

## Quality costs in a fruit processing company: a case study of a Serbian company

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### RESEARCH ARTICLE

#### Abstract

Quality costs represent an indicator associated with the achievement or non-achievement of quality. The objective of this study was to evaluate the values and structures of quality costs in a Serbian fruit processing company, to calculate the total quality cost index and analyse allocation of the costs related to quality and food safety. A structured survey in a selected company has been performed in order to collect data. Financial and management system documentation have been reviewed for a period of four years. A prevention-appraisal-failure quality cost model was used in determining, categorizing, processing and analysing the results. In 2008, 2009 and 2010 the quality costs were 49.66, 44.99 and 57.35 €/tonnes, respectively. During the observed period, the structure of costs changed. Prevention and failure costs increased while appraisal costs decreased. The total quality cost index increased from 1.94% in 2008 to 2.58% in year 2010. Results confirmed that the total quality cost index were within the published range of values for the food industry. The distribution of costs changes due to various factors such as additional legal and customer requirements related to food safety and quality, economic crisis and maturity of implemented management systems.

**Keywords:** fruit processing company, quality costs, quality and food safety

#### 1. Introduction

In order to build and maintain the consumers' trust in food safety and quality throughout the food chain, quality assurance and food hygiene became significant in the food sector (Aggelogiannopoulos *et al.*, 2007). Food producers have a moral and legal duty to ensure that food placed on the market is safe (Alldrick *et al.*, 2009; EC, 2002). As a result of the risks in the supply chain, various assurance schemes have been developed and are applied worldwide. In some cases, the supply and demand drivers support the decision on adopting a specific quality or other assurance scheme (Tsekouras *et al.*, 2002). Food producers consider certificates as a proof of an implemented and effective system.

Implementation of quality and food safety schemes and management systems in the Serbian food companies is on

one side required by legislation, and on the other by big multinational producers or retailers, with implementation of hazard analysis and critical control point (HACCP) as the predominant (Djekic *et al.*, 2011). The producers that were exporting food, basically to the EU, were the first to start implementing HACCP principles along with other food safety schemes. Most certification bodies certifying International Organization for Standardization (ISO) management standards (ISO 9001, ISO 22000, etc.) operate under the International Accreditation Forum recognised accreditations. On the other side, HACCP audits fall under an unaccredited scheme in accordance with guidelines for auditing HACCP based food safety systems issued by the Dutch Accreditation Council (RvA, 2005). Based on the ISO survey, by the end of 2011, a total of 311 ISO 9001 certificates had been issued in the food industry in Serbia (ISO, 2011). ISO 22000, as a typical food safety management standard according to the same survey, had been issued in

145 Serbian food companies. Official statistical data show that over 350 Serbian food companies have (unaccredited) HACCP certificates (Serbian Chamber of Commerce Belgrade, 2012).

During the last few years, development of management systems in the food industry came to a turnover so food companies and their customers seek justification for implemented systems. In the time of the on-going economic crisis, quality costs became interesting in terms of retaining companies' market position and improving their competitiveness. They represent the hidden portion of the cost iceberg, which can create a competitive advantage to the companies, as long as they are detected and controlled. The measurement of the costs of quality is worth taking into consideration not only at a company level, but also for the food industry (Omurgonulsen, 2009).

The term 'quality costs' has different meanings. Some equate 'quality costs' with the costs of poor quality (mainly the costs of finding and correcting defective work). Others equate this term with the costs to attain quality, while others use the term to measure the costs of running the quality department (Juran, 1998). In general, quality costs fall into two major categories: (1) the cost of achieving good quality, also known as the cost of conformance; and (2) the cost associated with poor quality products and processes also referred to as the cost of non-conformance (Campanella, 1990; Omurgonulsen, 2009). These costs represent an indicator associated with the achievement or non-achievement of quality, including all product/service requirements established by the food company and its contracts with customers (Campanella, 1990).

Juran (1951) was the first to define the term of quality costs with his famous analogy 'gold in the mine'. Other quality researchers like Feigenbaum (1961) followed him, further deploying the concept. He was the first to categorise quality costs into three components: prevention, appraisal and failure (PAF) (Feigenbaum, 1956). Since then, many authors have revised, explored and developed the concept (Giakatis *et al.*, 2001; Masser, 1957; Mukhopadhyay, 2004; Omurgonulsen, 2009). Finally, some authors redefined and added other types of costs such as 'extra resultant cost' or 'estimated hidden cost' (Yang, 2008).

In parallel with these researchers, various standards have been developed to determine and develop quality costs (BSI, 1990; DoD, 1963; ISO, 2006b). These standards and the American Society for Quality Control define quality costs as the costs incurred in ensuring quality, together with the loss incurred when quality is not achieved (ASQC, 1967; BSI, 1990).

Some researchers found that the quality improvement approach successfully influences quality, but the impact

on financial performance is weak (Everett *et al.*, 1997). Depending on the authors and industry, the percentage of quality costs goes up to 35% of sales (Giakatis *et al.*, 2001; Yang, 2008). In the food industry there is a limited number of published works and the quality costs index goes from 2 to 6% (Lupin *et al.*, 2010).

On the global market today, various international standards within their scopes specify whether they cover a quality, food safety or both schemes (ISO 9001, ISO 20000, British Retail Consortium, International Featured Standard, Codex Alimentarius, Foundation for Food Safety Certification 22000, Safe Quality Food, etc.). In a wider perspective, all schemes are understood as quality schemes where food safety is a part of total quality (Raspor, 2008). As a result, researchers have revealed difficulties in estimating costs and allocating them to specific managements systems (Colatore and Caswell, 2000; Krieger *et al.*, 2007).

An accurate measurement of quality costs enables focusing upon areas of poor performance that need improvement assisting in the overall control of quality and raising the firm's competitive advantage through higher quality and lower costs. However, the prerequisite to achieve these benefits is a complete quality-costing system (Yang, 2008).

In case of food industry companies, values of quality costs do not always behave according to theoretical models due to internal and external factors. Internal factors are related to the complexity of production and current trends in food technology, food safety risks coming from bacterial adoption/changes influencing increase of foodborne diseases and different food quality problems. On the other side, external factors coming from two interested parties – customers and national legislation – both produce additional requirements, forcing companies to invest in improving their quality and food safety systems.

This paper presents calculated values of quality costs from a fruit processing company in the Republic of Serbia. The company belongs to a group of small enterprises and is a supplier of three multinational food companies operating in Serbia. As a result of being in the multinational supply chain, the company was enforced to start implementing quality and food safety schemes. This research is one of the first in the Republic of Serbia and could be useful for further research in this area. At the same time, other companies could benefit by having a general impression of the main effects of quality costs in similar companies.

Since there are a limited number of researches from the food industry, the objective of this paper was to calculate the value of total quality costs, evaluate structure of the costs during the observed period and analyse whether the total quality cost index is within the limits given in literature.

Additionally, this paper analyses allocation of costs related to quality and food safety.

### Effects of adoption of various management systems

Effects of implemented management systems have been analysed by various authors focusing their research on different financial and non-financial segments (Table 1). Depending on the timing of evaluation of effects, three different kinds of evaluations can be recognised: (1) *ex ante* (prior to implementing a management system); (2) on-going/mid-term (during implementation); and (3) *ex post* (upon implementation). Evaluation tools can be classified as cost-benefit analysis or multi-criteria analysis (Bartolini and Viaggi, 2010).

Since ISO 9001 is a generic quality management system (QMS) standard applicable to all industries, many *ex post* studies analysed effects of this system (mostly upon successful certification) with limited studies focusing on the food industry. Most studies covered effects of implemented QMS, use of quality tools and benefits of implemented and certified QMS. Also, various models of quality costs have been analysed by several authors in various industries through an on-going and *ex post* evaluation. On the other side, effects of implementing HACCP/FSMS (hazard analysis and critical control points/food safety management system), as food industry specific concepts have been analysed in the food industry through all three kinds of evaluation: (1) *ex ante* (evaluating implementation costs including investments in prerequisite programmes); (2) on-going (through cost-benefit and quality costs over time); and (3) *ex post* evaluating effects of the system.

Quality cost methodology has its advantages in the fact that it's a concept that was developed more than 50 years ago and has been theoretically analysed by many authors. In order to evaluate these costs, the *ex post* accounting approach is used through structured surveys with the possibility to enumerate the inputs and outcomes, but

with certain difficulties in estimating the associated costs. Limited studies from the field, time consuming approach, small sample size and a few studies from the food industry raise doubts about the relevance of results and challenge this approach (Krieger *et al.*, 2007).

## 2. Materials and methods

Feigenbaum's PAF model was used in classified costs (Feigenbaum, 1956). Deployment of the three categories related to the food industry was modified as outlined in recent studies (BSI, 1990; Lupin *et al.*, 2010; Zugarramurdi *et al.*, 2007). Prevention (P) costs considered the following:

- consulting activities for implementing and maintaining quality and food safety systems;
- internal and external training;
- quality and food safety certification/surveillance audits;
- quality assurance and quality planning including internal quality and food safety audits;
- design and development of food safety measures and validation of control measures;
- calibration and maintenance of monitoring and measuring equipment and devices;
- quality and food safety planning including development of quality and HACCP plans, and improvement of sampling and verification process;
- review and verification of design of modified and new products developed during the period;
- supplier assurance including evaluation of suppliers and second party audits;
- quality and food safety improvement programmes;
- design of prerequisite programs (PRPs) and good hygiene practice (GHP);
- preventive maintenance of equipment.

Appraisal (A) costs considered the cost of evaluating the achievement of quality and food safety requirements, as outlined in quality/HACCP plans, including:

- incoming control with testing and inspection of raw materials, components and packaging materials;

**Table 1. Effects of implemented management systems according to recent studies.**

Topic covered	References
Quality management performance and effects	Arauz and Suzuki, 2004; Lagrosen and Lagrosen, 2005; Van der Spiegel <i>et al.</i> , 2003, 2006
Use of quality tools in quality management	Alsaleh, 2007; Sousa <i>et al.</i> , 2005
Total quality management practices	Beheshti and Lollar, 2003; Fotopoulos <i>et al.</i> , 2010; Psomas and Fotopoulos, 2010
Quality costs	Barad, 1995; Giakatis <i>et al.</i> , 2001; Kulkarni, 2008a,b; Lupin <i>et al.</i> , 2010; Mukhopadhyay, 2004; Omurgonulsen, 2009; Seog Ju <i>et al.</i> , 1996; Yang, 2008; Zugarramurdi <i>et al.</i> , 2007
Costs - benefits analysis of HACCP/FSMS	Henson <i>et al.</i> , 2000; Maldonado <i>et al.</i> , 2005; Traill and Koenig, 2010
Performance and effects of HACCP/FSMS	Bai <i>et al.</i> , 2007; Doménech <i>et al.</i> , 2011; Jin <i>et al.</i> , 2008; Tomašević <i>et al.</i> , 2013

HACCP/FSMS = hazard analysis and critical control points/food safety management system.

- process control of products;
- process control of hygiene plans;
- final control of products;
- all types of external analysis and mandatory inspection testing performed in ISO 17,025 accredited laboratories (analysis covered testing of raw materials, components, packaging, final products, water and swabs from surfaces in contact with food);
- materials consumed during analysis and tests;
- medical screening of workers;
- record storage.

Failure (F) costs are considered as internal and external ones. Internal failure costs included costs that arose from nonconformities or defects at any stage of the quality loop, such as: costs of scrap, rework, retest, re-inspection and redesign, corrective actions as a result of departure from critical limits, troubleshooting or defect/failure analysis and cost of time spent in defective products revision.

External failure costs were costs that arose after delivery to customers as a result of nonconformities, defects or complaints, which included the cost of claims, returned material, warranties, product liability, cost of recall, complaints research, concession to customers and loss of sales.

In relation to the classification of quality costs, a structured questionnaire has been created and sent to the company in advance. The structured survey was conducted from March until September 2012. The management representative of the company was asked to provide the authors with their financial and QMS/HACCP documentation. Financial documentation consisted of invoices, payment track logs and a financial database of suppliers and purpose of payment. Review of QMS/HACCP documentation covered overview of production, maintenance, control and training records including records of non-conforming products, customer complaints log and list of corrective and preventive actions. Six on-site visits to the company have been performed, including e-mail and phone communication during the survey period. The data used for this research were collected, processed and analysed for a period of four years (2007-2010). Data were processed using Microsoft® Office 2007 (Redmond, VA, USA). In order to analyse quality costs and enable comparing with similar research in the food industry, two basic parameters have been calculated: the total quality costs (TQC) and the total quality cost index (TQCI).

TQC is expressed by an equation that represents the total cost per unit of product (Lupin *et al.*, 2010):

$$TQC = \Sigma C_p + \Sigma C_A + \Sigma C_f \quad (1)$$

TQC is the total value of all costs per unit of product,  $\Sigma C_p$  is the summation of all prevention costs per unit of

product,  $\Sigma C_A$  is the summation of all appraisal costs per unit of product and  $\Sigma C_f$  is the summation of all failure costs per unit of product.

TQCI is based on PAF costs and sales (BSI, 1990; Lupin *et al.*, 2010).

$$TQCI = TQC / \text{net sales} \times 100 \quad (2)$$

HACCP based food safety systems consist of HACCP plans and PRP/GHP requirements (Sperber, 1998). PRP cover control of incoming materials, product identification, training of personnel, water/energy supply while GHP requirements cover personal hygiene, pest control, cleaning and sanitation, warehouse and distribution, layout and premise structure (CAC, 2003; Celaya *et al.*, 2007; ISO, 2005c; Sperber, 1998; Wallace and Williams, 2001). The authors calculated and presented costs related to quality and costs related to food safety using the following methodology.

Food safety costs were costs related to PRPs and GHP when the main intention of these activities was only food safety. It covered design of food safety system, pest control, cleaning and sanitation, personal hygiene, medical screening, purchasing of food safety lab equipment and test kits for the plant laboratory, validation of control measures, control of water, control of swabs from surfaces in contact with food, food safety control of incoming materials.

Costs related to quality and food safety included development of quality and HACCP plans, improvement programmes, internal and external product/process controls, consulting services, internal and certification audits, training and calibration activities. Half of the costs were allocated to food safety while the other half were allocated to quality costs.

Quality related activities such as purchasing of quality related lab equipment, maintenance activities of the equipment, evaluation of suppliers, review and modification of new/modified products, nonconforming products and other failure costs related to quality requirements were calculated only as quality costs.

There were no food safety incidents and no withdrawals/recalls recorded during the analysed period so these costs were not included.

### Company case study

The company that was analysed as a 'case study' has been operating for over 20 years in the food industry. It produces fruit pastes and syrups for the ice-cream industry, fruit toppings, bakery fillings, syrups for post-mix machines and hard candy fillings, as well as refining fruit concentrates for the beverage industry. Its production facility is 1,250

m<sup>2</sup> large and is located in Eastern Serbia. The first system to be implemented by the company was a HACCP based food safety system. It was implemented during 2005 and was certified in March 2006. HACCP audit was under an unaccredited scheme performed by US certification body. During 2007, the company started implementing ISO 9001 and certified its quality management system in December 2007. In 2010, the company started upgrading its HACCP based food safety system to satisfy the requirements of ISO 22000 and certified its food safety management system in November 2010. Certification was performed by a UK certification body. The scope of all certified systems, as stated on the certificates is 'development and production of fruit and confectionery preparations.'

### 3. Results

#### Total quality costs

In the year 2006 with only the HACCP system operating, limited data were recorded that can be classified as prevention or appraisal costs, with no recorded data concerning any failure costs.

During the implementation of QMS in 2007, the company started calculating quality costs in defined categories and presented results which are more precise (Table 2). Prevention and appraisal costs were low (18.56 €/tonnes of produced product) with no failure costs recorded. At

that time, the company had a low level of understanding of customer's quality requirements and they did not have any methodology for controlling conformity of its products. This is in concurrence with similar studies confirming difficulties in collecting and estimating costs. Most companies, although ISO 9001 certified, are not aware or do not follow PAF costs with a wide range of deployment of the concept, from a simple calculation of nonconformities or complaints to the calculation of all the categories of quality costs (Colatore and Caswell, 2000; Tarí and Sabater, 2004).

In 2008, after certifying QMS, a more proactive approach was implemented, with more intensive recording of all process activities being in place. This enabled calculation of failure costs and measuring all three types of costs. In this year the total costs achieved 49.66 €/tonnes of produced product. During this year, the company not only maintained integrity of its integrated quality and food safety system but also invested in lab equipment, development of two lab methods and in additional training. External factors that affected quality costs were training activities for implementing quality tools as enforced by its customers, namely statistical process control, histograms and Pareto diagrams. Also, during this year, a second party audit was performed by one of its multinational customers and in cooperation with that customer, the company started exporting. This led to additional prevention costs in investigating quality and food safety legal requirement of neighbouring countries.

**Table 2. Financial data for the period 2007-2010.**

	2007	2008	2009	2010
Total income (€)	2,112,597.00	2,045,808.00	2,047,319.00	1,717,893.00
Total production volume (kg)	915,869.00	797,710.00	939,512.00	771,819.20
Number of employees	16	23	25	28
Income (€/employee)	132,037.31	88,948.17	81,892.76	61,353.32
Production (kg/employee)	57,241.81	34,683.04	37,580.48	27,564.97
Value of product (€/kg)	2.31	2.56	2.18	2.23
Prevention costs (€)	9,553.81	15,265.63	17,929.35	20,638.54
Quality costs (€)	5,091.09	9,114.32	12,769.76	13,740.76
Food safety costs (€)	4,462.72	6,151.32	5,159.59	6,897.78
Appraisal costs (€)	7,446.51	22,103.40	23,002.58	19,933.14
Quality costs (€)	2,549.16	4,862.05	6,264.40	5,241.06
Food safety costs (€)	4,897.35	17,241.36	16,738.19	14,692.09
Failure costs (€)	0.00	2,243.65	1,337.43	3,689.47
Quality costs (€)	0.00	2,243.65	1,337.43	3,689.47
Food safety costs (€)	0.00	0.00	0.00	0.00
Total costs (€)	17,000.32	39,612.68	42,269.35	44,261.15
Quality costs (€)	7,640.25	16,220.01	20,371.58	22,671.29
Food safety costs (€)	9,360.07	23,392.67	21,897.78	21,589.86
Costs/tonnes (€/1000 kg)	18.56	49.66	44.99	57.35
Total quality cost index	0.80%	1.94%	2.06%	2.58%

After stabilizing the system in 2009, the company achieved improvements in regards to its costs. They decreased to 44.99 €/tonnes of produced product, and the company started exporting to the EU. There were no additional requirements by their customer that required any investments and development of the integrated management system.

The year 2010 was a year when several changes occurred. Due to the economic crisis, production volume decreased for 17.85%. As a result, PAF costs rose to 57.35 €/tonnes of produced product. External factors were customer demands to upgrade HACCP based food safety system to ISO 22000 which resulted in investing for additional consultancy and certification as well as legal and customer requirements to perform additional analysis for every batch of final product.

### Structure of quality costs

In four observed years, the structure of PAF costs changed (Figure 1). Prevention costs increased over time while appraisal costs decreased, proving Feigenbaum's models that the structure changes. The increase of prevention costs is related to new customer requirements and more quality planning. The decrease in appraisal costs structure is expected since mature quality and food safety systems have the ability to reduce all types of controls both internal and external (Lupin *et al.*, 2010). Although the company implemented some statistical tools and improved its control process, sampling procedures for inspection of attributes, variables and bulk materials is not performed according to statistically reliable methods as outlined in ISO standards (ISO, 2000, 2005a, 2006a). Failure costs increased in 2010, the final observed year, as a result of changing food safety conformity level required from customers and the new Serbian legislation. This confirms that the exact relation between the components of quality costs is not easily determined, because it may change from one system to another depending on the nature of the business, on

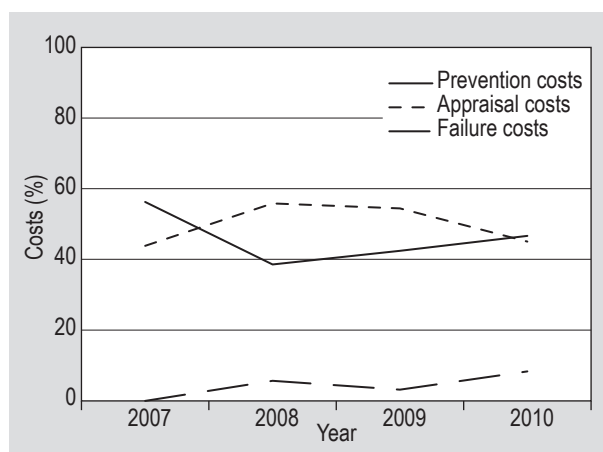


Figure 1. Structure of prevention, appraisal and failure costs.

legislation and on customer requirements (Liang-Hsuan and Ming-Chu, 2002).

### Total quality cost index

TQCI, shows that this index increased from 1.94% in 2008 to 2.58% in year 2010. In every country, geographic area or food chain link, HACCP and other systems are influenced by a complex set of factors (Taylor and Kane, 2005). However, theoretical models expect that over time, as quality systems mature the TQCI decreases. In calculating and comparing quality costs in food companies, various parameters influence the costs: scope of food business, salaries, raw materials, environment, legislation and business drivers. The objective of the food industry is to produce food in a sustainable way, satisfying all stakeholders (Omurgonulsen, 2009).

### Allocation of costs

Allocation of costs related to food safety and costs related to quality is presented in Figure 2. Food safety costs participate slightly above half of the total costs in the first three years. Only in the last year, quality related costs were higher than food safety costs. Extended food chain of different transparency, consumers using food and food ingredients from distant regions, development of new products and technologies, changes in consumers' habits and food consumption patterns, new food safety risks are some of indicators showing that the food industry is a risk based industry assuming changes in allocation of quality and food safety costs.

## 4. Discussion

In the case of this fruit processing company, the results are somewhat different from the theoretical model, but not unexpected for the following reasons.

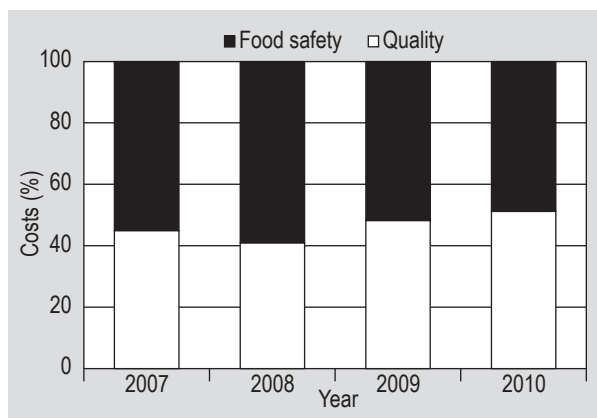


Figure 2. Distribution of quality and food safety costs.

Complexity of food safety and quality requirements imposed by customers' increases while organisational knowledge decreases and time for fulfilling the requirements shortens. To stay competitive, implementation and maturation of the systems causes investments in quality and food safety resulting in the increase of total quality costs.

With the certification of HACCP and QMS, companies expect to enhance certain financial benefits through improvement of the quality of products. The product price and sales volume did not increase in the four year period. Due to the economic crisis, the sales volume in 2010 in comparison to 2008 decreased by 16%. The average sales price in 2010 amounted 2.23 €/kg which is lower than in 2007.

Prevention cost increased which is expected, while an increase in appraisal cost was not expected. Many authors (e. g. Gall, 2000; Lupin, 2010; Saita, 1991) point out that a fall in appraisal cost could be assumed after implementation of HACCP. In the observed company this did not happen due to the fact that prices of external products' analyses significantly increased, starting from November 2007 when Serbia signed the Stabilization and Association Agreement with the European Union. As a result, the Serbian government enforced various activities within the food industry to comply with EU requirements and promote export of food to this market (EC, 2012). One of the activities was legal enforcement of additional, more strict and complex food product analyses in Serbia.

Failure costs increased also as a result of additional quality requirements and better understanding of customers and their requirements. Prior to implementation of QMS, the company did not recognise that a nonconformity is non-fulfilment of any requirement (ISO, 2005b). After second party audits, the company learned that any non-fulfilment related to the product should be recorded and calculated as a cost. This resulted in significant improvement of quality control but also in more precise recording of failure costs.

## 5. Conclusions

Since the company implemented QMS, quality costs are at the level between 45 and 57 €/tonnes of product. The costs vary due to several factors – economic crisis, additional customer demands and new legal requirements. As the system matures, prevention costs increase while appraisal costs decrease. The structure of the quality costs shows that share of failure costs increased due to better recording and higher and stricter quality and food safety requirements introduced by customers. The total quality costs do not decrease since customers change and expand their requirements to stricter ones. Results of our research confirmed that TQCI value fell within the published range of values for the food industry. The TQCI index shows the

tendency of growth, mainly because of the decrease of net sales in the analysed period. During the observed period, quality-related and food safety-related costs participated almost equally.

Limitations of the research stem from the fact that results were obtained from one company thus should not be generalised. Given the great technological and other differences within various food industries, more research is necessary to determine if similar results would be derived from different companies across other food industries in Serbia. This study did not attempt to specify the hypothesis regarding profile of an average Serbian company operating in the fruit processing industry.

The authors believe that future research should focus on specifying quality costs related to the food industry to be measured in companies in order to obtain consistent and comparable results, analysis of the correlation between maturity of quality and food safety systems, usage of various quality and statistical tools and enforcement of business drivers in analysing possible TQC patterns related to specific food industries.

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