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Current Status of Supply Chain Quality of Manufacturing Enterprises in Zhejiang Province——an Survey Study

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Abstract

To provide objective basis for the quality improvement and quality risk control in supply chain (abr. SC) for some manufacturing enterprises in Zhejiang province, China, the general quality status of SC should to be researched. To do it, through expert interviews and reading literature, questionnaire topics are designed, and the statistical approach of SPSS is used to emphatically analyze the 7 quality indexes which can provide us these critical factors of quality. Moreover, some key quality factors are presented as reference to SC quality management. But beyond that, to perceive the culture about quality of SC in these enterprises, the employees' recognition on the quality of SC should also to be surveyed.

Because China's research on supply chain quality is still in its infancy, especially in which the study on the status of quality of supply chain in manufacturing enterprise is very little, the topics design and the status analysis for the pointed survey questionnaire are relatively lack. Therefore, this research has certain reference value to this study, and to managers grasping quality management idea according to critical quality factors.

Keywords: *Manufacturing enterprises; Supply chain (abbr. SC) quality; Quality management*

1. Introduction

Since 21st century, economic globalization results in a fierce competition of market. The competition among enterprises has slid from the price to the supply chain, the quality of which determines the quality of products and the service. American quality management expert J. M. Juran said that "productivity won the 20th century and quality wins the 21st century."

As the market is complicated and Chinese enterprises are in the course of growth, there exists the hazy "quality black box". In recent years, the frequent occurrence of supply chain quality accidents indicates the urgency of quality management. For example, melamine milk powder scandal in 2008[1], financial crisis suffered by enterprises of Wenzhou, Zhejiang Province [2], the farmer spring scandal in Zhejiang in 2013 [3], etc. Problems of the supply chain and the management are interconnected and complicated. As a lack of professional knowledge, many enterprises mistake the supply chain quality management as the supply chain management, which leads to a weak quality supervision. Manufacturing enterprises in Zhejiang Province are representatives of Chinese enterprises. Thus, analyzing the current situation of the supply chain quality shall provide a valuable reference for enterprises on learning about the supply chain quality, the existing management situation as well as ways of improvement. Due to SCQM is an important emerging field that needs to be further studied [4], the recognition on the current status and on

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the quality factors of SCQ for manufacturing enterprises, which are the basis of study, should to be carried out.

2. Literature

Researches domestically and abroad are mainly as follows that can state the tendency of this research area.

2.1. Overseas Study on the Supply Chain Quality Management

Western countries have kept an eye on this problem since 1990s. With case study and experience of working in enterprises that are certificated by ISO 9001, Carol J. Robinson and some others construct a framework for high-qualified supply chain management and define the concept of the supply chain quality management [5]. Thierry [6] focuses on the integration of supply chain management and sustainable quality improvement. David Thomas [7] aims at basis concept and ways for managing the supply chain risk and argues that the supply chain quality is significant to enterprise's survival and bankruptcy and financial crisis have attracted attention of managers and scientist. Batson & McGough (2007) [8] build quality model of supply chain for quality prediction and quality improvement by the ideas of quality engineering. Zhu, etc [9] researched to achieve supply chain coordination operation between a manufacturer and a supplier through quality improvement strategies. Foster [10] focus on the concept of supply chain quality management from these aspects of customers, quality practices, supplier relations, leadership, human resource, operation effect, satisfaction, and etc. Ouardighi and Kim [11] studied the supply chain system based on one supplier and two manufacturers, and design the wholesale price contract and revenue sharing contract by using the non-cooperative dynamic game to improve the quality of supply chain. Jing Zeng, Chi Anh Phan and Yoshiki Matsui [12] proposed a conceptual framework to study the relationships among three dimensions of supply chain quality management including of internal quality management, conformance quality from suppliers, and customer satisfaction. K. V. Geetha nad R. U. thayakumar [13] formulate a supply chain model with single vendor and single buyer considering quality improvement which attempts to offer a best policy that provides possible solutions for both the buyer and the vendor to collaboratively agree on inventory control. To collaborate on improving both design and conformance quality between one manufacturer and one supplier, design quality is supposed to increase product desirability, and therefore market demand, while conformance quality should reduce the proportion of defective items, and therefore increase the manufacturer's sales revenue [14], and so on.

2.2. Research on the Supply Chain Quality Management in China

Bao Ju-fang [15] says that traditional concept and way of quality management cannot adapt to the new century. She also discusses the quality formation process, its characteristics and management level. A few scholars [16] provided to control the quality of suppliers' components, and established a quality control model of Assemble-to-Order (ATO) supply chain through the way of quality tracing. They think the best quality control mechanism (including component procurement price, the coefficient of supplier compensation and the amount of profit transfer, and etc.) for the final product manufacturer can to be obtained. Chen Xiang-feng [17] focuses on the quality warrant of the supply chain and constructs a "Nash Equilibrium Model" that is based on bilateral selection of buyers and sellers, which provides a reference for preventing quality credit risk by taking the advantage of the quality warranty contract. You Jianxin, Li Yan [18] analyzed the aggregating global supply

chain with strategy quality management, and put forward the organization notion and steps to implementation strategy quality management based on global supply chain. Based on the motivating the supplier and the manufacturer's actions, for improving the quality of contract in supply chain, Zhou Ming, etc. [19] analyze how to specify conditions on contract parameters to maximize the profits both each node enterprise and supply chain. Wu Qi and Xu Tong-bang [20] study the range of management of the supply chain and propose that enterprises with the supply chain at its core should supervise the design and manufacturing process of their own products and carry out quality management on suppliers, distributors, retailers and other related enterprises to form a controlling system for products and services. Guo Xu-liang, Gu Li [21] propose a quality guarantee mechanism for the whole supply chain process based on coordinated quality guarantee system from the perspective of core enterprises. This provides a theoretical basis for the supply chain management that can state the tendency of this research area.

2.3. Review on the Current Study

Generally, these researchers more or less focus on quality management related to links with the supply chain, such as the quality of the supplier, product quality. However, they have a weak definition on quality-related problems in the process of resource transfer. More importantly, there is a lack of theory and empirical analysis. In addition, as quality management is the key to improving product and service, strategic cooperation among enterprises begins to take shape to increase the competitiveness. A strong cooperation between enterprises, enterprise and the government or other institutions rests with the effectiveness of the resource, the duration of the cooperation, flexibility and the enforcement of the decision, etc. therefore, this research sets up topics and carries out the research about information, management idea, resources and strategic relationship.

Moreover, the quality factors of SC are not to be considered systematically which make us have difficulty in the affecting of QM. Although, in literature single quality factor such as cooperation, suppliers, customers' needs, culture, and so on is respectively considered for the improving of QM and performance for SC, the diverse and plain study is not insufficient. So, we aim to point out the challenge of enterprise facing with and to further present the critical quality factors of SC.

3. Primary Analysis of the Questionnaire Survey

This survey was taken from August 2013 to November 2013. The research objects are quality control department, sales department, production and technical department, procurement department as well as top decision-makers who have at least junior college degree. 879 out of 910 surveys were returned.

3.1. Basic Information of Samples

Among all objects, there are private enterprises, taking up 570 of total surveys or 64.8%; foreign-funded enterprises, taking up 259 of total surveys or 29.5%; State-owned enterprises, taking up 50 of total surveys or 5.7%. Private enterprises are dynamic and the major economic entities in Zhejiang Province.

3.2. Relevance of Indicators

Mean of the detailed indicator is used to test the relevance of 7 dimensional indicators of enterprises. The result is shown in Table 1. A big value means a good management on this dimensional indicator. This research adopts Pearson correlation to analyze the relevance of indicators. The result shows that many indicators have

such relevance. And for p that is smaller than 0.05 in the correlation coefficient test, there is a notable relevance. The coefficient of supply chain management and that of management on products' quality are as high as 0.417. Quality dimensional indicator has a high relevance with other indicators, 4 of which are higher than 0.3.

Table 1. Analysis on Indicators Relevance

	Cultural idea	Supply chain management	Capital	Information	Management on products' quality	Government relationship
Cultural idea	1					
Supply chain management	.202**	1				
Capital	.143**	.360**	1			
Information	.240**	.245**	.227**	1		
Management on products' quality	.186**	.417**	.352**	.357**	1	
Government relationship	.204**	.296**	.309**	.132**	.228**	1
Production	.059	.335**	.328**	.231**	.398**	.195**

3.3. Employees' Recognition on the Supply Chain Quality

The No. 1-8 questions stand for the recognition of employees at all levels on the supply chain. Results are shown in the order of product sales, commodity supply, production technology, management approach, strategic relationship, don't know, and agree with No. 1- 5 and other answers. The statistic results for SOEs are shown as follows:

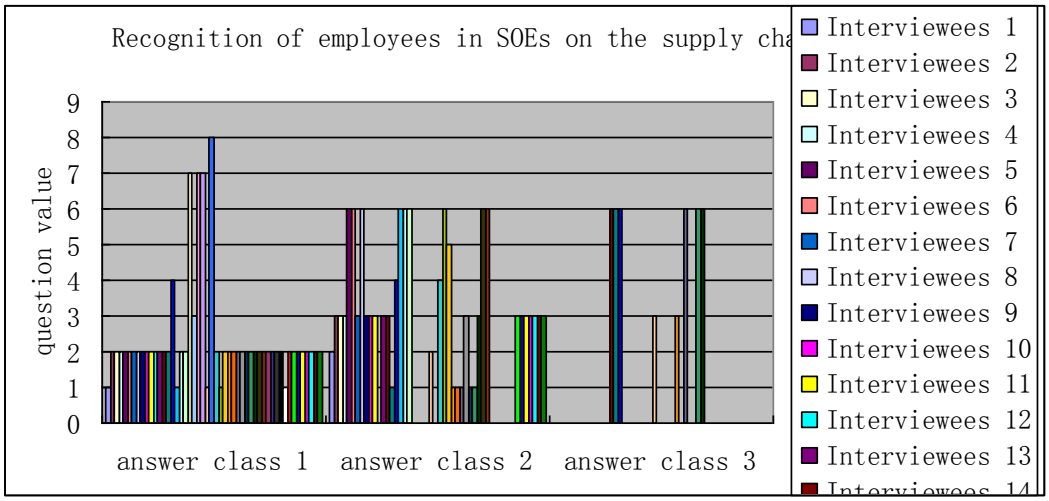

Figure 1. Recognition of Employees in SOEs on the Supply Chain Quality

Figure 1 shows that employees in SOEs mainly relate the supply chain quality to sales quality, quality of the commodity source and production technology. Most employees think that a smooth channel and a good quality for the commodity source guarantee the supply chain quality. Some think that production technology is the key and others deem that sales quality is important. Except that, some people have no idea of what the supply chain quality is and think that questions No. 1-5 are the answer. Few agree that improving the supply chain management will be necessary to the supply chain quality.

The result from employees in foreign-funded enterprises is different from that of the SOEs. Suppose to exclude 6 samples that are only filled with question No.8, the statistic result of the rest 254 samples are shown below.

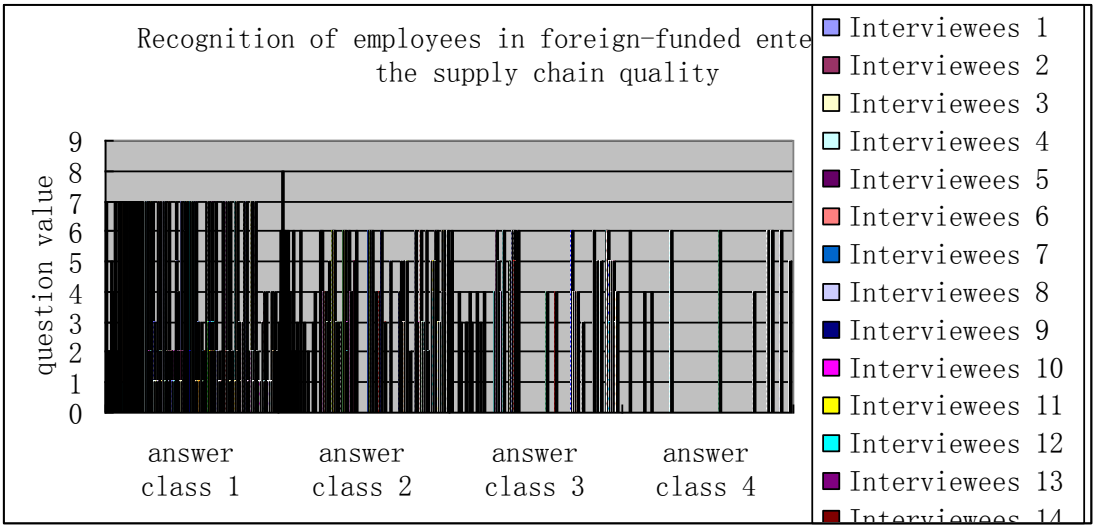

Figure 2. Recognition of Employees in Foreign-funded Enterprises on the Supply Chain Quality

Study Figure 2 indicates that employees in foreign-funded enterprises have a variety of recognition of the supply chain quality. Besides the three hard conditions including quality of sales, quality of the commodity source and production technology, these employees also have a high expectation on the management. They agree that management and capability are the key to the supply chain quality, which also implies that they are not satisfied with the existing management approach. Some others think that strategic cooperation relationship is significant to the supply chain quality. What's more, more people in foreign-funded enterprises than in SOEs label question No.1-5 as the answer and more regard the strategic cooperation relationship as an important factor. These show that employees in the foreign-funded enterprises have a higher quality and a better understanding on this question.

There are many private enterprises in Zhejiang Province with the largest surveys returned. These interviewees in private enterprises need also to answer the above eight question (including of sales quality, commodity supply, production technology, management approach, strategic relationship, don't know, questions No.1-5 are the answer and other answer). Their answers center on the four class question values, such as the radar in Figure 3.

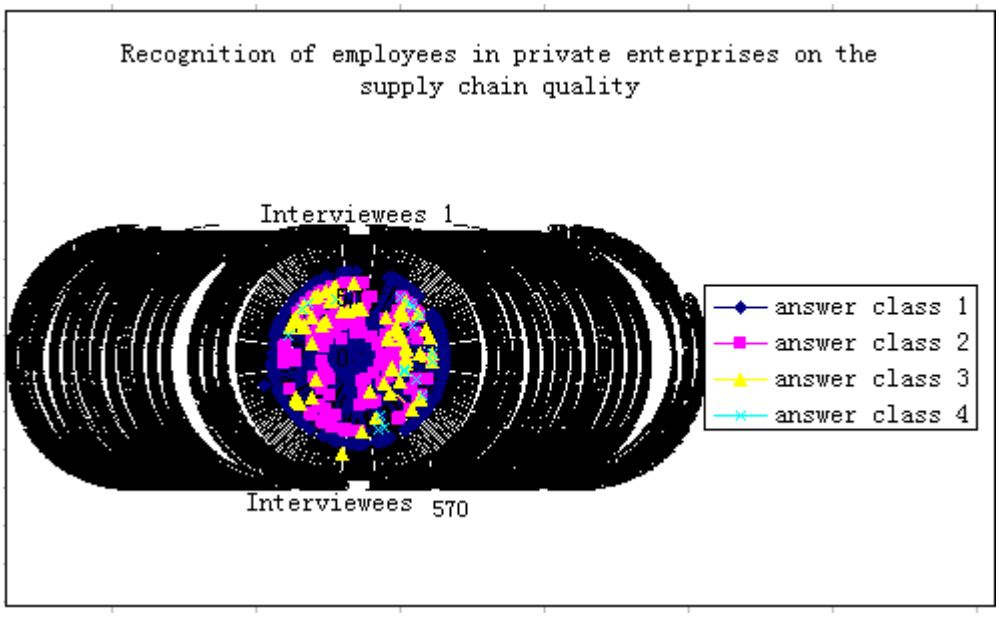

Figure 3. Recognition of Employees in Private Enterprises on the Supply Chain Quality

We can see question No.7 and No. 6 have the most answers. This distinguishes employees in private enterprises with the other two. Many also choose don't know and No. 1-5 as the answer, indicating that the quality of employees in private enterprises has a notable difference from one to another. Diminishing the ratio of employees with low-quality stays the key to the strategic management of private enterprises. In addition, some think that management approach and strategic cooperation relationship are important to the supply chain quality. But, many people think that the quality of sales is not important in quality management, which may be explained by the characteristics of private enterprises.

Comparing the answers of employees from three types of enterprise, we can see that employees in SOEs are conservative and conventional; employees in foreign-funded enterprises and private enterprises have a relatively higher quality and knowledge-absorbing ability. Next, the current situation of supply chain quality management will be the focus of the study for providing better solutions to this problem.

4. Statistical Analysis on the Current Situation of the Supply Chain Quality of Manufacturing Enterprises in Zhejiang Province

Based on previous analysis, we conduct statistical analysis on the data for the third part (about the current situation of the supply chain quality) from the perspective of the supply chain quality and discuss the bottlenecks for improving the competitiveness of manufacturing enterprises in Zhejiang Province.

4.1. Cluster Analysis on Indicators

This research adopts ward distance of the systematic cluster analysis method to classify 7 management indicators. Results show that 4 indicators, namely, supply chain management, management on products' quality, cultural idea and information, can form relatively independent linking dimensions, with production, capital and government management serving as the branches. The cluster of indictors is expressed in Figure 4.

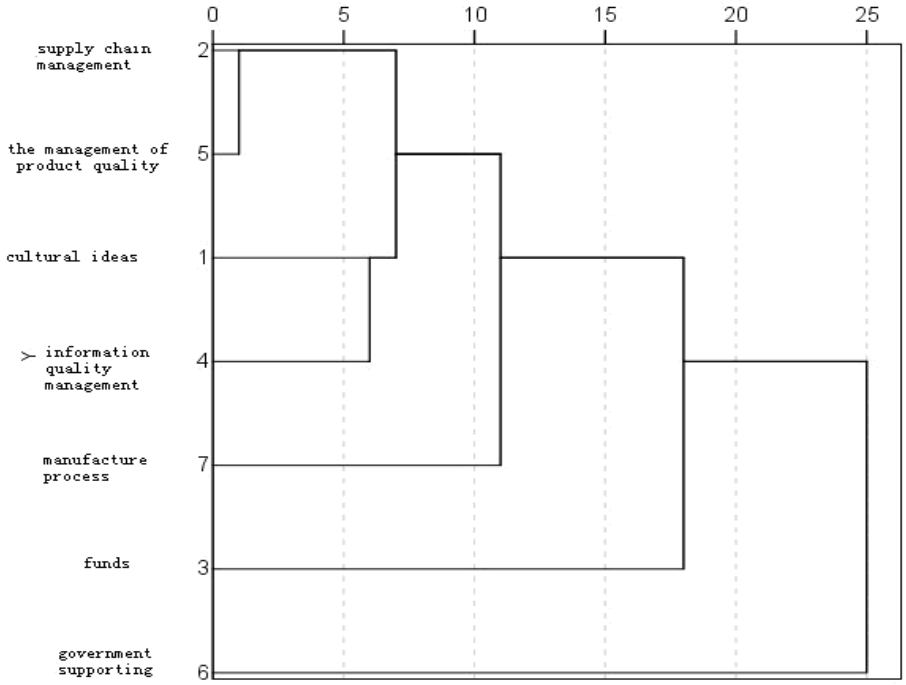

Figure 4. The Clustering Merger Tree on Average Connection

4.2. Analysis on Main Factors

This research adopts ward distance of the systematic cluster analysis method to classify

Table 2 shows the communality of 7 indictors, 3 of which are larger than 0.5, the rest 4 of which are larger than 0.3.

Table 2. The Communality

	Initial	Extraction
Cultural idea	1.000	.809
Supply chain management	1.000	.498
Capital	1.000	.474
Information	1.000	.382
Management on products' quality	1.000	.545
Government relationship	1.000	.306
Production	1.000	.593

Table 3. Total Variance

Factors	Characteristics of the initial			Extraction of the square sum			Rotation of the square sum	
	Sum	Variance %	Accumulated %	Sum	Variance %	Accumulated %	Sum	Variance %
1	2.605	37.219	37.219	2.605	37.219	37.219	2.203	31.469
2	1.001	14.295	51.514	1.001	14.295	51.514	1.403	20.046
3	.918	13.111	64.625					
4	.675	9.648	74.274					
5	.636	9.083	83.357					
6	.625	8.928	92.285					
7	.540	7.715	100.000					

Based on Table 2 and 3, we employ the main factor analysis method to get the main factor such as Figure 5.

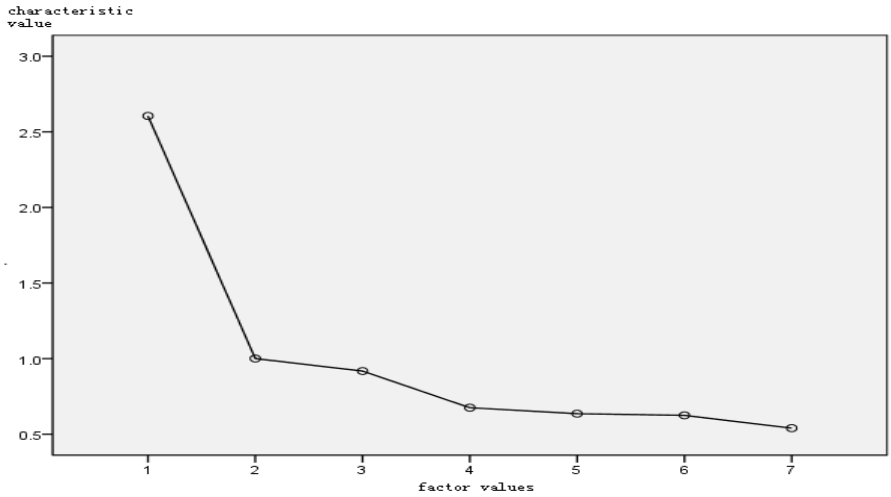

Figure 5. The Main Factors

Test it by the screed plot. The number of factors is the abscissa and Eigen value is the ordinate. The Eigen values of the first two factors are notable while the rest are not, which means that factor 1 and 2 have a remarkable effect on information description of the initial variable.

We construct the component matrix (which supposes that variables are linear combinations of factors) based on main factor method.

We employ extraction method of main factors to select relevance matrix. Results show that most of the indicators concentrate on factor 1, indicating that they have a high relevance with this factor. But another factor has a small relevance with the initial variables, which brings some trouble to the definition of the factor.

Table 4. Component Matrix [a]

	Factor	
	1	2
Management on products' quality	.728	-.123
Supply chain management	.701	-.080
Capital	.661	-.191
Production	.622	-.454
Information	.556	.269
Government relationship	.533	.146
Cultural idea	.408	.802

To better distinguish all indicators, we employ the maximum variance rotation, and repeat the maximum convergence of iterative process 3 times. We also rank the factor loading in descending order to better analyze the contribution of main factors.

Table 5. Rotation Component Matrix [a]

	Factor	
	1	2
Production	.766	-.082

Management on products' quality	.692	.258
Capital	.668	.166
Supply chain management	.647	.282
Cultural idea	-.049	.898
Information	.347	.511
Government relationship	.388	.393

Extraction method: main factors. Rotation method: cross rotation with standardized Kaiser. Based on Table 3 and 4, we can get component matrix shown in Figure 6.

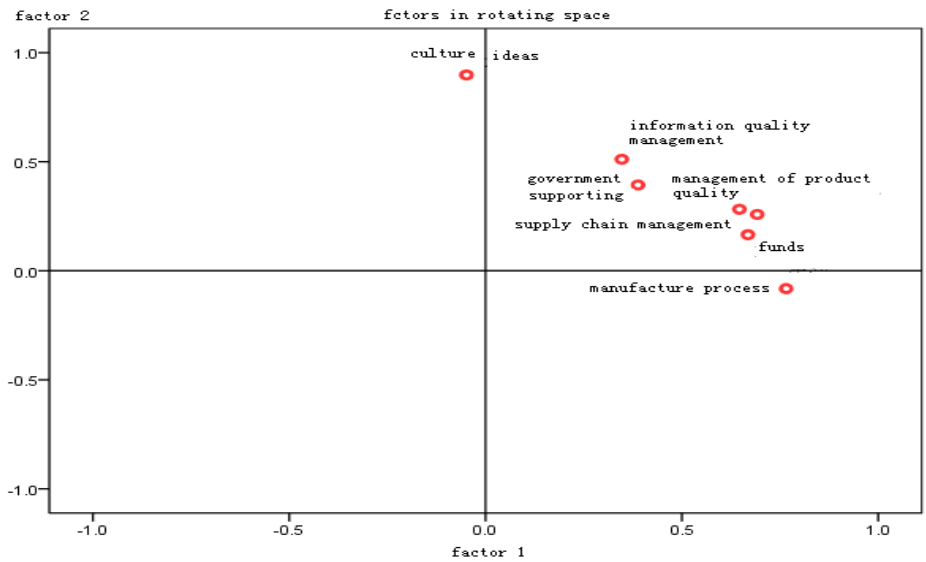

Figure 6. Component Matrix

The regression equation of main factors derived from score matrix is:

management attribute=(cultural idea *-0.266)+(supply chain management *0.273)+(capital*0.315)+(information *0.05)+(management on products' quality *0.303)+(government relationship *0.104)+(production*0.434).

coordinated attribute=(cultural idea *0.772)+(supply chain management *0.066)+(capital*-0.038)+(information*0.339)+(management on products' quality *0.034)+(government relationship*0.229)+(production*-0.273).

And we can get the total factor equation F=0.372193*f1+0.142947*f2 according to the contribution rate of each factor. Thus, the score of each main factor is shown in Table 6.

Table 6. Score Matrix

	Factors	
	1	2
Cultural idea	-.266	.772
Supply chain management	.273	.066
Capital	.315	-.038
Information	.050	.339
Management on products' quality	.303	.034

Government relationship	.104	.229
Production	.434	-.273

Extraction method: main factors. Rotation method: cross rotation with standardized Kaiser. Construct the score.

4.3. Analysis on the Current Situation of the Supply Chain Quality of the Manufacturing Enterprises based on Main Factors

According to the above research, we can further get the stratified numerical table for main indicators as Table 7.

Table 7. Stratified Numerical Analysis on Main Indicators (According to the Type of the Enterprise)

		f1		f2		f3	
		Average	Standard deviation	Average	Standard deviation	Average	Standard deviation
Type	Foreign-funded enterprises	.03532	.99770	.26550	.98401	.05110	.40028
	State-owned enterprises	.85316	.42899	-.12651	.63481	.29945	.15138
	Private enterprises	-.09105	1.00152	-.10973	1.01184	-.04957	.39892

From Table 7 it is clear that the value of factor 1 of SOEs is the highest while that of private enterprises is the lowest, indicating that SOEs have done a better job than foreign-funded enterprises and private enterprises in supply chain management, quality management on product, capital and production. They have a relative improved management system and lay more emphasize on product quality. An abundant capital enables the smooth production. In contrast, private enterprises may lack strategic operation idea that could limit the quality management.

But the value of factor 2 of foreign-funded enterprises is the highest while that of the SOEs is the lowest, indicating that foreign-funded enterprises have done better than SOEs and private enterprises in services, information and communication, decision transfer, government relationship and cultural idea. It also implies that private enterprises have some flexibility of operation, especially in service idea, though they have some weaknesses in management approach. As for factor 3, the score for relationship between the enterprise and the government of SOEs is higher than foreign-funded enterprises whose score is higher than private enterprises. This also accounts for that SOEs enjoy a higher status while private enterprises do not have such privilege. This may lead to imbalance of resources distribution and in return, costs the supply chain quality. The empirical analysis has already shown that employees do not have a full understanding of the supply chain quality. On one hand, it is attributed to the small invest in the training of staff. On the other hand, it reflects the quality management cultures in enterprise are relatively weak.

The current situation warns that it is necessary to adopt effective management policy to ensure enterprises of better development opportunity. Private enterprises should lay great importance on management mode, resource quality, a balance between production cost and product quality, open management and the like that are easy to cause problems on the supply chain quality. SOEs in Zhejiang Province have some advantages in resources and policies under the support of the government. But from the statistical result, their management tends to be mechanical with a poor sense of service, which could result in a lack of information, a poor service, a weak sense of decision making, a poor learning ability and weak integration ability of resources. As for foreign-funded enterprises, they have a relatively strong integration ability of resources and a flexible management that adapt well to the

market and are easy to come up with innovation. But these enterprises may expose problems of the supply chain quality in resource supply and demand, cultural idea, information flow and decision making.

4.4. Analysis on Quality Factors of SC in Manufacturing Enterprises

According to the above research, although different type manufacturing firms have different advantages in improving quality of SC, namely the quality nodes and quality factors in SC environment endowed with different forces sizes on these different sizes and different types firms, but on the whole composition of factors are the same.

Because the above 7 indicators are reflected in the quality nodes (namely, aspects, can be taken as "entities"), according to the product quality forming and the product quality satisfaction, we suppose the quality nodes as strategic partners, resources supplier, manufacturers, products, customers. In addition, the quality factors constructing quality nodes can be seen as the attributers of quality nodes. In view of the relation between quality nodes and quality factors can be presented directly in basis of "E-R" (Entity Relationship) diagram. On the above mentioned, from the quality attributes and elements forming questionnaire topics we provided the critical quality factors of SC in manufacturers shown as Figure 7.

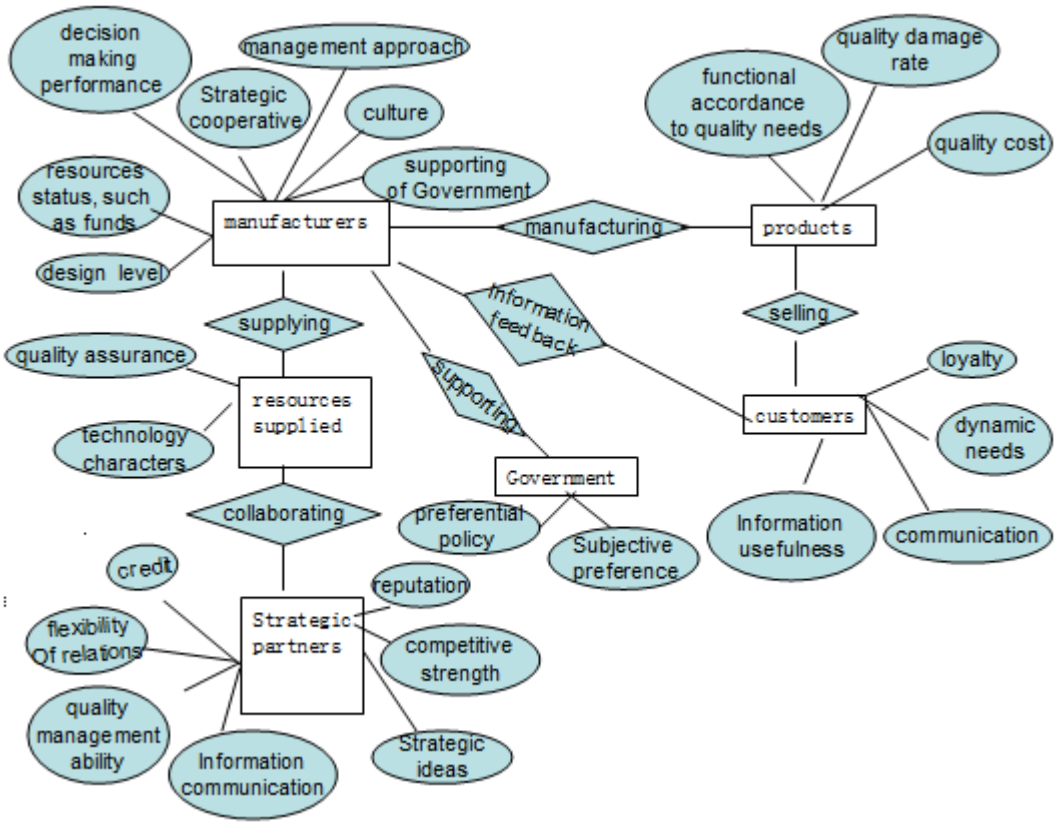

Figure 7. "E-R" Diagram of Reflecting Quality Factors of SC in Manufacturing

In Figure 7, we can see that the quality attributes of each entity are actually quality elements. Once the quality factors are clear, it will easy for us to assess the quality status of every links about quality in SC.

The first main factor: production, management on products' quality, capital, supply chain management that represent the management level of the enterprise and

thus are labeled as management attribute; The second main factor: cultural idea, information and government relationship that can be classified as management of the strategic cooperation and thus are labeled as strategic cooperation attribute.

5. Conclusion

On the one hand, in this study, some general problems existing in the supply chain quality management are further confirmed and the causes of problems are clear. This study aimed to make enterprise managers pay more attention on the current problems in quality management of SC, and present some objective basis for the improving of management. As we all know from above that the key of quality management for manufacture enterprise is the SC quality management, which depends on these quality factors from these quality aspects including of all kinds of supply and demand resources, services or management ideas, government supporting, product quality, customer needs and culture. On the other hand, the research has some deficiency in the these aspects of local data source, limited 7 indicators, here lacking of the transformation analysis of each question options into "quality attributes" in Figure 7 which will shown in the other paper, especially the quality factors in the figure 7 is not sufficient but a critical parts, and so on. Even so, it provides us method from phenomenon to essence. As a result, to some extent, it provides reference to us to know the general current situation of some enterprise and to obtain the critical factors of quality in SC. The follow-up study will be on this basis, using certain methods, such as QFD method, etc., carried on further study on the supply chain quality factors and quality risk controlling.

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