

Analysis and Application of Quality Economics Based on Input-Output

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Abstract. Quality economics analysis is an important research area in the current economic frontier, which has a huge role in promoting the quality-benefit type road development in China. Through the study of quality economics analysis and application, economics of quality and quality economics management are summarized, and theoretical framework of quality economics analysis is constructed. Finally, the quality economics analysis of aerospace equipment is taken as an example to carry on the application research.

1. Introduction

Quality is not only an important reflection of enterprise core competitiveness of, but also the basic elements of enterprise economy. Quality economics analysis combines the disciplines of economics and quality management, which analyses the quality problems from the perspective of economics. Research on quality economics analysis is still in grass-roots stage at home and abroad, therefore, it's urgent to speed up the research of quality economics analysis both in theory and in practice. Development and promotion of quality economics analysis has great practical significance for the comprehensive management of a country's long-term quality and economic issues, which can provide theory basis for a country to take the road of quality benefit and make contribution to the innovation and improvement of quality and economic management discipline.

2. Summary of quality economics analysis

Quality economics analysis emphasizes the rules that quality must follow from the perspective of economics, to seek the best combination of quality and economy and get the most economic benefits. The key lies in the economic analysis and regulation of quality according to the economic rules. "Quality" is examined from the perspective of economics, so "quality" itself from an economic point of view to examine the "quality", "quality" itself is endowed with the attributes of economy.

2.1. Economics of quality

The narrow sense of quality economics analysis refers to the study on specific technical and economic issues of quality-related from enterprise perspective. The broad sense of quality economics analysis is the systematic research on the status and function of quality issues in the social and economic development, the socioeconomic relations which quality category reflects, and the socioeconomic conditions of quality improvement.

The popular concept of quality economics analysis is the economic analysis and economic benefit evaluation of quality and quality management, to determine the best combination of quality improvement and economic benefits, that analysis object expands from product quality to a wider



range including quality management. Quality economics disputes the traditional concept of "defective products as little as possible", which is the important value of the research.

2.2. Management of quality economics

If an enterprise ignores the management of quality economics in the process of pursuing profits, the quality of products and services will be likely to decline, which lead to customer complaints, risk of liability and damage of organization image and reputation, so that market competitiveness and market share of enterprise go down. Therefore, business managers should establish quality policy and quality objectives of the organization, and build files, based on this, the activities of cost reduction and value added are planned and carried out to achieve the best economic results.

The core of quality economics management is to take into account the interests of enterprises and customers, and consider process cost and customer satisfaction of enterprises, from which to find the best combination point. Customer satisfaction is particularly important, and those details that can affect customer satisfaction should be identified. Customers are on behalf of the market, enterprises should continue to enhance customer satisfaction in order to improve efficiency. As shown in Fig.1, the general procedure of quality economics management begins with processes identification and review of organization, to determine, measure and report on organization's quality management activities and related costs in organization angle, and determine, measure and report on customer satisfaction index in customer angle. According to the reports of process cost and customer satisfaction, to implement the management of improvement, and based on economic analysis methods of cost profit and so on, to identify opportunities for improvement and determine whether to take suggestions for quality improvement activities combined with organization's short-term and long-term profit targets. After acknowledgement of quality improvement activities, organization begins planning and implementing the relevant activities, and collect process feedback information to evaluate the results.

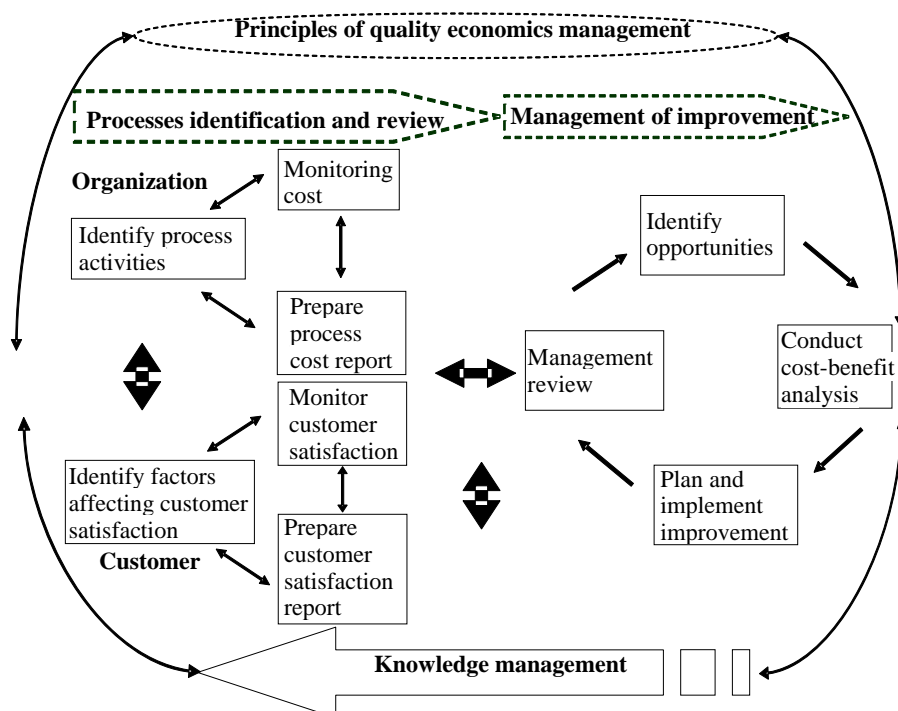


Fig.1 The procedure of quality economics management

3. Theoretical framework of quality economics analysis

The research and practice of quality economics analysis have experienced three stages: quality cost analysis, quality input-output analysis and knowledge-based quality economics analysis. These three stages are both characteristic and interrelated, and they together construct the theoretical framework of quality economics analysis, as shown in Fig.2.

3.1. *Quality cost theory*

Juran, an American quality management scientist, pointed out that quality cost should be divided into three categories: prevention cost, appraisal cost and loss cost. Prevention cost and appraisal cost which are the expense to ensure that products or services meet the requirements of standards and specifications are also called cost of conformance. Loss cost include internal loss cost and external loss cost, which are the expense caused by failure to meet the quality standards and specifications, also called cost of nonconformance. The early quality cost model argued that as the level of quality increased, cost of conformance were rising, while cost of nonconformance were declining, and when the rising cost of conformance (marginal cost) were greater than the declining cost of nonconformance (marginal revenue), quality improvement activities could be seen as uneconomical. With the rapid development of "zero defect" and "continuous improvement", the new quality cost model argued that "zero defect" could be realized economically, because marginal revenue of quality improvement were always greater than the corresponding marginal cost, so quality improvement were the basic way to increase organizational benefits.

3.2. *Quality input-output theory*

Quality input-output theory argued that quality cost only reflected project's input, but any quality improvement activity had the investment orientation, and the economics of quality activities could be evaluated by the ratio of quality benefits and quality costs, which was greater than 1 to demonstrate that quality activities were effective, so the quality improvement programs with higher ratio should be given priority. Quality benefits referred to the benefits or service values acquired or perceived by the organization.

The main factors affecting quality cost-benefit ratio were customer satisfaction, which could be divided into dissatisfied factors, satisfaction factors and pleasure factors. Reducing dissatisfied factors could bright down poor quality costs, increasing satisfaction factors could promote the improvement of quality benefits, and increasing pleasure factors could make customer satisfaction peak, thus to result in quality premium. Considering economics, organizations should usually put the elimination of unsatisfactory factors in the first place, reducing frequency and duration of dissatisfaction.

3.3. *Knowledge-based quality economics analysis*

Quality of products and services depended on the knowledge gained by enterprises and the efforts made in quality assurance, through the acquisition and application of quality knowledge and efficiency knowledge in the process of production practice and continuous improvement, enterprises could promote the improvement of process quality, and knowledge-based quality economics model was formed in terms of this logic. Process quality and quality assurance activities, such as monitoring, inspection, etc., played a decisive role in the final quality of products, and then determined quality benefits of enterprises, which affected performances of enterprises greatly quality together with production costs, and would be converted to customer value.

Knowledge-based quality economics model not only covered the whole process of quality formation, but also revealed basic factors of quality formation and source of their competitiveness, because of which it was more general, systematic and comprehensive than quality cost theory and quality input-output theory. Therefore, knowledge-based quality economics analysis could help enterprises to select quality-based competitive strategies more accurately and comprehensively.

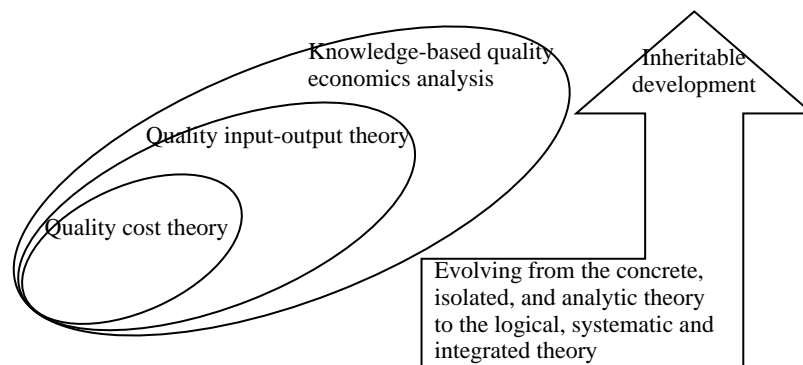


Fig.2 The theoretical framework of quality economics analysis

4. Quality economics analysis and application of aerospace equipment

Aerospace equipment, as a key development area of the "Made in China 2050" plan, plays a vital role in safeguarding national security and territorial integrity. Therefore, it is urgent and important to continuously establish and improve quality economics in the aerospace equipment manufacturing industry, and to achieve high quality economics returns through ensuring the quality of aerospace equipment.

4.1. The concept of quality economics of aerospace equipment

Aerospace equipment has such characteristics as complex technology, quality and reliability, high investment and high risk, which decides that the quality economics of aerospace equipment is different from ordinary products. The quality economics of aerospace equipment refers to the ratio of the revenue from quality to the cost of quality after entering the market or putting it into use. The cost of quality mainly refers to special expenses that use to improve the quality characteristics such as safety and reliability and the cost of related quality assurance activities. According to the theory of quality cost, the cost of quality belongs to the cost of prevention and appraisal. Different from ordinary products, it is not limited to a production unit, but covers the entire model of R&D and production process. The quality revenue of aerospace equipment mainly refers to the revenue from its own quality after entering market or putting into use, including direct revenue and indirect revenue. Direct revenue refers to the revenue of the aerospace equipment for its R&D unit, suppliers at all levels and direct users. Indirect revenue refers to the revenue of the equipment for the state and society, as well as revenue from technology driven and technology radiation applications.

4.2. The content of quality economics analysis of aerospace equipment

The quality economics analysis of aerospace equipment focuses on three aspects: the quality level of the equipment, the cost used to ensure and improve quality and the internal and quantitative relationship between the economic benefits resulting from the quality. The research area is more macro, not only consider the economic benefits of the quality from equipment research and development, production, launch services and operation of the unit, but also the economic impact from quality assurance and quality improvement to the user, the whole society and country. The content of aerospace equipment quality economics analysis is mainly to study how to improve the ratio of quality revenue and quality input of aerospace equipment, that is, through reasonable quality input, improving its quality level, and then obtaining more extensive revenue.

4.3. The model of quality economics analysis of aerospace equipment

Quality economics analysis model of the aerospace equipment as shown in Figure 3, mainly describes the relationship among the quality level of aerospace equipment, quality revenue and quality cost, they are indicated by the quality-revenue curve and the quality-cost curve respectively. Quality cost has a promoting effect on quality improvement when the quality of the aerospace equipment at a relatively

low level, but when quality at a high level, it requires huge investment to further improve the level of quality. In figure 3, the quality level of the aerospace equipment is divided into three important points, the mission success or failure point, the mission requirement point and the international advanced point. When quality level is lower than the mission success or failure point, it means that the mission is not successful, and it cannot obtain positive quality and economic benefits, such as carrier rocket explosion, etc. When quality level is higher than the mission success or failure point but lower than mission requirement point, it means that although the mission did not fail, the quality and efficiency are not fully met the requirements of the mission, such as some functions are disabled after the satellite has been put into service. At this time, the quality and economic benefits of aerospace equipment are produced by many factors, such as technology, quality and so on, which is not obvious. When the quality level exceeds the mission requirement point but fails to reach the international advanced point, it indicates that there is still a lot of room for improvement in quality and reliability. At this stage, quality revenue grows at a high rate, if we increase quality input to improve quality level at this time, we can get good quality and economic benefits. Such as improving the reliability of satellites, prolonging the service life and so on, all of them can produce huge economic benefits. When quality level exceeds the international advanced point, it is very difficult to improve the quality characteristics. However, quality and economic benefits grow gently. At this time, whether increase quality input to improve quality characteristics or develop new product needs to be decided.

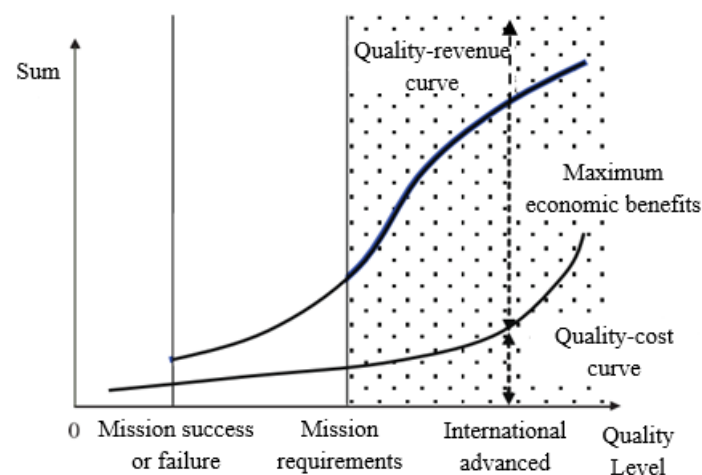


Fig.3 The quality economics analysis model of aerospace equipment

Therefore, before putting in the quality cost, the investment project which closely related to the quality characteristics of aerospace equipment should be analyzed, the contribution rate which investment project brings to the quality and the quality and economic benefits should be evaluated, based on this, the percentage which the cost of each investment project account for the cost of total investment project of quality can be determined.

5. Conclusion

Continuously to promote quality economics analysis is a new effective way to improve the quality of products, which helps our country change the idea that quantity is more important than quality and yield is more important than efficiency, and provides important theoretical support for quality- benefit type road in China. In this paper, the main contents of the quality economics analysis are summarized, and the theoretical framework of the quality economics analysis is constructed. Finally, aerospace equipment is taken as an example to carry on application research. The quality economics analysis of aerospace equipment aims to study the relationship between aerospace equipment quality assurance and improvement activities and the economic benefits produced by the quality, which provides support

for the way that through reasonable investment to improve the quality of aerospace equipment and operation service, to increase quality and economic benefits, and ultimately to create more value for development and production enterprises, suppliers, customers and society.

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References

- [1] Juran J M (2003) “Juran on leadership for quality”. *Simon and Schuster*.
- [2] Li Juan (2014) “Talking about quality management from zero defect”, *Management Review*, (20), pp.116-117.
- [3] An Jingwen, Lu Qiang (2015) “Quality spirit: an enterprise in the bones of a quality”, *China Quality*, 4, pp.2-4.
- [4] Sun Wei, Li Yuesheng (2015) “Quality and economic benefit analysis of space equipment”, *Quality and Reliability*, (3), pp.25-27.
- [5] Pu Jin, Lu Qiang (2016) “Effectiveness evaluation of the equipment manufacturing industry green quality management system”, *Coal Mine Machinery*, 37(8), pp.1-3.