196
V23	.292	-.007	.124	.044	**.751**	.371
V24	.215	.123	-.058	.212	**.814**	.235
V25	.176	.035	-.074	.171	**.672**	.281
V26	.183	.132	.195	-.015	.313	**.808**
V27	.271	.279	-.007	-.193	.323	**.710**
V28	.158	-.128	.490	.201	.112	**.659**
V29	.252	.024	.122	.056	.240	**.734**
V30	.082	.520	-.051	.284	.208	**.558**
V31	.142	.205	.115	.333	.221	**.602**
V32	-.004	.103	-.230	.337	.166	**.635**
Cumulative variable explained	8.07	15.46	26.33	39.04	54.70	70.62

CSF 1: Laws, regulations & standards. This encompasses three variables that explained 8.07% of the variance. The items are all related to the laws, regulations and standards of food safety and food traceability.

CSF 2: Government support. This includes two variables that accounted 7.4% of the variance. These items deal with the importance of equipment investment and technology support for enterprises implementing systems from government.

CSF 3: Consumer knowledge & support. This consists of three variables that related to consumers' understanding and support of food traceability implementation. This factor explained 10.87% of the variance.

CSF 4: Top management, company-wide & vendor support. This is comprised five variables that explained 12.7% of the variance. These items explain the importance of support from top stratum and all functional department staff in the company for the system implementation. Besides, the vendors' support is also important.

CSF 5: Efficient management & communication. This includes seven variables that related to system implementation management, administrators' quality and communication between upstream and downstream companies. This factor explains 15.66% of the variance.

CSF 6: Information quality & system quality. This encompassed seven variables which explained 15.92% of the variance. The items deal with traceability information quality and system quality.

C. CSF Framework

Based on the factor analysis results, a CSF framework is generated as shown in Figure 1. TS implementation success measures in the context of Chinese food enterprises include: system users' satisfaction; information users' satisfaction; improved food quality and safety; and enhanced brand and enterprise reputation.

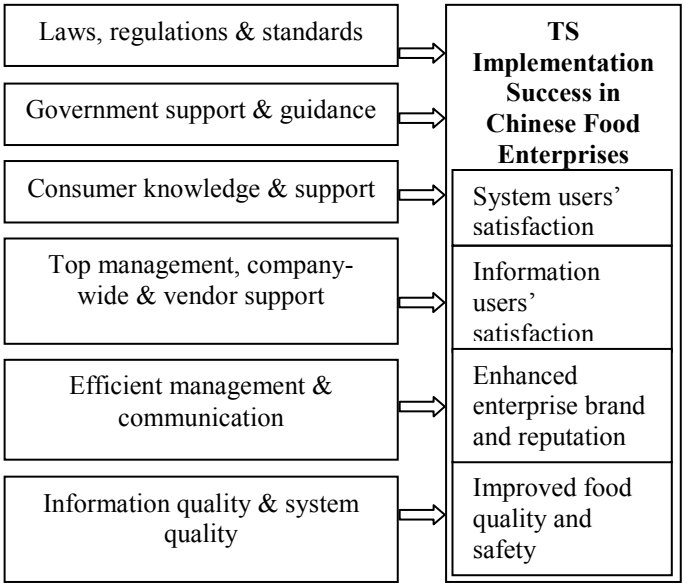

Figure 1. A CSF framework for implementing TS in Chinese food enterprises

V. CONCLUSION

This research acknowledges that much research has been carried out on the traceability system development in food industry, but little research has focused on traceability system implementation success. Since the implementation of TS in China faces many challenges which are creating major barriers to the traceability system success, the results of this study make valuable contributions to the understanding on the TS implementation success in Chinese food enterprises and the critical success factors affecting implementation success.

Six dimensional CSF are derived using factor analysis, which include (1) laws, regulations & standards; (2) government support & guidance; (3) consumer knowledge & support; (4) top management, company-wide & vendor support; (5) efficient management & communication; (6) information quality & system quality. "Top management, company-wide & vendor support", "efficient management & communication" and "information quality & system quality" are frequently discussed in the literatures, but factors in relation to "laws, regulations & standards" and "government support & guidance" are hardly mentioned which are critical in traceability system implementation in China. Food traceability application in China is still in its primary stage, the application environment is immature, and the food enterprises have little implementation experience. Thus, food traceability system application in China is mainly led by the government. The government should continue to provide not only financial help and support, but also the appropriate laws, regulations, and the standards.

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