



## Investigating the relationship between quality costs and quality in Pegah Khuzestan dairy industry

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### ABSTRACT

This research aims to study the relationship between the components of quality costs and quality in company. The relationship between the components of quality costs and quality in company has been studied separately for materials, manpower, machinery, and whole of company. In this study, traditional method was used to collect quality costs and PAF model was used to determine the components of quality costs. Research hypotheses were examined based on a statistical sample for a production company with ISO for a three-year period from 2011 to 2013 using correlation coefficient model. Results obtained from the study shows that there is a significant diverse relationship between sum of prevention and appraisal costs, and material failure, human resources and overall costs. But there is not a significant inverse relationship for machinery costs. As well, there exists a direct and significant relationship between sum of prevention and appraisal costs, and the quality level of manufactured product, and an inverse and significant relationship between failure costs and the quality level of manufactured product.

### Keywords:

quality costs, prevention costs, appraisal costs, internal and external failure costs, quality



## 1. Introduction

In the present era, concepts associated with quality have received great importance and extent due to global developments in the field of technology, rapid changes and developments in markets, and more competitive field of activity for businesses. Many organizations evaluate the quality as a fundamental pillar to gain customer satisfaction and a voucher for survival and development in competitive conditions. Nowadays, quality is a concept beyond reliability of the product and its objective is to reach comprehensive quality in which performance and individuals of organization are also effective (Farsijani, 2007). Comprehensive quality system is a continuous and steady effort which steadily helps to increase of process efficiency and efficacy and also increase of quality of products and services. To assure the position of comprehensive quality process, it is required to create a formal structure associated with the system and to use appropriate and related tools and techniques.

Producing a good, providing a service, or performing a qualitative activity which provides a high level of customer's satisfaction is not adequate itself. The costs of gaining this goal must be investigated accurately in such a way that long-term effect of these costs on activity of company or organization is desired. These costs are a correct measure for performing of qualitative activities. In fact, establishment of balance between quality and costs of achieving it is the main role of management. This goal can be estimated in the best way through analysis of components of quality costs. As it mentioned in the most of quality texts, quality costs is divided into four main groups: 1) prevention costs; 2) appraisal costs; 3) internal failure costs; and 4) external failure costs.

So, we need an analytic framework that explains the relationship between quality and quality costs. In the other words, it determines the relationship between sum of prevention and appraisal costs, and failure costs, and the relationship between sum of prevention and appraisal costs, and quality of product, and the relationship between sum of failure costs, and quality of product. When these relations is defined and understand clearly, the ability of organization to decide on quality improvement, decreasing of quality costs and increasing of efficiency will be increased significantly.

There exist few studies about creation of an effective empirical relation between quality costs and quality. This research investigates the relationship between components of quality costs and level of quality for three input elements of material, machinery and human factor separately and firm as a whole, by integrating concepts of quality costs (prevention costs, appraisal costs, internal failure costs, external failure costs) and level of quality with considering each of those elements.

## 2. Literature Review

Quality costing is a process-based costing method which conceptually seeks to measure and establish a balance between preventive costs and quality assurance costs versus the costs of poor quality, wastes, and customer's dissatisfaction. In this method, which is created in the heart of financial and industrial accounting system, costs of activities are categorized and compared based on the amount of their effect on quality. The goal of quality costing system is to decrease quality costs to its lowest level. Quality costing system as an efficient tool helps management in determining, collecting, recording, and reporting costs of quality, and provides a basis to identify types of activities effective on decrease or change in its costs' compositions and analyze them, and establishes the possibility to prioritize quality improvement activities (Mombeini, 1998).

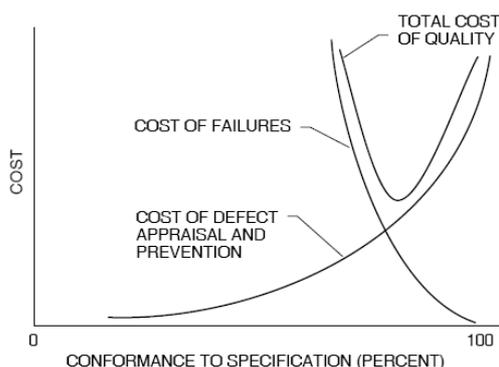
In this study, PAF<sup>1</sup> model was used to determine the components of quality costs which is the oldest and the most prevalent method for quality costing. The majority of organizations which are seriously consider quality costs in their systems and apply quality costing, use this method. Costs are divided into three sections in this method including: prevention costs (which are paid to ensure produce a good or service with desired quality), appraisal costs (costs of inspecting and evaluating all parts engaged in production), and failure costs (which are paid because of outputs without desired quality and in order to correct a defective product or service [internal or external]) (Dale and Plunkett, 2002).

Juran (1962) proposed a theory based on this model which demonstrates inverse relationship between prevention and appraisal costs in one hand and failure costs on the other hand. According to this,

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<sup>1</sup> prevention-appraisal-failure

more investment on prevention and inspection results in decreasing of failure costs. This inverse deal which is well-known and highly accepted, expresses the concept of optimum level of quality well and is the basis of quality costing (see Fig. 1) (Farsijani and Kiamehr, 2008).



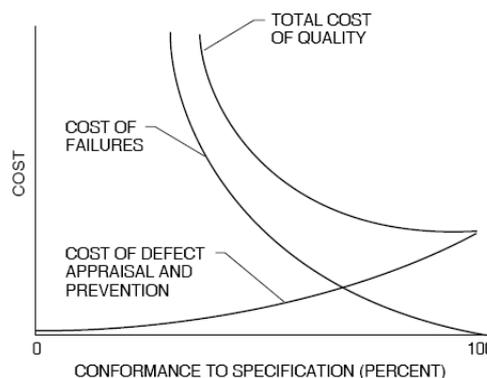
**Fig. 1- the relationship between prevention and appraisal costs, and failure costs**

Therefore, there is a level of quality in which quality costs is in its minimum. Albeit, some researchers criticized this theory and challenged it in later periods. These theories were based on this principle that there is no optimum economic point for quality and in fact, optimum level of quality is the no-flaw level.

Burgess tried to match the two theories. The result of his studies was that classic viewpoint is appropriate for certain and limited time periods and modern viewpoint is appropriate for unlimited time periods. Also, Fine, Dawes, Marcellus, and Dada proposed that traditional model provides an accurate and static picture of economic levels of quality, while, in dynamic and multi-period conditions, failure costs decrease as time passes without need to increase in prevention and appraisal costs (see Fig. 1) (Farsijani and Kiamehr, 2008).

As it can be seen in Fig. 2, sum of prevention and appraisal costs are related to production of good quality product and sum of internal and external failure costs are related to production of undesirable product. These two types of costs, namely, cost of good quality product and cost of undesirable product are inversely proportional to each other; the more costs we pay for good quality product, the less costs

of undesirable product will be needed. Quality costs is minimum prior to 100% quality; hence organizations try to produce their product in the range in which the cost is minimum.



**Fig. 2- modern theories (no-flaw level as optimum level of quality costs)**

Despite criticisms has been raised relating to Juran's traditional theory, the traditional theory and inverse relation mentioned above still has extensive acceptance and it is cited in arguments about quality. Accordingly, PAF model is used to determine quality costs. As well, the research hypotheses are developed on the basis of Huran's theory as the followings:

- 1) There is an inverse and significant relationship between sum of prevention and appraisal costs, and failure costs.
  - 1.1- There is an inverse and significant relationship between sum of prevention and appraisal costs of material and product, and failure costs of material and product.
  - 1.2- There is an inverse and significant relationship between sum of prevention and appraisal costs of human factor, and failure costs of human factor.
  - 1.3- There is an inverse and significant relationship between sum of prevention and appraisal costs of production machinery, and failure costs of production machinery.
  - 1.4- There is an inverse and significant relationship between sum of prevention and appraisal costs of firm, and failure costs of firm.

- 2) There is a direct and significant relationship between sum of prevention and appraisal costs of firm, and quality level of product.
- 3) There is an inverse and significant relationship between failure costs of firm, and quality level of product.

In this section, studies which has been performed related to this research's issue and a summary of their results are presented.

Harrington (1998) studied the effect of prevention and appraisal costs on total cost. The result of his study indicated that increase in prevention costs leads in reduce of faults and finally result in reduction of total cost, while increase in appraisal costs does not reduce total number of faults and just identifies output faults before delivery of product to customer. Also, the results showed that quality improvement leads in efficiency improvement through reduction of quality costs (Harrington, 1998).

Harrington (1998) and Zhao (1999) found that increasing of prevention and appraisal costs results in reduction of failure costs, therefore increases quality and efficiency.

Chauvel and Andre (2004) examined relationships between components of quality costs. They concluded that preventive activities has direct and positive effect on marginal profit and investment on prevention and appraisal costs leads in reduction of quality costs significantly. Investment on evaluation may result in unacceptable costs or affect validity of a firm (Farsijani, 2007 quoted from Chauvel and Andre, 2004).

He (2010) in a research entitled "Engineering quality systems: cost of quality" discuss about concept of management and quality control. He concluded that the aim of applying quality system is to reduce total quality costs and gain maximum profit.

Chopra and Garg (2011) in a research entitled "Behavior patterns of quality cost categories" study on the correlation between various categories of quality costs. They believe that by increase of efforts toward preventive and appraisal activities, costs of non-compliance will decrease, also they found that there is a negative correlation between costs of compliance and costs of non-compliance.

Omar and Morgan (2014) in their research entitled "An improved model for the cost of quality" concluded that reduction in failure costs results in decrease or no increase in costs of non-compliance, and that traditional accounting approach is not

sufficient for quality costing because its results mainly depend on the direct cost of labor. While direct cost of work consists only 3 percent of total quality costs.

Ebrahimi (2001) conducted a study entitled "Investigating quality costs in small-sized industries in Farman Khodro Sepahan Company". Quality costs in this research have been raised as a scientific method to quantify the size of quality issue. On the basis of theoretical principles, these costs divided into four category of internal failure costs, external failure costs, prevention costs, and appraisal costs. Any category itself is consisted of components that the components and their degree of importance can be different in case of studying problem. According to the surveys conducted, quality costing approach was been identified as an appropriate approach to estimate these costs. Results showed that these costs have a substantial share in sales of firm in a financial year. The most share is related to the category of internal failure costs followed by appraisal, prevention and external failure costs. Finally, main items of cost has been identified using Pareto analysis and some solutions have been proposed.

Rajabi (2001) conducted a research entitled "Designing a pattern to identify and control quality costs, case study of Dena Tire Company". Since there were not data from the past and the system was designed and deployed for the time in the company, just facts and figures of sales were used to analyze quality costs. This is done by analyze of proportions. In quality costing system, activities which are spent on failure, are considered as no value added activities. In the other words, it is showed that separation of these costs from financial costs how much can mislead users of the financial statements and cost information. By segregating quality costs from financial costs, administrators will be capable to make more accurate decisions in order to improve the company's quality systems.

Purzandi et al. (2010) performed a research on the subject of designing a pattern to identify and calculate quality costs in automobile industries. In this research they designed a pattern to identify and calculate quality costs in a salon of Iran Khodro industrial company. They separated and categorized quality costs in four groups of prevention costs, evaluation and test costs, and costs of internal and external failures.

Results of a case study on behavior of quality costs in Iran Khodro industrial Dies indicates that the trend of failure costs can be control by controlling of prevention and appraisal costs, as well one can comment on state of wastes, re-working, and its relation with quality control costs. Results of the study confirm the inverse relationship raised by Juran which state that prevention and appraisal costs have an inverse relationship with failure costs (anonymous, 2011).

Izadinia and Kamali (2013) in a study investigated the effect of implementing the quality costing system on cost management in Fajr Jam Gas Purification. Results of the study showed the existence of a negative correlation between prevention and appraisal costs and firm's profit, with costs of internal and external fault. By increase of efforts toward preventive and appraisal activities, costs of internal and external fault will be reduced, and deploying of information and reporting system of

quality costs, will facilitate management of costs in order to reduce faults in organization, followed by reduction in sum of costs and increase of gas sales.

This study is of applied researches which their goal is to develop applied knowledge in a special area. In this study, identifying the relationship between quality costs and quality can provide users of these information with useful data by delivering a clearer and more reliable picture about quality costs. In terms of nature and method, the research is a correlative-descriptive case study.

The case study of this research is Pegah Khuzestan dairy industry during 2011 to 2013. Having ISO certificate was the precondition to perform the research, because firm which have ISO are familiar with the issue of quality. Also, the willingness of management and quality control expert of the company to performing of this study and investigating the relations, was of main reasons to select the company.

**Table 1- measurement and collecting method of variables**

Calculation method	Type of cost	Component of quality costs	Factor
Accounting data	Cost of testing the materials and examining new product (R&D)	prevention costs	Material and product
Accounting data	Storage		
Accounting data	Marketing costs before purchasing the material (examining the materials' quality)		
Sum of quality control undertaker's salary per year * 5%	Auditing quality management system (following up instructions and required documents by guarantee Expert)		
Sum of commerce undertaker's salary per year * 10%	Evaluating, developing and auditing the suppliers and contractors		
Sum of quality control undertaker's salary per year * 5%	Cost of expertise for temperature control during production (Transmission operator)	Appraisal costs	
Accounting data	Cost of equipment for test of accuracy, inspection, and measurement (calibration)		
Accounting data	Consuming material of laboratory		
Sum of quality control undertaker's salary per year * 5%	Post-production tests and examinations		
Sum of quality control undertaker's salary per year * 5%	Cost of control of printed date and standard logo		
Sum of quality control undertaker's salary per year * 3%	Cost of final inspection of product		
Sum of packing costs per year * 3%	Cost of inspection of type and mode of packing	Internal failure costs	
Sum of quality control undertaker's salary per year * 3%	Inspection and control of inputs during process and final product		
Accounting data	Cost of bad storage of materials		
Accounting data	Loss of materials and products	External failure costs	
Accounting data	Cost of returning and sending the product		

Calculation method	Type of cost	Component of quality costs	Factor
Sum of quality control undertaker's salary per year * 5%	Cost of personnel training by quality control undertaker	prevention costs	Human factor
Accounting data	Cost of personnel training		
Accounting data	Cost of human resource for laboratory activities	Appraisal costs	
Accounting data	Cost of safety and personal protective equipment		
Accounting data	Healthcare costs	Internal failure costs	
Sum of repair and maintenance costs per year * 3%	Preventive service and maintenance (replacement parts NET)	prevention costs	Machinery
Sum of quality guarantee undertaker's salary per year * 5%	Repair and maintenance of measurement tools and test equipment	Appraisal costs	
Accounting data	Cost of repair and maintenance of machinery after failure	Internal failure costs	
Sum of prevention costs for material, human factor and machinery			Firm
Sum of appraisal costs for material, human factor and machinery			
Sum of internal failure costs for material, human factor and machinery			
Sum of external failure for material, human factor and machinery			
The ratio of healthy and flawless product per year to total product per year (healthy and defective)			Quality of product

In this study Traditional method was deployed to collect quality costs which widely was used. This method is based on the early writings of Juran. It uses existent data in the organization which are available via records of financial or accounting department. These data may obtain from presence and absence reports, costs reports, purchase orders, re-working reports, wastes reports, and other similar reports. This method is the easiest and the most standard method which is the best for beginning of quality costing, because most organizations have financial or accounting department which records some of quality costs such as training, guarantee costs, and waste costs in their system. This method is used in all of small and big organizations, universities, software manufacturers, and any type of organization. It provides a rapid view about quality costs of organization.

In this research, descriptive statistics were used in order to describe and provide statistical specifications of variables and parameters. Since the study is of descriptive-correlative researches, namely, investigates the relationship between quality costs and quality, inferential statistics such including normality test and correlation analysis were used to test research hypotheses. Data analysis was performed by Microsoft Excel spreadsheet and SPSS software.

### 3. Methodology

According to research hypotheses, research variables are included prevention costs, appraisal costs, internal failure costs, external failure costs, and product quality that their collecting procedures and measuring method are proposed in Table 1. At first, production process was drawn and quality costs in each step was identified. Then, identified costs were categorized into prevention, appraisal, internal failure, and external failure. In the next step, accounting information were investigated and the amount of some costs were identified. Because that the value of other quality costs were not been allocated to a certain cost, those costs were identified using management expert opinion and quality control undertaking, and using financial and non-financial information and were allocated to related quality costs.

### 4. Result

In this section, at first, descriptive statistics and then inferential statistics are provided. Descriptive statistics of research data in three parts of material and product, human factor, and machinery is provided in Table 2.

**Table 2- description of research data for three parts of material and product, human factor, and machinery**

Coefficient of skewness		Standard deviation	Median	Mean	Number of correct data	Type of cost	Factor
Standard error	Statistics						
1.225	.849	560359195.21672	2151458966.0000	2261422424.3333	3	prevention costs	Material
1.225	.849	1397519442.50138	5365675732.0000	5639921380.6667	3	appraisal costs	
1.225	.849	1856982268.51129	7129750322.0000	7494159783.0000	3	Sum of internal and external failure costs	
1.225	.849	213723152.25876	820574724.8000	862515210.7000	3	prevention costs	Machinery
1.225	.849	71241050.80710	273524908.5000	287505070.5000	3	appraisal costs	
1.225	.849	196648014.90337	755015958.8000	793605663.3333	3	Sum of internal and external failure costs	
1.225	.849	56173523.91533	215674218.7000	226697567.6667	3	prevention costs	Human factor
1.225	.849	203454335.05318	781148337.0000	821073696.4333	3	appraisal costs	
1.225	.849	151581917.10979	581987906.3000	611733954.8000	3	Sum of internal and external failure costs	

In terms of inferential statistics, at first, factor analysis was used to confirm validity of research data. In this method, Kaiser-Meyer-Olkin test (KMO) was used to examine adequacy of statistical samples. In fact, KMO is a measure of sampling adequacy which examines whether partial correlation between variables is small, and determines if common variance of research variables is affected by some hidden and underlying factor or not (Momeni and Fa'al-Ghayoumi, 2010). KMO takes values between 0 and 1, with small values meaning that the data are appropriate for factor analysis (usually below 0.6), otherwise, the results of factor analysis do not seem appropriate for the desired data.

Also, Bartlett test in exploratory factor analysis examines when the correlation matrix is identified and hence, is not appropriate for identifying the model structure. Data matrix for factor analysis must contain significant data. Significance of data in a matrix can be confirmed through Bartlett's chi square test. Significance of chi square statistic and Bartlett test is the minimum condition for factor analysis. Null hypothesis of Bartlett test is that variables just have correlation with themselves. Rejection of null hypothesis suggests that correlation matrix has significant data and there are minimum conditions for factor analysis. It is Bartlett's sphericity test. If significance of the test is below 5%, factor analysis is appropriate for structure identification, because the null hypothesis is rejected.

According to table 3, amount of KMO is 0.802 which indicates adequacy of research samples. also, the significance of Bartlett's test proves the validity of research.

**Table 3- results of factor analysis**

Kaiser-Meyer-Olkin Measure of sampling Adequacy		.802
Bartlett test of Sphericity	Approx. Chi-Square	1155.658
	Df	6
	Sig.	.001

In order to analyze research hypotheses, at first, it is required to perform normality test to select type of correlation test (parametric or non-parametric). To examine normality of variables, Kolmogorov-Smirnov test was used the results of Kolmogorov-Smirnov test is provided in Table 4.

Results provided in table 4 suggest that variables have normal distribution, so Pearson correlation coefficient can be used to test hypotheses. Results of hypotheses test is reported in table 5 in summary.

According to the significance level of Pearson correlation coefficient in table 5, there are inverse and significant relationships between prevention and appraisal costs, and failure costs for material, human resources and whole of firm, but there is not the inverse relationship for machinery. Also, there are direct and significant relationships between prevention and appraisal costs, and failure costs of whole of firm and quality level of product. Results of research confirmed theory of Juran (1962) and is in accordance with results of Harrington (1998) and Zhao (1999). Also, results of this research are in accordance with the study of behavior patterns of quality cost in Iran Khodro industrial Dies (2011).

**Table 4- results of normality test**

Sig.	Kolmogorov-Smirnov	Maximum deviation			Normal distribution parameters		N		
		Negative	Positive	Absolute value	Standard deviation	Mean			
0.994	0.423	-0.194	0.244	0.244	1856982269	7494159783	3	internal and external failure costs	material
0.994	0.423	-0.194	0.244	0.244	1957878637	7901343806	3	prevention and appraisal costs	
0.994	0.423	-0.194	0.244	0.244	151581917.1	611733954.8	3	internal and external failure costs	Human resources
0.994	0.423	-0.194	0.244	0.244	259627858.9	1047771264	3	prevention and appraisal costs	
0.994	0.423	-0.194	0.244	0.244	196648014.9	793605663.3	3	internal and external failure costs	machinery
1	0.321	-0.185	0.18	0.185	347667267.1	1028453655	3	prevention and appraisal costs	
0.994	0.423	-0.194	0.244	0.244	2205212200	8899499401	3	internal and external failure costs	Whole firm
0.994	0.423	-0.194	0.244	0.244	2479953956	10008265300	3	prevention and appraisal costs	

**Table 5- results of hypotheses test**

Result	Sig.	Correlation coefficient	Description	Hypothesis
Confirmed	.000	-0.198	relationship between prevention and appraisal costs, and internal and external failure costs for material and product	1-1
Confirmed	.000	-0.310	relationship between prevention and appraisal costs, and internal and external failure costs for human factor	1-2
Rejected	.000	0.950	relationship between prevention and appraisal costs, and internal and external failure costs for machinery	1-3
Confirmed	.000	-0.366	relationship between prevention and appraisal costs, and internal and external failure costs for whole of firm	1-4
Confirmed	.000	0.121	relationship between prevention and appraisal costs, and quality level of product	2
Confirmed	.000	-0.185	relationship between internal and external failure, and quality level of product	3

### 5. Conclusions

Production of a good or service with high quality which satisfies the customer itself is not adequate. Costs of reaching to this goal must be investigated accurately in a way that long-term effect of these costs on the activity of organization of company is desired. These costs are a correct index to perform qualitative activities. In fact, the main task of management is to balancing between quality and its costs.

In this way, the goal this paper was to investigate the relationship between components of quality costs and quality separately for materials, manpower, machinery, and whole of company. As it was expected based on the theory of Juran (1962), results of the research indicates inverse relationship between prevention and appraisal costs in one hand and failure costs on the other hand, and according to this, more

investment on prevention and evaluation leads in reduction of failure costs. So there is a level of quality in which quality costs are in it minimum. Also the results showed that there are a direct and significant relation between prevention and appraisal costs and quality level of product, and an inverse and significant relation between failure costs of firm and quality level of product. Findings of this study reveals that the trend of failure costs can be controlled by controlling of prevention and appraisal costs. Also, one can comment on state of wastes, re-working, and its relation with quality control costs.

Based on results of this paper it is recommended that:

1. Quality costing system as an efficient tool helps management in determining, collecting, recording, and reporting costs of quality, and provides a basis to identify types of activities effective on decrease or change in its costs'

- compositions and analyze them, and establishes the possibility to prioritize quality improvement activities.
2. Quality costing is a simple but advanced method for management which provides detailed and basic information of financial costs, ability to control and better planning and decision-making managers.
  3. Identifying, controlling and removing of implicit and explicit losses of quality and costs of quality, results in increase of production efficiency, providing feedbacks for continuation of quality and customer satisfaction, minimizing costs of quality and facilitates steady improvement.
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