Quality Costing and Quality Management Maturity in Greece: An Exploratory Multi-Dimensional Data Analysis

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Abstract

Purpose

This paper explores how the sophistication of a quality costing system depends on the quality management maturity (QMM) level in Food and Beverage enterprises (F&B). Since no previous research has taken place in this area, the paper aims at analyzing the relationships between quality costing and the specific variables that define the various maturity stages.

Research Methodology

A structured questionnaire was used to survey 457 F&B companies. This produced 104 usable responses (23% response rate). Multidimensional Correspondence Analysis (MCA) with Hierarchical Cluster Analysis (HCA) were

used to detect and represent underlying structures in the categorical data set and to detect possible clusters between variables.

Findings

The more mature a company's QMM, the more emphasis they placed on appraisal quality costs and effective use of quality costs information. Prevention costs have no statistically significant connection with the level of maturity. A generalized 'expensive' use of Quality Costing, with no focus on problematic areas and possible solutions, does not always lead to the resolution of problems.

Originality/Value

It is the first time that QMM levels of Greek F&B companies have been reported. The research explores the characteristics that a quality costing system of Greek F&B organizations develop at the various maturity levels. The analysis uses an exploratory method – Multiple Correspondence Analysis- which can highlight intense correspondences of characteristics and clusters, which cannot be predicted in advance.

Research limitations/implications

A complicated - and some think unfair - tax system, combined with limited cash liquidity constitutes an unstable environment for Greek companies, in which they have to survive and develop. This environment does not support quality costing, thus resulting in limited interest by company management in participating in our research. Furthermore, the Greek Uniform Chart of Accounts and the Greek Accounting Standards do not include specific quality-related accounts, making it difficult for companies to measure Quality Costs and for researchers to investigate the quality costing field.

Keywords: Cost of Quality, Quality Management Maturity, Maturity Grid, Greek Food and Beverage enterprises, Multidimensional Data Analysis, Multiple Correspondence Analysis, Hierarchical Cluster Analysis.

1. Introduction

The study of Quality Costs plays a fundamental role in Total Quality Management approach. The major role that TQM and Cost of Quality (CoQ) have in the continuous improvement process of manufacturing companies has been largely analyzed in a number of papers (Fu et al, 2015; Ismyrlis and Moschidis, 2015; Ahmed Al-Dujaili, 2013; Sansalvador and Brotons, 2013; Dale et al., 2001; Dale and Plunkett, 1999; Carson, 1986). The work of Juran (1951), Feigenbaum (1956, 1991) and other gurus on the Quality Cost models has set the basis for numerous cases, where researchers focused on Quality Costs and the impact of their analysis in the manufacturing sector. However, little attention has been paid to the Food and Beverage (F&B) industry, as far as the Quality Costing analysis is concerned.

Especially in the case of Greece, literature indicates limited implementation of TQM in general (Fotopoulos and Psomas; 2009) and Quality Costing in the F&B sector in particular (Chatzipetrou and Moshidis (2016; 2017). According to a recent survey Chatzipetrou and Moschidis (2016) conducted among 159 Greek supermarkets, Cost of Quality as a percentage of annual sales was below 5%,

although the Greek F&B sector constitutes the larger 'employer' of domestic Manufacturing, since one fourth (25.2%) of the total workforce in Manufacturing is employed in F&B. (*source: Foundation for Economic and Industrial Research, Food and Beverages Industry, Facts and Figures 2014,www.iobe.gr).* Furthermore, in a survey among Greek F&B enterprises (Chatzipetrou and Moschidis, 2017), it is concluded that Total Quality Cost Index (TQCI=Total Quality Cost/net sales x 100) ranges from 1.14 % in micro companies to 4.3% in very large companies, which falls within the published range of values for the Food industry (1-6%). However, Chatzipetrou and Moschidis (2017) imply that the low percentage (1.14%) of small and micro companies does not imply high quality, but rather limited attention to quality. The absence of a quality-oriented Greek Chart of Accounts, which would enable companies to monitor and measure Quality Costs in separate accounts rather than categorize them under the general categories of overheads or other operating expenses, definitely plays an important role in the implementation process.

It seems that the implementation of Quality Management has not always achieved successful results (Fu et al, 2015). Many authors have suggested that there is a need for an appropriate organizational maturity level, to support the implementation of such an approach (Fu et al, 2015; Sansalvador and Brotons, 2013; Prickett and Rapley, 2001; Prickett, 1997). Maturity models are useful tools for an organization and its management to assess their processes, their effectiveness and results. Pullen (2007) defines maturity models as a structured collection of elements that describes the characteristics of effective processes at different stages of development. Pullen (2007) suggests the need for 'points of demarcation between stages and methods of transitioning from one stage to another' (p. 9). A maturity model, as Pullen (2007)

further adds, provides a framework for setting priorities and also a way to define progress and measure improvement, usually by benchmarking with other organizations.

In order to explore the relationship between the maturity level of F&B enterprises and its Quality Costing system, emphasis is placed in this paper on Crosby's Quality Management Maturity Grid (QMMG), which was developed by Phillip Crosby (1979) and was one of the first maturity models for the evaluation and assessment of quality maturity. Given that our aim is to present the stage where the analyzed F&B enterprises find themselves, we propose that Crosby's QMMG is the most simple and appropriate method. It is a straightforward tool which depicts, in a very expressive way, five stages of system maturity (Uncertainty, Awakening, Enlightenment, Wisdom, Certainty) in respect to six measurement categories. Criticism has been exercised (Albliwi et al, 2014; Wendler, 2012) that it is a straightforward tool, which entails subjective evaluation of maturity. Since our aim is to present an overall depiction of the maturity level of F&B enterprises, we believe that it is by definition expected that our tool will have a mechanistic approach. Furthermore, as mentioned by Tarhan et al, 2016; Wendler, 2012 and Fraser et al., 2002, Crosby's QMMG has been the origin of the majority of the subsequent maturity models (Capability Maturity Model –CMM- for Software, Capability Maturity Model Integration –CMMI, OMG's Business Process Maturity Model – BPMM, etc), which emphasizes its importance and reliability.

Although CMMI is the only "standard" maturity model really noticed within the academic community (Wendler, 2012), it is a framework representing a path of improvements recommended for *software* organizations that want to increase their

software development processes to achieve higher quality (Tarhan et al, 2016; Paulk et al, 1993). However, since the focus of the present paper is the Food Industry and F&B enterprises, and given the fact that, to the writers' knowledge, no similar research has been conducted in Greece before, we chose to use Crosby's concept of maturity stages building on each other, as a simple and effective tool for analysis and measurement. Crosby's so called quality management process maturity grid fits into the potential performance perspective (Wendler 2012), which means that it shows the potential arising of a higher maturity level and the user may decide if it is desirable to proceed to the next stage (Crosby, 1979). Furthermore, in the food industry, food safety management and quality management are considered to be closely related (Röhr et al, 2005), so it can be concluded that the Quality Management Maturity Grid is a "logical starting point" (Jespersen et al, 2016).

Although major work has been conducted worldwide on Crosby's model and its connection to Quality costing, the authors believe that there is limited reference in the literature, as far as the connection of the PAF model with Crosby's quality management maturity stages is concerned. Papers have emphasized the relationship between general sophistication of the quality system and the PAF model (Prickett, 1997; Prickett and Rapley, 2001), or costing systems in general (Al-Omiri and Drury, 2007), or have proposed a newly developed model on quality level and its relationship with the PAF model (Ayati and Schiffauerova, 2014). Further work used the Crosby model in connection with fuzzy logic and a fuzzy Quality Costs estimation method (Sansalvador and Brotons, 2013; Martinez and Selles, 2015). To the knowledge of the authors, however, not much emphasis has been placed on studies that can produce conclusions on the specific cost elements used in each stage, their expenses and possible interrelations. Our survey is an attempt in this direction. A further objective

of this research is to investigate whether the sophistication of quality costing systems of Greek F&B enterprises is dependent upon the level of maturity where companies place themselves. The findings may form a framework for management and practitioners about the role that Greek 'mature' enterprises should play in the implementation process of Cost of Quality. This role becomes even more crucial in the difficult Greek economic environment, which is characterized by vague financial prospects and strict restrictions imposed upon companies by the austerity measures. Mature companies, therefore, could identify their important role and development potential, in order to lead the process of continuous improvement, with a focus on costs minimization and quality optimization. Furthermore, the originality of the paper lies in its suggestion that by simply observing the quality management level of a company, it is possible to gain knowledge about the characteristics of its quality costing system. Finally, this research highlights the inability of the Greek Uniform Chart of Accounts and the Greek Accounting Standards to include quality-related accounts, which would enable the monitoring and measurement of Quality Costs. The present research could trigger a discussion among the responsible Chambers, the academic community and the State, for the necessity of a reformed accounting framework relevant to the requirements of Quality Costing.

Our exploratory effort focuses on the identification of the large variances from the Average in a holistic way, for all company characteristics related to the phenomenon under research. This can be achieved through the investigation of the directional variance. The most appropriate tool for this purpose and for the nature of the characteristics is Multiple Correspondence Analysis.

The remainder of the paper is organized as follows: Section 2 provides a literature review on Quality Costs, self assessment and maturity models, as well an

overview of Crosby's Maturity Grid. Section 3 describes the research methodology used and Section 4 the analysis of the results. In Section 5 the discussion of the results is presented. The conclusions, limitations and further research close the paper in Section 6.

2. Literature Review

Quality costs

The concept of Quality Costs was first introduced in the 1950s by Juran (1951) and Feigenbaum (1956) and has ever since become the basis for a number of different definitions (Trehan et al, 2015; Lari and Asllani, 2013; Yang, 2008; Roden and Dale, 2000; Dale and Plunkett, 1999; Crosby, 1979). Campanella proposed the following definition, which encompasses the core of most definitions: 'Quality Costs are the total of the costs incurred by a)investing in the prevention of non-conformances to requirements, b) appraising a product or service for conformance to requirements and c) failure to meet requirements' (Campanella, 1999, p.4).

One of the most widely spread models of quality costing is the P-A-F Model. The basic idea originated from the need to organize all costs related to the quality system and the inspection of products, as well as all costs incurred when the product failed to meet the requirements. According to BS 6143 (1990), Quality Costs can be categorized as

- Prevention costs, which depict the costs of all activities that are undertaken in order to prevent defects in products or services, i.e. costs relevant to the supplier evaluation or to the maintenance of machinery

- Appraisal costs, which are costs incurred during inspections, tests and other evaluations of products or services, in order to ensure that product quality will conform to requirements, i.e. calibration of measuring and test equipment or inspection/test of purchased material.

- Internal failure costs, which describe the costs that occur *before* a defective product reaches the customer, that is, the costs of scrap, replacement, rework, re-inspection.
- External failure costs, which are the costs arising from inadequate quality *after* the delivery of the product to the customer i.e. costs in relation to returns, complaints, warranty claims, loss of sales etc.

The original PAF model has been developed, expanded and enriched. Its initial categorization, however, has been used as a useful tool in a number of studies, in an attempt to better depict and re-organize a company's structure and processes.

Malik et al, 2016; Raßfeld et al, 2015; Kirlioğlu and Çevik, 2013; Tye et al., 2011; Jafar et al. 2010; Omorgonulsen, 2009; Desai, 2008; Omachonu et al., 2004 are only a few of the numerous studies that have been conducted, based on the P-A-F Model. The traditional premise of the above model is that the increment in prevention and appraisal costs would lead to the decrease in failure costs. It is supported that non-conformance costs (internal and external failure costs) can only be reduced by increasing expenditures on conformance activities (Ittner, 1996). The curve "costs of appraisal plus prevention" rises, therefore, to infinity as perfection is approached, and the optimal level of quality is somewhere below perfection (Gryna, 1988).

This concept has been challenged, however, by an alternative view (Juran and Gryna, 1993), which claims that perfection is achievable in finite conformance costs. It represents conditions that evolved later in the twentieth century, when advances in technology, robotics and automation reduced failure rate in production. Consequently, the exponential behavior of prevention and appraisal costs is eliminated, while the cost optimum shifts to the perfect quality level, as perfection can be achieved at finite costs (Burgess, 1996).

Regardless of the various schools of thoughts about the Quality Costing, Ayati & Schiffauerova (2014) assert that its advantage is basically that it provides precise identification and classification of Quality Costs. Moreover, they support that it helps identify the contribution that each quality cost has, in relation to the total COQ. This provides useful information on the cost category which needs more attention, in order to achieve higher quality levels or reduced costs. In this direction stand Chopra and Singh (2015), whose work proposes that total COQ are directly proportional to total failure costs. They suggest that if SMEs run their operations at optimized values of prevention and appraisal costs to keep total failure costs at lowest possible levels, total COQ will be diminished and profitability and market share raised. Kerfai et al (2016) also reach a similar conclusion. They suggest that companies with quality cost systems experience less internal and external failures than others, while they seem to invest more in prevention and appraisal actions than others, since prevention activities become an integral part of the management system. Furthermore, they also support the idea that the adoption of quality costing has positive consequences on the company's performance and control of costs, by promoting actions allowing the reduction of the internal and external failures. On the other hand, Plewa et al (2016)

imply that higher levels of quality do not necessarily require increased spending on prevention and appraisal. They find in their study, among others, that no association exists between higher prevention and appraisal costs and higher overall quality levels. Furthermore, they conclude that lower failure cost is not associated with higher prevention and appraisal costs. They, therefore, reject the notion that lower failure cost being achieved at the expense of higher prevention and appraisal costs, and propose a modification of the modern model, which implies that at higher overall quality levels, CoQ is lower not only in total but also in its components.

Self-assessment

It is widely recognized (Fu et al, 2015; Dellana and Kros, 2014; Balbaster Benavent et al, 2005; Sturkenboom et al, 2001; Van der Wiele and Brown, 1999; Brown and Van der Wiele, 1996; Van der Wiele et al, 1996) that quality management self-assessment processes provide the link between TQM and company business objectives, while they motivate management to design and implement an improvement agenda with a set of prescribed actions. According to Balbaster Benavent et al. (2005) 'quality management self-assessment is a useful tool for fostering the continuous improvement of the whole company, comparing its activities and results with an excellence model' (p. 432). Ton van der Wiele and Brown have conducted major research on the use and benefits of self-assessment implementation and identified various reasons - relevant to the external and internal environment of the companies – for self-assessment processes. Many benefits of self-assessment have been highlighted, with an emphasis on the effects of self-assessment on business results. Among others, it has been made clear that 'the use of quality maturity matrix

correlates with a more positive perception about the relationship between self-assessment and business results' (Van der Wiele and Brown, 1999, p. 250).

Maturity Models

Maturity can be represented as 'a number of cumulative stages, where higher stages build on the requirements of lower stages' (Maier et al, 2012, p. 146). The highest number represents high maturity and the lowest represents low maturity. Aranda and Márquez (2015) describe maturity models as a sequence of levels that creates an anticipated, desired or logical path from an initial state to maturity, usually defining the different levels as follows: Level 1: Initial, Level 2: Managed, Level 3: Established, Level 4: Predictable/Quantitatively managed, Level 5: Optimised. According to Fraser (2002), maturity models define a number of dimensions or process areas at several discrete stages of maturity, with a short description of characteristic performance at each stage. Through the use of a maturity model, the current state of a given system is evaluated, in a way that improvement plans are developed. In a systematic analysis of 237 articles published on the maturity models, Wendler (2012) identifies a number of benefits created by maturity models. Firstly, they generate an awareness of the state, importance, potentials, requirements, complexity, etc. of the analyzed organization. Furthermore, they may serve as 'reference frame' to implement a systematic and 'well directed' approach for improvements, to ensure a certain quality, to avoid possible errors and assess one's own capabilities on a comparable basis. In the same direction, Jespersen et al (2016) suggest that a maturity model can help an organization understand how industry peers are performing and how this performance compares to its own. Acceptable industry practices can be summarized in a way that an organization can assess the necessary

requirements in order to reach a certain level of management and control of these practices. "Organizations can evolve toward a culture of process improvement excellence which, in turn, leads to greater efficiency of operations, more accurate planning, safer decision making, less risks and higher credibility" (Antoniades, 2014, p. 12). A number of further papers (Albliwi et al, 2014; Maier et al, 2012; Röglinger et al, 2012; Fraser et al, 2002; Brown and van der Wiele, 1996) have also presented and compared the most widespread maturity models, which better depict the efforts towards a proper Quality management system.

Crosby's Grid

The cornerstone of the majority of maturity models is the Quality Management Maturity Grid (QMMG), proposed by Phillip Crosby in 1979 in his seminal work 'Quality is Free'. A maturity grid describes and codifies, in a few phases, 'what might be regarded as good practice (and bad practice), along with some intermediate or transitional stages' (Fraser, 2002), while it is typically used as an instrument of assessment, since it is less complex as diagnostic tool without aspiring to provide certification (Maier et al, 2012). Given that a maturity grid may be used as a stand-alone assessment (Maier, 2012; Pricket, 1997), we chose QMMG in our paper as the basic tool for assessing a company's quality management maturity level, as suggested by previous studies conducted worldwide (Sansalvador and Brotons, 2013; Zhang & Dai, 2013; Prickett & Rapley, 2001; Landin & Persson, 1998, Prickett, 1997). Although many maturity models have developed through time, which measure the capacity and maturity of other disciplines and practices, such as project management practice, software maintenance, business processes etc, Crosby's model is recognized as the root of all subsequent approaches, which emerged out of quality

management and offers a simple and effective tool for analysis and measurement. It constitutes the most appropriate tool for the recognition of the importance of human factors, such as leadership, attitude and collaborative work, as well as for the positioning of the company in the quality management spectrum (Albiwi et al, 2014).

QMMG suggests five phases that a company is likely to evolve through: 'Uncertainty', 'Awakening', 'Enlightenment', 'Wisdom' and 'Certainty'. Although Crosby later modified this Grid to Uncertainty, Regression, Awakening, Enlightenment, Certainty (Crosby, 1996), the original QMMG is the most well known Grid, that produced many derivatives in various scientific areas. The essence of the QMMG is depicted in Table 1, where only the summation of a company's quality posture is included.

Table 1: Crosby P.B, 'Quality is Free', 1979, p. 38-39.

	Stage 1:Uncertainty	**Stage II: Awakening**	**Stage III: Enlightenment**	**Stage IV: Wisdom**	**Stage V: Certainty**
Summation of company quality posture	"We don't know why we have problems with quality"	"Is it absolutely necessary to always have problems with quality?"	"Through management commitment ad quality improvement we are identifying and resolving our problems"	"Defect prevention is a routine part of our operation"	"We know why we do not have problems with quality"

According to Crosby (1979), in Stage 1 – 'Uncertainty', the company has no knowledge of Quality as a positive management tool. Cost of Quality is an unknown term, unsolved problems produce new problems and pressure is put on every level of

the organization by a disorganized management team. Improvement is not considered an option, as 'the number one symptom is emphatic denial that this condition exists'.

Stage 2 – 'Awakening' is the beginning of the realization that quality management may be useful. Inspection and testing are performed more often, problems are identified earlier. However, it has not yet been recognized that quality management is more than adhering to the technical aspect of processes. Long-range solutions are not considered seriously.

Stage 3- 'Enlightenment' appears when management establishes a more regular quality policy. Problems are faced openly, with the admission that 'we cause our own problems' and task teams are responsible not only for resolving a problem, but also for preventing it in the future. Cost of Quality is developed in a more effective way, while management is better organized and quality-oriented.

In Stage 4 – 'Wisdom' cost reductions are in effect and problems are handled effectively. Cost of Quality is more accurately reported and management realizes that Quality Control is possible. 'Wisdom is the stage at which the company has the chance to make the changes permanent'. However, if the new attitude and systems are taken for granted and further improvement efforts are not applied, then the whole process can be threatened.

Stage 5 is 'Certainty'. It is in this stage that quality management has become a vital part of the organization. Problems hardly ever occur, since the prevention systems of quality costing are apparent in every department.

3. Research Methodology

In this paper we provide an insight into the relationship between an organization's Quality Management Maturity level and the sophistication of its

quality costing system. Although there is evidence in international literature of previous work on this area (Sansalvador and Brotons, 2013; Xiaofen, 2013; Sower et al, 2007; Prickett and Rapley, 2001; Prickett, 1997), Quality Management Maturity and the sophistication of Quality Costing are not sufficiently documented in Greek F&B enterprises (Chatzipetrou & Moschidis, 2016; 2017). Therefore, we decided to conduct a survey with the use of an online questionnaire.

We had 104 usable responses out of 457 Greek Food and Beverage companies (23% response rate), which were chosen by simple random sampling in each sub-sector (dairy, fruit and vegetables, bakery etc) from the members of the Chamber of Commerce and Industry, in order to achieve representativeness. For the highest response level possible, we proceeded to personal and phone interviews via structured questioning using the online survey form, in cases where the returned questionnaires were incomplete or not returned in time. Furthermore, we contacted 15 randomly selected companies from the list of non-respondents after the main survey, who attributed their non-response to lack of relative quality cost data. It would be interesting to note, however, that, according to published literature (Fulton, 2016; Peytchev, 2013) surveys with low response rates do not necessarily contain significant non-response bias. If there are no systematic differences between respondents and non-respondents, the sample remains representative of the target population and can provide valid inferences. Thus, when using survey data to make inferences about a population, response representativeness is more important than the response rate (Cook et al, 2000).

The profile of the respondents in terms of Business Sector and ISO-HACCP Certification is presented in Tables 2 and 3. As analyzed by Chatzipetrou and

Moschidis (2017), the operational costs for ISO/HACCP systems can be measured as part of the prevention and appraisal quality costs of the companies. The Total Quality Cost Index (TQCI), based on sales and PAF data, reaches 2%, which is an acceptable value in the literature (Lupin et al, 2010).

Table 2: Profile of respondents (Business Sector)

BUSINESS SECTOR	Frequency	Frequency %
Bakery	45	43%
Dairy	7	7%
Fruit - Vegetables	18	17%
Alcoholic Drinks-Refreshments-Water	21	20%
Meat-Fish	13	13%
TOTAL	104	100%

Table 3: Profile of respondents (ISO/HACCP certification in Euros)

ISO-HACCP	Frequency	Frequency %
not certified	13	13%
up to 500 euros	25	24%
501-1000 euros	27	26%
1001-2000 euros	22	21%
more than 2000	17	16%
TOTAL	104	100%

The work of Rasamanie and Kanapathy, 2011; Arvaiova et al. 2009; Prickett and Rapley, 2001, was a useful guide for the structure of our questionnaire, with categorical and 5-point Likert scale questions. The questionnaire was divided into four sections: the first section was designed to gather general information about the participating companies (for example sales turnover, number of employees, annual

balance sheet total, business sector, ISO-HACCP Certification). The second part of the questionnaire investigated which prevention-appraisal-failure costs (according to the PAF Model) were monitored by the respondents and at what annual cost. The third section included general questions on the organizations' quality costing system, investigating the reasons that supported its implementation, the difficulties encountered, possible benefits or disadvantages, the uses of Quality Information (level of analysis, departments involved) etc. Finally, the fourth section included questions in relation to the maturity level of the companies, developed according to Crosby's Maturity Grid – QMMG (1979).

Crosby's QMMG served as a tool for the identification of the maturity level of the enterprises. The Financial or/and Quality Manager of the companies were requested to assess the stage where the analyzed organization found itself, according to Crosby's Maturity Grid, by rating each category (Table 4) from 1(=totally disagree) to 5(= very much agree).

Table 4: Crosby's Grid Measurement Categories

Measurement Categories
Management understanding and attitude
Quality organization status
Problem handling
Cost of Quality as % of sales

Each rating represents the stage level on Crosby's Grid for that category. The total score for all six categories is then divided by 6, which indicates the Crosby Maturity Stage the company finds itself (Table 5). Cosby (1979) suggests in his

original work that the six categories be treated as equivalent. Therefore, we assumed that all measurement categories are equally weighted, as we did not intend to introduce any subjective elements in the analysis, in contrast to Sansalvador and Brotons (2013) and Martínez and Selles, (2015).

Table 5: Transformation of Crosby Score into Crosby Stage*

Score	Crosby's Stage
1 - 1.5	Uncertainty
1.6 - 2.4	Awakening
2.5 - 3.4	Enlightenment
3.5 - 4.4	Wisdom
4.5 - 5	Certainty

*Because the average scores are fractional, they were converted to nominal categories using the given scale.

By using Table 5 to classify organizations according to their individual scores, the following distribution was obtained (Table 6).

Table 6: Distribution of organizations into Crosby Stages

Crosby's Stage	Frequency	Frequency %
ST 1: Uncertainty	9	9%
ST 2 : Awakening	9	9%
ST 3: Enlightenment	56	54%
ST 4: Wisdom	14	13%
ST 5: Certainty	16	15%
Total	104	100%

Based on the companies' maturity stage, an exploratory analysis of the findings was conducted, in order to gain a better understanding of the interrelationship between Quality Costing and Quality Management Maturity of F&B enterprises. We aimed at examining the relationship between the maturity level and the characteristics of a quality costing system, as they are described in the relevant literature (Al-Omiri and Drury, 2007; Prickett and Rapley, 2001; Rapley et al, 1999; Prickett, 1997). The variables presented in Table 7 seem the most appropriate in our attempt to assess the sophistication of a quality costing system.

Table 7: Variables measured for the sophistication of a quality costing system

Variables	Sophistication of Quality Costing
Q3 Q4 Q5 Q6	The cost elements of the PAF model measured
Q11	The level of detail that quality costs are calculated
Q12	The nature of Information Technology (IT) used to assist with quality costing
Q13	The areas of an organization where quality costs are measured
S	The size of the organization
BS	The business sector of the organization

As suggested in the literature (Al-Omiri and Drury, 2007; Prickett and Rapley, 2001; Rapley et al, 1999), the general support role that Quality Costing plays in the organization, as well as the focus on Quality Costs, are the core of a sophisticated costing system. Variables Q3-Q4-Q5-Q6 depicted 5-point scale questions about the Prevention, Appraisal, Internal and External Failure cost categories, respectively. Indicative costs for the Prevention costs category were 'planning and maintaining of quality systems', 'employee quality training', etc. Appraisal costs category included, among others, 'annual costs of inspection and testing during manufacturing' and 'quality control of incoming material'. Some costs relating to the Internal Failure

category were ‘scrap’, ‘re-inspection’ and ‘idle time’. Finally, some External Failure costs were ‘replacements’, ‘loss of sales’ and ‘fines’. The first class represented the ‘no monitoring of this cost’ option, while classes 2 to 5 represented the annual expenditures for each cost category (2=less than 500 euros, 5=more than 2.000 euros).

Variable Q11 provided information on the level of detail that quality costs were calculated. Respondents were asked to rate certain statements (i.e. information used on ‘better planning’, ‘better process control’, etc) from 1 (=totally disagree) to 5 (=totally agree). Variable Q12 included questions about the nature of IT used (i.e. ERP software, other special software, Excel spreadsheets, etc), while variable Q13 included all possible areas where quality costs could be measured (i.e. production department, sales, quality control, etc). It should be noted that, although the use and quality of Information Technology was not a significant variable in the study of Al-Omiri and Drury (2007), we chose to include it –together with business sector- in our research, in an attempt to investigate their individual roles in the development of a sophisticated quality costing system in more detail.

Organizational size (variable S) and Business Sector (BS) were also included in the research. For the determination of size, annual turnover (in euros) was the variable that was taken into consideration in a 5-point scale question (1=less than 2 million euros - micro companies), 5=more than 200 million euros – very large companies). Finally, the Business Sectors that have been investigated were cereals, dairy, fruit and vegetables, refreshments and drinks, fish and meat etc).

For the examination of the correspondences between the above variables, we chose Multiple Correspondence Analysis as the most appropriate tool. Multiple Correspondence Analysis is applicable to a large set of categorical variables and is most useful when analyzing nominal categorical data used to detect and represent

underlying structures in a data set (Moschidis, 2009; Greenacre, 2007). It is an exploratory methodology, which aims at a holistic analysis of the data structure. More specifically, it ranks the largest covariances of the involved variables into axes, highlighting the most intense interactions (Greenacre, 2007). The statistical dependency of the multicontingency matrix of the variables has been tested with the X^2 test and was found to be statistically significant at a=5%. Because the research was going to take place in an unknown and vague environment, we chose not to formulate any hypotheses in advance, but rather let the data "talk". Multiple Correspondence Analysis depicted the interactions between the various Crosby stages, which stand for the maturity variables, and the variables of system sophistication (Table 7). Hierarchical Clustering (Moschidis, 2015) was used as a separate, more illustrative part of the research, in order to cluster the sophistication characteristics in relation to the various variables that define the maturity stages (Table 4). Since the data was categorical, these methodologies were preferred to Factor analysis, which is useful mainly in the case of quantitative data, as it does not show the structure of the dependence in large matrixes with multi-categorical variables (Greenacre, 2007).

4. Analysis of Results

Multiple Correspondence Analysis

The analysis has been conducted by the use of SPAD, a Data Analysis Software. The analysis is presented in two separate axes, rather than in a combined plot (factorial level), in order to better de pict the two vertical directions with the largest dispersion. The presentation of the factorial level with the Multiple

Correspondence Analysis (MCA) may lead to the elimination of the different significance of the findings in the axes. The first factorial axis is the one with the largest dispersion and the second factorial axis is the one with the second largest dispersion. MCA displays equivalently in each axis the rows and the columns of the analyzed contingency matrix (unlike Factor analysis, which displays accurately only the quantitative variable columns of the matrix).

The results of the first analysis are presented in Table 8, which shows the rate of total dispersion for each axis (interpretation %). By analyzing only the first two axes, there is a 60.27% interpretation of the total inertia, while the first factorial axis covers 36.32% of the available information, which depicts the dominant tendency. The total inertia of the table is the measure of the table's total variation, equal to the weighted sum of squares of the centred matrix that is approximated (Greenacre, 2000).

Table 8: Eigenvalues and Inertia

Total Inertia 0.14550				
Axes	Inertia	Interpretation %	Sum %	| Scree Plot
1	0.0528519	36.32	36.32	|**********
2	0.0348416	23.95	60.27	|**********
3	0.0307864	21.16	81.43	|**********
4	0.0270191	18.57	100.00	|**********

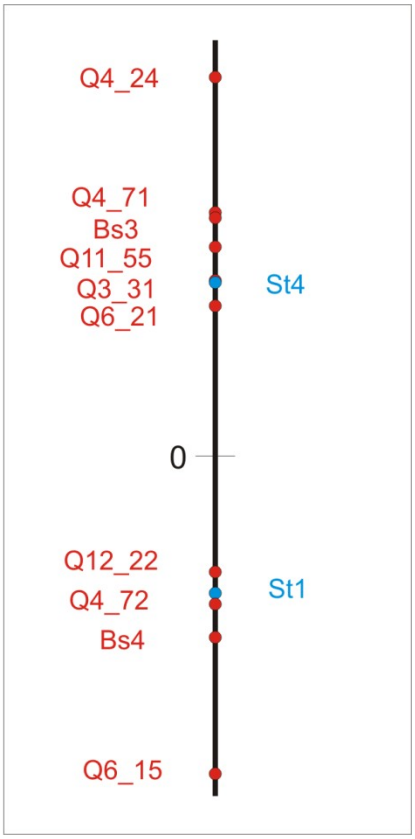
After the use of Multiple Correspondence Analysis, the variables that had the highest Contribution indicator (CTR) were taken into consideration, which depict the directions of the largest dispersion. The points with high CTR emphasize the importance of each variable (characteristic) in the axes construction process. The average CTR in this analysis is 1000:209= 4.784, where 209 is the number of points-

elements. Points of high contribution in axis construction are generally considered those with CTR value above average. However, in this case, we chose to focus on CTR>13 in the first 2 factorial levels, in order to highlight the variables that have the highest possible contribution to the construction of each axis. The first axis presents the main directions of the largest dispersion, while the second axis presents the second largest dispersion.

The following analysis is based on the indicators CTR and the Coordinates. The depictions of the axes are the projections of the points and not the points themselves. The analysis of the first axis (Figure 1) shows the formation of two groups of companies at both sides of point zero (0) of the axis, which diversify themselves in relation to their characteristics. The first group of companies have placed themselves in maturity stage 1 (St1), while the second group belongs to maturity stage 4 (St4).

Figure 1: Interpretation Indicators: Coordinates and Highest Contributions (CTR) of the first axis.

variables	COORDINATES	CONTRIBUTION
Q4_71	644	23
Q4_72	-363	23
Bs3	630	22
Q4_24	1002	19
Q6_21	397	17
Q11_55	553	17
Bs4	-480	17
Q3_31	464	16
Q12_22	-307	14
Q6_15	-841	13
St4	459	507
St1	-392	214



Companies in the 'Uncertainty' stage (St1) represent the Beverages subsector, including 'alcoholic drinks, refreshments and water' (Bs4). They are characterized by a low sophistication level, since they invest heavily in external failure costs, in contrast to the core concept of effective Quality Costing that proposes focus on conformance activities. Companies spend more than 2000 € annually on external failure costs, and in particular 'replacement costs' (Q6_15), which is the dominant variable for this maturity stage. A weaker tendency is depicted by appraisal costs, on

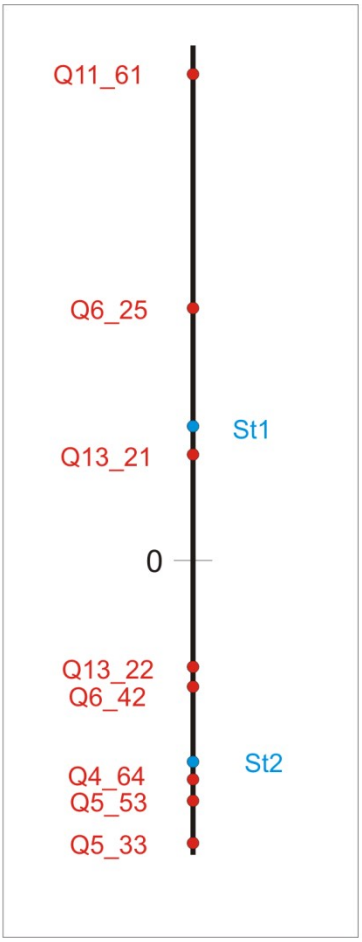
which companies in the Uncertainty stage annually spend less than 500 € ('process control measurements'- Q4_72). In terms of sophistication, it appears they do not use any special IT for monitoring Cost of Quality (Q12_22). No other relevant variables appeared in connection to the 'Uncertainty' stage.

The group of companies that belong to stage 4 – the 'Wisdom' stage (St4), seem to be large companies located in the Fruit subsector (Bs3). The sophistication level at this stage is higher, since Quality Costing is implemented with an emphasis on appraisal costs. Appraisal costs absorb annually 1001-2000 € on 'inspection and testing during manufacturing' (Q4_24) and is the most dominant variable for this maturity stage. Limited emphasis is put on supplier evaluation (Q4_71), on the planning and development of control equipment (Q3_31) and the handling costs of low quality products (Q6_21). The quality costing system sophistication is higher at the 'Wisdom' stage, since companies seem to share common views as to the uses of quality cost information, as their answers point out that information supplied by Quality Costing is used towards 'the comparison between costs in different processes within the company' (Q11_55).

As far the analysis of Axis 2 is concerned (Figure 2), there is a distinctive pattern for companies that have assessed their status in the 'Awakening' Stage (St2).

Figure 2: Interpretation Indicators: Coordinates and Highest Contributions (CTR) of the second axis.

variables	COORDINATES	CONTRIBUTION
Q11_61	1322	**50**
Q5_33	-768	**33**
Q5_53	-653	**24**
Q13_21	288	**23**
Q13_22	-289	**23**
Q4_64	-595	**20**
Q6_42	-343	**16**
Q6_25	686	**13**
St2	-547	**635**
St1	365	**283**



The sophistication of the 'Awakening' stage is of a medium level due to the monitoring of internal failure costs, especially costs resulting from 'manufacturing idle time' (Q5_53) and 'rework and repair' (Q5_33), on which companies annually spend 501-1000 €. Moreover, appraisal costs are monitored in the form of 'record keeping costs' (Q4_64), on which 1001-2000 € is annually spent. The analysis further highlights that although variable Q11_61 ('information supplied by Quality Costing is NOT used for the development of new products/services') is also dominant, it does not appear in the Awakening stage, which is the main feature in this axis.

Hierarchical Cluster Analysis

At this point, we proceeded to a more detailed analysis of our findings. With the use of Hierarchical Cluster Analysis (HCA), we attempted to cluster the sophistication characteristics (Table 7) in relation to the variables that define the maturity stages according to Crosby's Grid, as presented in Table 4. For the distance between elements we used metric X^2, since the data table was a contingency table. The Ward Criterion was used for the formation of the clusters, which is compatible with Correspondence Analysis and the categorical nature of the data.

Subsequently, we aim at a confirmatory verification of the MCA findings with more analytic data on the maturity stages, through Hierarchical Cluster Analysis.

This more detailed analysis shows that the most satisfactory clustering forms four clusters. Cluster characterization took place after a one-sided Z-test at a significance level of a= 0.05. Only numbers above 1.65 were recorded, which is the critical value of Z-test at a level of a=0.05. Although all characteristics above 1.65 are considered statistically significant, we chose to take into consideration the most dominant characteristics for each cluster.

The analysis concludes that:

- The 'No sophistication level' cluster includes almost all PAF components rated with 4 (more than 1000 € on quality costs) or 5 (more than 2000 € on quality costs) (Q3_15, Q4_55, Q5_55, Q3_75, Q6_35), which represent an expensive horizontal implementation of Quality Costing, with no focus on specific prevention and appraisal activities, which leads to excessive total costs. In terms of quality management maturity, despite the fact that quality improvement is a normal and continued activity (Q9_45) and Top

management has a role in the quality process (Q9_93), companies have no idea why they have problems with quality (Q8_81). Teams are set up to attack major problems, but long-range solutions are not produced (Q8_72). Finally, the reported percentage of Cost of Quality to sales is 8%, while the actual seems to be 12% (Q15_3).

- The 'Low sophistication level' cluster involves most of the PAF components rated with 2 (less than 500 €) or 3 (501-1000 € on quality costs) (Q3_13, Q5_32). Other characteristics also show little or no use of quality cost information and special IT (Q12_22). Although there are some obvious 'motivational' short-range efforts in terms of quality improvement (Q9_42), turmoil and tension are apparent, without adequately defined problems (Q8_71, Q8-82).
- The 'Medium sophistication level' cluster is characterized by the lack of prevention and appraisal costing (Q3_11, Q3_31, Q3_61), whereas internal and external failure costs absorb a considerable amount of money. Quality cost information is used most effectively (Q11_75). In relation to maturity, management understands the absolutes of quality and their role in the process (Q8_14), with an emphasis on Prevention (Q9_95, Q8_75). They seem to have a clear understanding of how to avoid quality problems (Q8_85).

- Finally, the 'High sophistication level' cluster is characterized by high prevention and appraisal costs (Q3_43, Q4_24), and at the same time by low investment on internal and external failure costs, which depicts the essence of successful Quality Costing implementation. Quality costs are measured for most of the organizational areas and quality cost information is used

effectively (Q11_35). The maturity measurement categories in this cluster show that problems are indeed identified early in their development (Q8_74), since defect prevention is a routine part of the companies' operation (Q8_84).

5. Discussion

With the use of Multiple Correspondence Analysis, an interesting relationship between the maturity level of enterprises and the level of sophistication of their quality costing system has been identified, enriched with variables of the PAF Model. The results point out the leading role that the PAF Model plays in the process, not only as an important element of quality system sophistication, but also as a dominant variable in relation to the Quality Management Maturity level. In our case certain Cost of Quality components are interrelated with the maturity stages of 'Uncertainty' (stage 1), 'Awakening' (stage 2) and 'Wisdom' (stage 4), which constitute the most dominant characteristics. External failure costs seem to be of great importance in the 'Uncertainty' stage, followed by appraisal costs. On the contrary, appraisal and internal failure costs characterize the 'Awakening stage', while appraisal costs seem important in the 'Wisdom' stage. Finally, prevention costs do not seem to have any statistical significance.

The above findings are consistent with the general quality management assertion, that companies with a weak quality costing system are expected to have high external and internal failure costs. Meanwhile, in a more mature system the failure categories are expected to be smaller and the appraisal and prevention

categories would either rise (Martínez and Sellés, 2015; Sower et al, 2007; Beecroft, 2001; Montgomery, 1996; Crosby, 1979) or, sometimes surprisingly decrease, as a result of continuous improvement efforts (Plewa et al, 2016; Ayati & Schiffauerova, 2014; Ittner, 1996). Furthermore, our findings confirm the general characteristics of each stage, as developed in Crosby's Grid (Crosby, 1979). Consequently, it is validated by our research that:

- F&B companies at the **'Uncertainty'** stage appear to have limited knowledge of Quality as a positive management tool, are unaware of Cost of Quality and leave problems unsolved, without making any efforts to prevent poor quality. This stage is characterized by high external failure costs and spends a minimum amount on appraisal processes, as confirmed by our results.
- in the **'Awakening'** stage comes the realization that quality management may be useful, which leads to more regular inspection and testing and earlier identification of problems, especially in the food manufacturing industry (Djekic et al, 2014; Lupin et al, 2010; Omurgonulsen, 2009). Our findings show, accordingly, that companies have significant appraisal and internal failure costs, which emphasizes their attention to better quality and all types of control.
- F&B companies in the **'Wisdom'** stage can handle cost reductions and report Cost of Quality more accurately. Therefore, they use quality cost information for the comparison between costs and for a detailed monitoring of the companies´ processes (Martínez & Selles, 2015), and invest a large amount in certain appraisal costs, as in our case.

- quality cost information proved to be actively connected with a company's profile in terms of quality management (Pires et al, 2015). Information on quality-related costs is rarely used by companies in the 'Uncertainty' stage for improvement of their processes or new products' development, while they never use it for marketing or pricing strategies. Their answers confirm that a form of quality costing system is implemented. Companies in the 'Awakening' stage do not use information effectively, either. Only companies in the 'Certainty' stage appear to use quality cost information for the comparison between costs in different processes within the company. As far as the use of IT is concerned, the results show that companies in the 'Certainty' stage use special statistical packages during the monitoring process of Quality Costs.
- although 'size' and 'business sector' have produced contradictory results in the literature (Xiaofen, 2013; Trigueros Pina and Sansalvador Sellés, 2008; Prickett, 1997), both variables appear to be statistically significant in the present analysis. In relation to 'size', medium-sized companies seem to share the characteristics of 'Wisdom' and 'Certainty', while smaller companies belong to the 'Awakening' stage. Taking into account that the size of companies is defined by the number of employees, turnover and/or annual balance sheet total (Commission Recommendation 2003/361/EC), it can be deduced that small companies in Greece have limited knowledge, resources, training and, obviously, motivation in order to focus on continuous improvement and promotion of quality techniques (Chatzipetrou and Moschidis, 2017). As far as the 'Business Sector' is concerned, there is evidence that companies in the Beverage sector are characterized by the

‘Uncertainty’ stage, while companies in the Fruit sector belong to the ‘Wisdom’ and ‘Certainty’ stage. These results seem reasonable, considering that the Fruit sector processes very sensitive products, which demand high levels of preservation and standardization and high degree of quality awareness.

The use of cluster analysis provides useful identification of groups of companies with differentiated profiles (as in Pires et al, 2015). With Hierarchical Clustering as part of the analysis, it was further attempted to form clusters of the sophistication characteristics of a quality costing systems, in relation to the individual measurement categories of maturity stages. The clusters that have been formed share common characteristics with the maturity stages, as described by Crosby. This detailed analysis in our paper pointed out some interesting results.

- It is clear that the expenditure on all Quality Costs by spending large amount of money does not always lead to the resolution of all problems, as in the case of clusters with no sophistication or a low sophistication level. Extensive examination of all procedures and departments is necessary, in order to identify problematic areas and possible solutions.
- It is the *quality* of the implementation of a Cost of Quality program rather than its mere existence that affects the results that can be achieved in an organization (Sower et al, 2007). Implementation of cost of quality techniques helps companies focus upon the areas that need improvement, gauge the progress of improvement activities and improve communication within the organization for better quality control (Kerfai et al, 2016; Őzkan and Karaibrahimoğlu (2013), Prickett and Rapley, 2001). Furthermore, it has been

found that Quality costing sets the priorities for the necessary corrective actions, so it is not to be implemented as a general 'expensive' overall technique, but rather as a *focused* solution for reduction of defects, reduction of costs and continuous improvement. As Gupta and Campbell (1995) interestingly put it, "attending a CoQ seminar has nothing to offer those searching for a quick fix or an easy answer. But for corporations willing to go that extra mile, it can set the stage for continuous improvement and cost-effectiveness" (p. 49).

- It was evident from our findings that the intentions of management do not always depict the reality that exists at lower levels of the organization, as in the cluster with a medium sophistication level. A quality cost program should always move from top to bottom i.e. top management should make it a part of overall production process (Trehan et al, 2015; Prashar, 2015). Management visions or perception of reality may differ from the actual conditions of their organization. "If CoQ is used as an accounting measure by unenlightened management, it becomes a useless pain" (Gupta and Campbell, 1995, p. 47). Communication may be hindered due to lack of motivation or excessive pressure on employees, abstract definition of goals or employee resistance. Good intentions of management are not the sole key to improvement.

6. Conclusions – Limitations- Future Research

The present paper offers a first insight into the Quality Management level of Greek F&B enterprises, a field that has not been extensively studied in the literature.

The paper ranks companies in quality maturity stages and emphasizes the relationship between the maturity level and the sophistication of their Quality Costing systems. Evidence shows that Quality Costing, in the form of the PAF model, is directly related to maturity level. The higher the maturity level, the more companies focus on better quality and more effective use of information (Jespersen e al, 2016; Ayati and Schiffauerova, 2014; Gupta and Campbell, 1995). Furthermore, it has been found that mainly the appraisal and failure costs are evident in our results. Prevention costs, although present, do not constitute a significant component of the Quality Costs associated with each maturity level.

The economic restrictions on Greek economy since summer 2015, in the form of capital controls, unbalanced the Greek economic and manufacturing environment and disorganized Greek enterprises. This environment does not constitute 'fertile ground' for quality costing techniques. This explains, therefore, why companies and their management show limited interest in participating in our research. Furthermore, the Greek Uniform Chart of Accounts and the Greek Accounting Standards do not cover the topic of Quality Costs by specific quality-related accounts, which discourages companies from paying any attention to Quality Costs' monitoring and measurement, and hinders the efforts of researchers in the depiction and analysis of Quality Costs' implementation in Greece.

It seems imperative, therefore, that Greek F&B companies take into account the general characteristics of the maturity level they are placed in, and evaluate its general characteristics and attributes. Action can then be taken, in respect to their attitude towards Quality Costing. The more they focus on quality, the more positive results they will get, which will lead to a general improvement of all processes within

their organizations and a consequent achievement of a higher level of maturity. A maturity model can, therefore, serve as a framework for companies to approach problems and defects in a more holistic way, to set priorities and to overcome difficulties. Quality Costing is indispensable when following this path.

We suggest that further research be done in other business sectors, apart from Food & Beverage, to generate new knowledge on the implementation of Cost of Quality in Greece and its interrelation with Quality Management Maturity level. It would be interesting to expand the area of research, in an effort to examine whether the results of the present study could apply to other industries as well. The time span of the research could also be expanded, since a longitudinal study could produce interesting results on the various relationships and connections. Furthermore, bearing in mind that the F&B sector in Greece is a dominant component of domestic Manufacturing, further research could highlight the important contribution that 'mature' F&B companies could have in the quality costing implementation process by the majority of Greek companies. Our research confirmed that a 'mature' company is characterized by consistency, focus on continuous improvement and commitment to Quality costing. It is for this reason that 'mature' companies need to realize their leading role towards a general wave of quality management implementation and, thereby, set the foundations for an overall 'restart' of the Greek economy. Finally, the present research could trigger a discussion among the responsible Chambers, the academic community and the State, for the necessity of a reformed accounting framework, relevant to the requirements of Quality Costing.

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