

Cost of quality measurement in food manufacturing companies. The Greek case

Abstract

Purpose – The present study focuses on Cost of Quality (CoQ) in food manufacturing companies. The study aims at empirically validating the conceptual structure of the core dimensions of CoQ (prevention, appraisal, internal and external failure cost) and determining their level and relationships. Determining the reasons for not measuring the CoQ as well as the barriers-difficulties and benefits of the CoQ measurement is also an aim of the present study.

Design/methodology/approach – Greek food manufacturing companies were approached through a structured questionnaire and ninety one participated in the study. Exploratory and Confirmatory Factor Analysis, descriptive statistics and correlation analysis are applied for data analysis.

Findings – The structure of the core dimensions of CoQ is empirically validated, while all of them range within medium levels and are inter-related. The reasons for companies not measuring the CoQ as well as the barriers-difficulties of companies measuring the CoQ are not significant. On the contrary, significant benefits are derived from the CoQ measurement.

Research limitations/implications – The small sample of the food manufacturing companies operating in one country and the subjective business evidence collected are the main limitations of the present study.

Practical implications – Food companies can be motivated to establish a robust CoQ measurement system, which would reflect the level of the CoQ dimensions. According to the results of the CoQ measurement, a food company can make decisions to increase the prevention and appraisal costs and decrease the internal and external failure costs in order to be more competitive in the market.

Originality/value – The paper provides deeper insights into the level and inter-relations of empirically validated CoQ dimensions. Very few studies on CoQ in food manufacturing

companies have been carried out in Greece and the present study makes the picture of the CoQ status in this sector more clear.

Key words – Cost of quality, PAF model, food manufacturing companies, Greece.

Paper type: Research paper

1. Introduction

In the modern global market, business organizations are confronted with highly competitive and complex circumstances (Wudhikarn *et al.*, 2015), due to the internationalization of transactions, the rapid growth of technology and the changing socio-political and economic environment (Mahmood *et al.*, 2014). Such a dynamic trading environment provides many potential opportunities, but hidden risks for companies (Arvaiova *et al.*, 2009). As far as Greek companies are concerned, a complicated and unfair tax system, combined with limited cash liquidity, constitute an unstable business environment in which companies have to survive and develop (Chatzipetrou and Moschidis, 2016).

In such a business environment, consumers demand lower priced and yet superior quality products while companies concentrate on the identification of their cost drivers and increasing their market share and profit (Stapleton *et al.*, 2004; Wudhikarn *et al.*, 2015). In other words, companies have to improve the quality of their products and services and simultaneously focus on the cost factor because they have not only to satisfy the customers' needs and requirements with regard to quality but also to provide the products/services with the minimum cost (Snieska *et al.*, 2013; Malik *et al.*, 2016). Companies should bear in mind that quality is a prerequisite that is no longer a differentiator in today's intensely competitive business climate, and thus, they should strive for a reduced level of cost of poor quality (Prashar, 2014). The measurement and evaluation of all the quality costs seems to be a critical issue for a company's improvement in all business areas, since it plays an important role in increasing efficiency, reducing unfruitful expenditure and enhancing profitability (Sahu and Sridhar, 2013; Satanova *et al.*, 2015). Thus, in order for companies to obtain a competitive advantage in the modern market, they should evaluate the Cost of Quality (CoQ) and more specifically *its most commonly used dimensions including* the prevention, appraisal, internal and external failure cost (**PAF model**) (Snieska *et al.*, 2013).

Although the concept of CoQ is not recent, very few studies have been conducted on the measurement of CoQ so far (Mahmood and Kureshi, 2015). Bhatti *et al.* (2014) state that although there is a reasonable amount of detailed advice available on the CoQ, there are only a few published practical examples that give insights into the costs that should be included or excluded in quality costing, and how these costs are collected (Bhatti *et al.*, 2014). Similarly, Snieska *et al.* (2013), note that the scientific literature still has questions on how to calculate all the constituents of CoQ dimensions in detail. Moreover, Pires *et al.* (2017), mention that there is limited research that describes the way CoQ information is used in the management process. Chatzipetrou and Moschidis (2017) support the view that that not much attention has been paid by researchers to the depiction and analysis of CoQ practices in Greek manufacturing and especially in food and beverages enterprises.

Based on the above, it is obvious that there is a gap in the literature with regard to the CoQ. Thus, many future research suggestions have been made by several authors and experts in the field. Sailaja *et al.* (2014) propose to extend their study by incorporating in the CoQ measurement the hidden elements of CoQ, given that their study focuses only on direct and visible costs which are easy to track and measure. Further studies are also needed to find out how companies make use of the CoQ information to formulate a survival strategy at a time of economic downturn and a growth strategy for their future expansion (Cheah *et al.*, 2011). According to Pires *et al.* (2017), how exactly CoQ information is used by managers in their day-to-day tasks, as well as the reasons for the use of the CoQ information by managers are questions that should be deeply investigated. Lim *et al.* (2015) suggest the investigation of quality cost models for more complex situations where failures are not necessarily independent. Furthermore, it would be interesting to explore, mainly in relation to the economic restrictions of the Greek economy, which CoQ elements are monitored the most and which elements are constantly ignored, and reach some useful conclusions about the way

the Greek food companies perceive not only the value of Quality Costing in general, but also the essence and the content of each individual CoQ element (Chatzipetrou and Moschidis, 2017).

In order to fill the above mentioned research gap and contribute to the literature, this study focuses on the CoQ in food manufacturing companies. Based on a sample of Greek food manufacturing companies operating in a business environment where an economic downturn and financial crisis dominates, the study aims to empirically validate the structure of the core dimensions of CoQ (prevention, appraisal, internal and external failure cost) and determine their level and relationships. Exploratory and Confirmatory Factor analysis are used for this purpose. The study also aims at determining the reasons for companies not measuring the CoQ, and the barriers-difficulties and benefits of companies measuring the CoQ. To the best of the authors' knowledge, the only recent research studies which focus on the CoQ in the Greek food sector are the studies of Chatzipetrou and Moschidis (2016), Chatzipetrou and Moschidis (2017) and Moschidis *et al.* (2018). More specifically, Chatzipetrou and Moschidis (2016) focus on food retail companies meaning the supermarkets and examine, through multiple correspondence analysis, the extent of use of the PAF model and its content and how these are diversified according to a number of demographic variables (e.g. size, HACCP/ISO certification). Chatzipetrou and Moschidis (2017) extend their previous work on supermarkets to the food manufacturing sector. Finally, Moschidis *et al.* (2018), examine through multiple correspondence analysis, the relationship between the quality costing system as defined by the PAF approach and the quality management maturity level of food manufacturing companies. From the above it is apparent that the objectives of the previous studies in the Greek food sector are different from those of the present study. Moreover, the present study examines more subjects regarding the CoQ (e.g. reasons for not measuring CoQ, barriers-difficulties and benefits of CoQ measurement) and furthermore it is

based on a larger variety of CoQ elements, comparing to the previous studies in the Greek food sector, in order to empirically validate the structure of the core CoQ dimensions. Thus, both academics and practitioners can benefit from the present study, given that it expands the knowledge already gained in terms of CoQ in the food manufacturing sector.

The rest of the paper is structured as follows: in the first part, the existing CoQ literature is reviewed focusing on the definition of CoQ, the PAF model, the reasons for not measuring the CoQ and the barriers-difficulties and benefits of the CoQ measurement. The research questions of the study are then formulated. In the next part of the paper, the methodology of a research study carried out in Greek food companies is described. This is followed by the presentation of the study findings and their discussion. In the following part, the final conclusions and practical implications are presented. Finally, the paper ends with the limitations of the study and future research recommendations.

2. Literature review

2.1 Cost of Quality (CoQ)

The inception of the concept of CoQ can be attributed to Juran and Feigenbaum in the 1950's (Sailaja *et al.*, 2014). However, there is no general agreement on a single broad definition of CoQ, and hence, different definitions exist in different industries and among researchers (Plunkett and Dale, 1987; Juran and Godfrey, 2000; Schiffauerova and Thomson, 2006b; Malik *et al.*, 2016). A large number of different terms have been used in order to analyze the term “cost of quality”, such as “quality cost”, “economics of quality”, “poor quality cost”, “price of non-conformance” or “cost of poor quality” (Kiani *et al.*, 2009). The generally accepted interpretation of CoQ includes the cost of all efforts made by a company in order to provide a product that can meet the necessary requirements and the customers' needs (Chatzipetrou and Moschidis, 2016). According to Pires *et al.* (2017), CoQ is commonly

understood as the monetary expression of the efforts undertaken by the organization to ensure the intended levels of quality.

One of the most important concerns of organizations is how to achieve a balance between the desired level of quality and the expenses associated with it (Heravi and Jafari, 2014). There was a mistaken notion that the achievement of better quality requires higher costs because better quality would somehow cost more and make production difficult (Chopra and Garg, 2011). This was the myth that prevented many companies from investing more in CoQ related programs (Sahu and Sridhar, 2013). An optimal quality improvement policy provides a trade-off between the minimization of the CoQ and the maximization of the quality of conformance, in order to achieve high quality in a most economic way (Sailaja *et al.*, 2014; Duarte *et al.*, 2016).

2.2 PAF (Prevention-Appraisal-Failure) model

One of the most widespread models of quality costing is the PAF model suggested by Juran in 1951 and Feigenbaum in 1956, classifying CoQ into prevention, appraisal and failure cost (Plunkett and Dale, 1987; Juran and Godfrey, 2000; Schiffauerova and Thomson, 2006b, Chatzipetrou and Moschidis, 2016). Failure cost is further classified into two sub-dimensions, namely internal failure and external failure costs. In general, the four categories of quality costs, which are emphasized by many companies, are described as follows (Bendell *et al.*, 1995; Goulden and Rawlins 1997; Juran and Godfrey, 2000; Roden and Dale, 2001; Superville and Gupta, 2001; Dale and Wan, 2002; Chopra and Garg, 2011; Chiarini, 2015; Guinot *et al.*, 2016; Farooq *et al.*, 2017; Moschidis *et al.*, 2018):

- *Prevention costs*: These costs are associated with the design, implementation and maintenance of the quality management system. Prevention costs are planned and are incurred before actual operation. Some examples of prevention costs are quality planning

and certification, supplier capability surveys, process capability evaluations, quality education and training, etc.

- *Appraisal costs*: These costs are associated with the evaluation of purchased materials, processes, intermediate and final products and services to assure conformance with the specified requirements. Some examples of appraisal costs are the costs of [incoming, in-process and final inspections/tests](#), product and process audits, calibration of measuring and test equipment, etc.
- *Internal failure costs*: These costs occur when the results of work fail to [reach quality standards, while these failures](#) are detected before transfer to the customer takes place. Some examples of internal failure costs are scrap, rework, re-inspection, retesting, machine stoppages, etc.
- *External failure costs*: These costs occur when products or services fail to [reach quality standards, while these failures](#) are not detected until after the products or services are transferred to the customer. Some examples of external failure costs are customer returns, warranty claims, product recalls, replacement, compensation payments to the customer, etc.

An alternative to the PAF approach was introduced by Philip Crosby in 1979 and is known as Crosby's Model ([Crosby, 1979](#); Chatzipetrou and Moschidis, 2016). According to [Crosby \(1979\)](#), quality means "conformance to requirements" and non-conformance refers to failure to do things right the first time. The price of conformance (PoC) is the cost involved in making certain that things are done right the first time, which includes actual prevention and appraisal costs, while the price of non-conformance (PoNC) is the money wasted when work fails to conform to customer requirements, usually calculated by quantifying the cost of correcting, reworking or scrapping, which corresponds to actual failure costs ([Crosby, 1979](#); Schiffauerova and Thomson, 2006a; Vaxevanidis *et al.*, 2009).

2.3 Reasons for not measuring the CoQ and barriers-difficulties of the CoQ measurement

A wide variety of reasons why companies do not measure CoQ and the barriers-difficulties of those measuring CoQ have been suggested by researchers. Some of them are the following (Bamford and Land, 2006; Eldridge *et al.*, 2006; Sower *et al.*, 2007; Arvaiova *et al.*, 2009; Cheah *et al.*, 2011; Guinot *et al.*, 2016; Pires *et al.*, 2017): lack of understanding of the CoQ concept, lack of knowledge of how to track the CoQ, absence of management interest in tracking CoQ, difficulty in collection of quality data, lack of adequate accounting and computer systems necessary to track CoQ, lack of cooperation with other departments, the management philosophy and company culture do not promote CoQ evaluation, management belief that there is no value in any efforts to fully measure CoQ, lack of experienced manpower to accomplish the task, the fact that management deems CoQ to be an extra workload and organizations do not see the benefits of CoQ or they focus on areas which they perceive to be more important.

2.4 Benefits of the CoQ measurement

Numerous research studies have been dedicated to the determination of the CoQ benefits. Reviewing the literature, it is apparent that there is a general consensus among authors regarding the benefits gained after CoQ measuring and reporting. So, according to the literature, the main benefits of the CoQ system implementation are the following (Stapleton *et al.*, 2004; Miguel and Pontel, 2004; Schiffauerova and Thomson, 2006a; Bamford and Land, 2006; Uyar, 2008; Kim and Nakhai, 2008; Kiani *et al.*, 2009; Walsh and Antony, 2009; Arvaiova *et al.*, 2009; Chopra and Garg, 2011; Khataie and Bulgak, 2013; Sahu and Sridhar, 2013; Malik *et al.*, 2016; Pires *et al.*, 2017; Chatzipetrou and Moschidis, 2017): increase in profit, sales volume, product/service quality and company competitiveness; achievement of

significant cost reductions; improvement of productivity; increase in customer and employee satisfaction; decrease in customer complaints; elimination of all forms of waste; provision of vital information for management to be aware of the size of the problem; identification of high-cost problem areas; prioritization of improvement actions with the highest potential payoff; evaluation of the worth of individual quality activities; increase in the overall level of quality awareness; and explanation of the conflicting cost behaviors that historically have been destructive to practitioners and researchers.

2.5 Inter-relations between CoQ dimensions

Many researchers have sought to understand the correlation between different CoQ dimensions. A large body of current literature shares general assumptions according to which (Omachonu *et al.*, 2004; Sower *et al.*, 2007; Ramdeen *et al.*, 2007; Kiani *et al.*, 2009; Chopra and Garg, 2011; Sailaja *et al.*, 2014; Omar and Murgan, 2014):

- there is a positive relationship between the prevention cost and the appraisal cost as well as between the internal failure cost and the external failure cost,
- there is an inverse relationship between the prevention cost plus the appraisal cost and the failure cost, in other words, a strong negative relationship exists between the conformance cost (prevention and appraisal cost) and the nonconformance cost (internal and external failure cost),
- increasing the prevention and appraisal costs will decrease the total CoQ.
- the prevention cost has the most effect on total CoQ rather than the appraisal cost.
- there is a strong negative relationship between the prevention cost and the internal failure cost, and between the prevention cost and the external failure cost.
- there is a strong negative relationship between the appraisal cost and the internal failure cost, and between the appraisal cost and the external failure cost.

2.6 Research questions

Bearing in mind the purpose of the present study, the literature gap identified, the research proposals suggested by many authors and the above review of the literature, the following research questions are formulated in order for them to be examined in Greek food manufacturing companies:

RQ1. Do food companies measure CoQ?

RQ2. Which are the main reasons for the food companies not measuring CoQ?

RQ3. Which are the main barriers-difficulties encountered during the CoQ measurement by food companies?

RQ4. Which are the main benefits derived from the CoQ measurement by food companies?

RQ5: Do the four core CoQ dimensions namely, prevention cost, appraisal cost, internal failure cost and external failure cost reflect the measured CoQ elements identified in the literature?

RQ6. Which are the levels of the dimensions of CoQ in food manufacturing companies?

RQ7. Which are the relationships between the dimensions of CoQ in food companies?

3. Research methodology

3.1 Questionnaire development

In order to answer the above research questions, a research project was carried out focusing exclusively on the Greek food sector. A postal survey was employed in order to investigate the CoQ in this sector. A structured questionnaire was used as the data-collection method, the design of which was based on a comprehensive literature review in the field of CoQ. A draft of the questionnaire was firstly reviewed by academics and professionals and then subjected to a pilot test by practitioners, proving its appropriateness and achieving the content validity of the questionnaire items.

The final version of the questionnaire consists of five parts. The first part includes questions on the demographic profile of a company. The second, third and fourth parts contain statements with regard to the reasons why companies do not [measure CoQ](#), the barriers-difficulties and the benefits of the CoQ measurement respectively. Finally, the fifth part of the questionnaire contains statements describing [CoQ elements](#). The questionnaire items describing the reasons for companies not measuring CoQ and the barriers-difficulties companies face with the CoQ measurement were drawn from the studies of Bamford and Land (2006), Eldridge *et al.* (2006), Sower *et al.* (2007), Arvaiova *et al.* (2009), Cheah *et al.* (2011), Guinot *et al.* (2016) and Pires *et al.* (2017). The questionnaire items describing the benefits companies derive due to CoQ measurement were drawn from the studies of Stapleton *et al.* (2004), Miguel and Pontel (2004), Schiffauerova and Thomson (2006a), Bamford and Land (2006), Uyar (2008), Kim and Nakhai (2008), Kiani *et al.* (2009), Walsh and Antony (2009), Arvaiova *et al.* (2009), Chopra and Garg (2011), Khataie and Bulgak (2013), Sahu and Sridhar (2013), Malik *et al.* (2016), Pires *et al.* (2017) and Chatzipetrou and Moschidis (2017). The questionnaire items [describing the most commonly referred to the literature CoQ elements](#) were drawn from the studies of Roden and Dale (2001), Dale and Wan (2002), Schiffauerova and Thomson (2006a), Vaxevanidis *et al.* (2009), Chopra and Garg (2011), Chiarini (2015), Guinot *et al.* (2016) and Chatzipetrou and Moschidis (2016). Respondents were asked to indicate the degree of agreement or disagreement with these statements, using a seven-point Likert scale (from 1: strongly disagree to 7 strongly agree).

3.2 Sample

The Greek food manufacturing companies constitute the population of the organizations of interest of the present research study. [In the period which the present study was carried out, the database of ICAP \(the largest business information and consulting firm in Greece\)](#)

included 277 food manufacturing companies operating all over Greece, with full access on their contact information. The questionnaire was addressed to the CEOs of these companies, allowing them to decide who would be the best member of staff to answer the questionnaire. Ninety one companies responded positively and returned the questionnaire completed in full, which represents a response rate of 32.8 per cent.

In order to exclude the risk of non-response bias, the companies participating in the research were compared with those which refused to do so, in terms of their company size (based on the number of employees) (Mann-Whitney test). No differences were found among these two groups. Moreover, it is also worth noting that several non-responding companies stated, when contacted, that the major reason for them not participating in the research project was lack of time (Psomas *et al.*, 2013). Thus, the possibility of facing a problem with non-response bias was rejected. Moreover, since the questionnaire was completed by a single respondent from each company, the common method variance was checked by applying the single-factor test (Martinez-Costa and Martinez-Lorente, 2008). This method produced poor results as indicated by the low percentage of the variance extracted (below 25%), confirming that the common method variance is not a substantive problem.

The majority of the food manufacturing companies participating in the present study are small and medium sized enterprises (SMEs) (92.3%), based on the number of employees. More specifically, according to the Commission Recommendation 2003/361/EC (2003) concerning the definition of SMEs, the responding companies can be categorized as follows: 29.7% as micro enterprises (<10 employees), 34.1% as small enterprises (11-50 employees), 28.6% as medium enterprises (51-250 employees) and 7.7% as non-SMEs (>250 employees). All the sample food companies implement the Hazard Analysis of Critical Control Points (HACCP), as they are obliged by law to do so (Chatzipetrou and Moschidis, 2017), however, a rate of 78% implement a Food Safety Management System (FSMS) certified according to

the ISO 22000 standard. Moreover, it is worth noting that 44% of the sample companies are ISO 9001 certified, while 37.3% are both ISO 22000 and ISO 9001 certified.

3.3 Data analysis

Exploratory and Confirmatory Factor Analysis was applied in order to validate the structure of the core dimensions of CoQ (Psomas *et al.*, 2013; Psomas and Antony, 2015), while their level is evaluated through descriptive statistics (Tye *et al.*, 2011; Arvaiova *et al.*, 2009) and their relationships through correlation analysis (Omachonu *et al.*, 2004). Descriptive statistics were also calculated to describe the companies' profile, the reasons why companies do not track CoQ, the barriers-difficulties encountered and the benefits derived from CoQ measurement (Tye *et al.*, 2011). The statistical package SPSS is used for data processing.

4. Results

4.1 Descriptive statistics

A percentage of 29.7% of the sample companies stated that they do not measure and evaluate CoQ elements. Table 1 presents the major reasons why these companies do not track CoQ. From Table 1 it is apparent that the first and most significant reason for the companies not measuring CoQ is the ignorance of the benefits of CoQ measurement. This is followed by the lack of knowledge and experience of how to track CoQ. The remaining and less significant reasons for not measuring CoQ, are the economic difficulty to cover the required expenses and the lack of interest of top management.

Insert Table 1 here

The most significant barriers-difficulties encountered by those companies which measure the CoQ (70.3% of the sample companies) are the following, in descending order according to

their mean value (Table 2): the extra paperwork involved, the difficulty of staff in identifying sources or causes of CoQ, the difficulty in identifying quality cost elements and the difficulty in assigning CoQ elements to its dimensions. The remaining barriers-difficulties are less significant (the mean values range from 3.40 to 2.82). It is worth noting that the least significant difficulty is the refusal of the auditors to fill out records determining how the time is distributed during the audit.

Insert Table 2 here

Table 3 shows the most significant benefits from the CoQ measurement. The identification of areas that can be further improved is rated as the most important benefit gained. The rest of the benefits have a small difference in significance compared to the first one (Table 3).

Insert Table 3 here

4.2 Exploratory Factor Analysis (EFA)

The number of the responding companies in the present study is deemed, according to Hair *et al.* (2005), large enough for multivariate data analysis. So, the CoQ elements identified in the literature were used as measured variables of an EFA. The result is the establishment of four latent factors (Kaiser-Meyer-Olkin = 0.840, Bartlett's test of Sphericity = 828.76, $p = 0.00$, eigenvalue > 1, Measures of Sampling Adequacy > 0.75, factor loadings > 0.608 except for one item with a loading equal to 0.44, Cumulative Variance = 76.28%). According to Hair *et al.* (2005), factor loadings of ± 0.30 to ± 0.40 are minimally accepted, while a minimum of three items should represent each factor. So, based on these criteria, few low loading items (< 0.4) were excluded from the data analysis. The extracted latent factors are explained using the measured variable loadings and can be labeled in accordance with the core dimensions of CoQ namely prevention cost, appraisal cost, internal failure cost and

external failure cost. The mean value of each CoQ dimension is calculated, based on the mean values of the respective items (Table 4). The prevention cost is the most highly evaluated CoQ dimension followed the appraisal cost. The internal failure cost is rated as the third highest dimension, while the least important dimension is the external failure cost.

Insert Table 4 here

4.3 Confirmatory Factor Analysis (CFA)

No case was excluded from the CFA, since all the ratios of Mahalanobis D^2 /independent variables were lower than 3, which indicate that no outliers exist (Hair *et al.*, 2005). The univariate statistics of the variables used, including the skewness (from -0.585 to -0.01), kurtosis (from -1.215 to 0.144) and the standardized residuals ($< \pm 2.5$), show that there are no significant departures from normality, based on the thresholds suggested by Hair *et al.* (2005). Moreover, given that none of the inter-item Pearson correlation coefficients in this study is greater than 0.9, the possibility of multicollinearity in the data is very low (Singh *et al.*, 2011). From the above mentioned it is obvious that the basic assumptions of multivariate analysis are not violated.

CFA is performed to further validate the measures for all the factors considered in this study (Figure 1). In doing so, the goodness of fit of the model to the measured data is established. More specifically, the Basics of Goodness of Fit, the Absolute Fit Indices, the Incremental Fit Indices and the Parsimony Fit Indices indicate an acceptable fit of the proposed model (Table 5). From the above, it is apparent that the results consistently support the structure of the latent factors - CoQ dimensions revealed as discussed earlier in the EFA stage (Bayraktar *et al.*, 2009).

Insert Table 5 here

Insert Figure 1 here

From Table 6 it is apparent that the vast majority of the standardized regression weights are above 0.73 and that just three of them are between 0.579 and 0.651. Moreover, the respective squared multiple correlations are satisfactorily high, except for three of them which range between 0.336 and 0.424. Thus, the factor loadings are adequately high and a high amount of measured variable's variance is explained by a latent factor. In other words, the measured variables - CoQ elements are well loaded onto the factor - CoQ dimension they are intended to measure. This means that the unidimensionality of the CoQ dimensions is ensured (Sadikoglu and Zehir, 2010).

Insert Table 6 here

Reliability analysis was also applied by the internal consistency method calculating the Cronbach's alpha coefficient (Sadikoglu and Zehir, 2010) and the Composite/Construct Reliability index (Avella and Vazquez-Bustelo, 2010). Table 7 shows that all the Cronbach's alpha coefficients and the Construct Reliability indexes are above 0.798 indicating that the selected CoQ elements reliably estimate the CoQ dimensions (Hair *et al.*, 2005; Sadikoglu and Zehir, 2010). Table 7 also supports the construct validity of the CoQ dimensions. According to Hair *et al.* (2005), construct validity is confirmed by evaluating convergent validity ($AVE > 0.502$) (Kim, 2009); discriminant validity ($AVE > Corr^2$) (Kim *et al.*, 2012); and nomological validity (significant correlations among the extracted latent factors) (Singh *et al.*, 2011).

Insert Table 7 here

4.4 Correlation Analysis

Table 8 displays the results of the correlation analysis of the CoQ dimensions (prevention cost, appraisal cost, internal failure cost and external failure cost). All the relationships are statistically significant ($p < 0.01$). The analysis indicates that the strongest relationships are

those between the internal failure cost and the external failure cost (0.677) and between the prevention cost and the appraisal cost (0.676), which are almost the same.

In addition, the findings show that the negative relationship between the prevention cost and the internal failure cost (-0.607) is stronger than the negative relationship between the prevention cost and the external failure cost (-0.524). The relationship between the appraisal cost and the external failure cost is also negative (-0.551). Finally, the least significant relationship concerns the negative relationship between the appraisal cost and the internal failure cost (-0.512).

Insert Table 8 here

5. Discussion

The small-medium size of the Greek companies is justified taking into consideration their small market size, the low GDP per capita, and the tendency towards self-employment (Hyz, 2011). The Greek food companies studied by Psomas and Fotopoulos (2010) are also SMEs.

The majority of the companies participating in the present study do measure and evaluate CoQ. This is justified given that the majority of the sample food companies have been ISO 22000 certified for many years now. This means that these companies have many years of experience in implementing a FSMS according to an international standard, which is process and customer oriented (Chountalas *et al.*, 2009), and this may have made them adopt more inherently the total quality principle concerning the evaluation of CoQ. The tendency of these companies to evaluate their CoQ is also justified due to the current economic downturn and financial crisis which dominates in the Greek business environment. It seems that these circumstances may force companies be more aware about their cost of quality. This view is not in line with Moschidis *et al.* (2018), according to which the unbalanced Greek economic environment, which has disorganized Greek enterprises, does not constitute a fertile ground

for quality costing techniques. However, the finding of the present study with regard to the high rate of food companies measuring CoQ, is in line with the respective finding of Miguel and Pontel (2004), according to which approximately 65% of the respondents in their research study assess such costs. The percentage of the sample companies of the present study assessing CoQ is considered to be much higher than the respective percentage of the studies conducted by Sower *et al.* (2007) and Glogovac and Filipovic (2017), where only 34% and 42%, respectively, of the respondent organizations systematically track CoQ.

According to the findings, there are not such significant reasons for not measuring CoQ, given that the sample food companies assessed half of the proposed reasons as being of medium importance and the remainder as being of low importance. This is very optimistic and reflects the possibility of future CoQ measurement by those food companies which do not measure the CoQ at present. The ignorance of the benefits of CoQ measurement is the first most significant reason for companies not measuring CoQ. The study findings of Prickett and Rapley (2001) and Tye *et al.* (2007) reveal that the most frequent reason for not measuring CoQ is the lack of knowledge and experience of how to track CoQ, which is in line with the present study findings, since this reason is considered by the sample food companies as the second most significant reason for not measuring CoQ. However, the findings from the study of Prickett and Rapley (2001) suggest that the economic difficulty to cover the required expenses is another common reason of companies for not tracking CoQ, while the present study reveals that this reason is not of high importance. It is worth noting that the research of Sower *et al.* (2007) comes to the opposite finding compared to the present study, meaning that the primary reason of their responding companies for not measuring CoQ is the lack of interest by top management. They also rank, contrary to the present study, the ignorance of the benefits of CoQ measurement and the lack of knowledge and experience of how to track CoQ as less important reasons for not tracking CoQ.

The majority of the food companies participating in the present study do not face significant difficulties in measuring the CoQ, given that all the difficulties proposed are considered by these companies as of medium or low importance. This may be justified taking into consideration the ISO 22000 implementation and certification by the majority of the sample companies. The records these companies keep in the context of the FSMS, may help them collect data with regard to CoQ, and thus, not face significant difficulties in measuring CoQ. The low level of these difficulties is a significant message for those companies not measuring the CoQ and can act as a strong incentive for them to collect data for CoQ evaluation. Contrary to the present study findings, the difficulty in identifying quality cost elements is rated as the least significant difficulty in the study of Rasamanie and Kanapathy (2011), while the extra paperwork is not rated as a significant difficulty in the study of Chatzipetrou and Moschidis (2017) in Greek food companies.

The benefits the sample food companies derive from the CoQ measurement are worth discussing. According to the present study findings, significant benefits are derived, especially with regard to the internal business environment of a company. This is an optimistic finding and another strong incentive for those companies not measuring CoQ. The present study findings are similar to the findings of the studies of Prickett and Rapley (2001), Tye *et al.* (2007), Uyar (2008), and Glavan *et al.* (2009), according to which the identification of the areas that can be further improved, the economic determination of the losses that a company incurs due to the possible lack of quality and the CoQ determination as a good marketing tool are among the main benefits derived from CoQ measuring and reporting.

The present study findings validate the structure of the core CoQ dimensions. The level of all the four dimensions of CoQ is not considered high by the sample food companies. Thus, it is apparent that these companies do not invest much money in prevention and appraisal activities. This may be justified due to the medium level of the internal and external failure

costs of these companies, which may motivate them to under invest in prevention and appraisal activities. The medium level of the internal and external failure costs, may be due to the HACCP implementation by all the sample food companies and the ISO 22000 implementation and certification by the majority of the sample companies. The internal and external audits accomplished in the context of the FSMS, make the sample food companies reduce significantly the incidences of failures in the internal and external business environment. The medium level of the prevention and appraisal cost of the sample companies, demonstrates that these companies are not mature enough from the total quality perspective. A high level of total quality maturity, may make companies be more proactive and invest a higher proportion of their budget in prevention and appraisal activities. Moschidis *et al.* (2018) also support the view that the more mature a company's quality management system is, the more emphasis the company places on appraisal quality costs and effective use of quality costs information. However, it seems that this is not the case as far as the food companies participating in the present study are concerned.

The relationships among the CoQ dimensions are also worth discussing. Two main issues are reflected in these relationships. The first issue deals with the high positive relationship between the two dimensions of Cost of Conformance (the correlation coefficient between the prevention and appraisal cost is 0.676) and the high positive relationship between the two dimensions of Cost of Non Conformance (the correlation coefficient between the internal and external failure cost is 0.677). The positive sign of the relationship between the prevention and appraisal cost may be justified by the process monitoring and auditing implemented by the sample companies in the context of the FSMS as well as the proactive character of this system. The positive sign of the relationship between the internal and external failure cost means that improving internal failure costs (decreasing them) results in improving external

failure costs (decreasing them). On the contrary, increasing the internal failure costs results in increasing also the external failure costs.

The second issue revealed from the relationships among the dimensions of CoQ, is related to the negative relationships between the prevention cost and the two dimensions of Cost of Non Conformance (internal and external failure cost) and the negative relationships between the appraisal cost and the two dimensions of Cost of Non Conformance (internal and external failure cost). This means that increasing prevention and appraisal costs leads to decreasing both internal and external failure costs. However, according to the study findings, all these relationships are of medium level, which shows the need for them to be strengthened by enhancing the costs the food companies invest in effective prevention and appraisal activities. In other words, the inadequate prevention and appraisal activities the sample food companies have implemented until now do not ensure the absolute decrease in the internal and external failures.

The positive relationship between the prevention and appraisal cost revealed in the present study is in line with the findings of the studies of Chopra and Garg (2011) and Sailaja *et al.* (2014). Contrary to these studies, as well as the present study, Ramdeen *et al.* (2007) and Abdelsalam and Gad (2009) show that there is a negative relationship between the prevention and appraisal cost. It seems that in those cases, the preventive actions are effective enough in reducing the necessity to implement appraisal activities. The findings of the present study regarding the positive relationship between the internal and external failure cost are in accordance with the findings of the studies of Chopra and Garg (2011) and Sailaja *et al.* (2014).

Several researchers such as Ramdeen *et al.* (2007), Sower *et al.* (2007), Chopra and Garg (2011), Sailaja *et al.* (2014) have also asserted the negative relationship between the prevention cost and the internal and external failure cost. By contrast, Su *et al.* (2009) observe

that the relationship between the prevention cost and the external failure cost cannot be supported and they also reach the conclusion that the prevention cost and the internal failure cost do not have a significant real-time relationship and that a perfect inverse relationship appears when there is a six-month time delay.

The present study findings are consistent with the findings of Chopra and Garg (2011) and Sailaja *et al.* (2014), according to which there is an inverse relationship between the appraisal cost and the internal failure cost. Furthermore, many studies such as those of Sower *et al.* (2007), Su *et al.* (2009) and Sailaja *et al.* (2014), similar to the present study, reveal that there is a negative relationship between the appraisal cost and the external failure cost. However, the research study of Chopra and Garg (2011), shows the opposite, that the relationship between the appraisal cost and the external failure cost is positive.

6. Conclusions and Practical Implications

The measurement of CoQ and the interrelations among the CoQ dimensions have been important research subjects for many years now. In order to [further](#) investigate the CoQ measurement within food companies, a research study was conducted in Greece. The present study contributes to the existing body of knowledge by offering deeper insights into the [evaluation of CoQ](#) in the food manufacturing companies.

The study shows that the sample Greek food manufacturing companies have adequately followed the worldwide trend with regard to the measurement of CoQ. The reasons for companies not measuring the CoQ and the barriers-difficulties of companies measuring the CoQ are not significant, while the benefits derived from the CoQ measurement are significant. All the [core](#) CoQ dimensions (prevention, appraisal, internal failure and external failure cost) [validated through empirical data](#), range within medium levels and are inter-

related. More specifically, the study reveals a positive relationship between the elements of Cost of Conformance and between the elements of Cost of Non Conformance, while the relationship between the Cost of Conformance and the Cost of Non Conformance is negative.

The reasons for not measuring CoQ which are not considered important, the low level of barriers-difficulties as well as the high level of benefits of CoQ measurement, constitute significant incentives for any food company to include CoQ measurement into its daily priorities. By collecting data for evaluating the level of all the valid core dimensions of CoQ, a clear picture is provided for the existing balance between the Cost of Conformance (prevention and appraisal cost) and the Cost of Non Conformance (internal and external failure cost). This will help food companies to choose suitable strategies and allocate resources properly to improve the balance between the CoQ dimensions in favor of the Cost of Conformance dimensions. In so doing, the internal and external failure cost will be reduced, which in turn will make the food company more efficient and able to satisfy its customers. Thus, the foundations are laid for the food company to improve quality and competitiveness, withstand the financial crisis and survive. Companies belonging to the manufacturing sector in general can also be benefited from the present study findings and consider CoQ measurement as the means by which they can clearly understand the pros and cons of their quality initiatives.

7. Limitations and Future Research Recommendations

The study presented in this paper suffers from some limitations that should be taken into consideration when generalizing. First, the number of the sample food companies is not large enough, while the number of measured variables included in the model is limited, compared with all the theoretically identified CoQ elements. Second, since the data includes subjective views of only one representative from each company who is responsible for the CoQ

measurement, there is a risk of receiving biased responses regarding the indicators of the CoQ. Lastly, the sample of the responding food companies is limited to companies operating in a specific country (Greece) and does not include companies operating in other European countries.

The above limitations suggest future research recommendations. Future research is recommended using a broader sample of food companies operating all over Greece *as well as more CoQ elements including the hidden ones*. Another avenue for future research could be to expand the study beyond the boundaries of Greece. Based on a large number of companies participating in the future research studies of CoQ, *more* advanced statistical methods can be applied. Moreover, using multinational data, the differences among food companies of several countries in terms of CoQ system implementation can be determined and comparisons can also be made between companies operating under conditions of economic turbulence and companies operating in technologically advanced or developed countries which do not face financial problems. Collecting subjective data from more than one company representative as well as objective data from the company files with regard to CoQ is also suggested.

Additionally, it would also be interesting to validate the underlying structure of the *CoQ elements* in different sub-sectors of the food sector. Given that the present research focused on the whole food manufacturing sector, it is recommended that empirical data from different food industry sub-sectors be collected in order to detect whether there are any statistically significant differences *with regard to CoQ* in different sub-samples within the food sector. Moreover, another proposal for future research is to confirm the findings of this study on companies that belong to the broad manufacturing and services sector as well. By addressing the above issues, future research could offer additional insights into the literature.

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