

Food safety management system implementation and certification: survey results

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The worldwide implementation and certification of food safety management systems (FSMS) have increased significantly during the last few years, thus reflecting the importance of assuming these standards in some activity sectors. Based on the literature review carried out, there are a large number of research projects that have been conducted in this area. However, as far as Portugal is concerned, the nationwide research projects related to ISO 22000 are scarce. Therefore, this paper reflects what we believe to be a pioneering contribution in order to study FSMS adoption by Portuguese companies. In more detail, our aim is to provide fact-based insights, among others, into the following issues: (1) What are the motivations and benefits of ISO 22000 certification? (2) What are the main obstacles, difficulties and drawbacks of ISO 22000? (3) What are the benefits and costs directly related to the food management system implementation, certification and maintenance? (4) What are the market evolution perspectives of the food management system? In order to answer these questions, we used a research methodology that was based on a survey that was e-mailed to the ISO 22000-certified Portuguese companies.

Keywords: ISO 22000; food safety management systems; survey

1. Introduction

The safety of food products was affected by successive crises in the food chain during previous years. As a way of re-establishing the confidence of consumers, it is important that food organisations prevent this kind of situation.

The increasing concerns related to food safety among consumers have been addressed by competent authorities, through the publication of communitarian legislation and the ISO 22000: 2005.

In September 2005, the International Organization for Standardization (ISO) published the ‘ISO 22000: 2005 standard – food safety management systems (FSMS) – requirements that are applicable to any organisation in the food chain’. This standard integrates the requirements defined by ISO 9001 and the methodology used by hazard analysis and critical control points (HACCP).

Based on the literature review carried out, we were able to observe that there were a lot of studies related to FSMS implementation and certification, mainly related to HACCP. However, as far as Portugal is concerned, the research projects that been conducted regarding this issue are scarce. Thus, our aim was to conduct a research project in order to study the ISO 22000 adoption by Portuguese food companies.

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The main goals of this work are as follows:

- To identify the motivations of ISO 22000 implementation and certification.
- To identify the benefits and difficulties of ISO 22000 implementation.
- To identify the market evolution perspectives of ISO 22000 implementation.
- To identify the costs and benefits directly related to the implementation and certification of FSMS.

In order to address these issues, we conducted a large-scale survey among all the ISO 22000 Portuguese companies.

This paper proceeds as follows. First, we present a brief literature review related to FSMS implementation and certification. Then, we highlight some methodological aspects that were considered in the project, including the research methodology that was used and the questionnaire reliability and validity tests. Finally, we conclude with the analysis and discussion of the information gathered, followed by general conclusions and suggestions for future research.

2. Literature review

ISO 22000: 2005 standard is based on the Codex Alimentarius HACCP principles and it was developed by lining up with the ISO 9001 standard in order to improve the compatibility and integration with the quality management standard.

In the group of enterprises with the HACCP system in full operation, there was advanced voluntary implementation. Also, the prior adoption of ISO 9000 had a direct influence on the implementation of HACCP for these firms. For implementation, it is important that enterprises have the information necessary to concretely evaluate the magnitude of the costs in each type of plant prior to implementation (Maldonado et al., 2005).

In practice, HACCP application in regulation consists of elements of process, performance and information standards. In the European Union, it replaces a more prescriptive regulation specifying good manufacturing practices (GMPs) and thus gives firms greater flexibility.

The HACCP system has been used as one of the most effective approaches to ensure high quality and safety of food, from the standpoint of human health. However, its success and effectiveness in disease prevention and health risk reduction in consumers depends on the correct application of its principles, in combination with other programmes, including the security of the infrastructure and 'GMP' and 'good hygiene practice' programmes (Roberto, Brandão, & Silva, 2006).

The identified critical control point (CCP) numbers interfere directly with the resources necessary to implement, develop and maintain an HACCP plan. The reduction in the identified CCP numbers resulted in a decrease in the cumulative cost after the fourth month. Thus, the estimated costs for the implementation and maintenance of an HACCP plan considering the previous compliance of industry to the pre-requisites were lower than those for the implantation of an HACCP plan without compliance with the GMP/ Sanitation Standard Operational Procedures pre-requisites. This fact emphasises the importance of a solid pre-requisite programme (PRP) to improve the economic viability for HACCP implementation (Roberto et al., 2006).

The implementation and maintenance of the HACCP system can be enriched if the company takes the whole experience of the other implemented management systems into consideration. If the company has other management systems implemented, the HACCP system should be integrated with the company's management system. According

to the ISO 22000 standard, the FSMS will be more effective if established, operated and updated within the framework of a structured management system and if integrated in the overall organisation management activities. Thus, there will be a maximum benefit for the organisation and stakeholders.

An ISO 22000-certified organisation demonstrates the ability to provide safe products, in accordance with government requirements and regulations and consumer needs, promoting continuous improvement.

There is confusion regarding PRPs and HACCP plan, their relations and how they should be managed. This becomes worse due to the lack of specific hazard analysis. The reasons for this confusion are the negative guideline factors and lack of understanding, and it is difficult to say which barrier occurs first. As all this occurs among industry personnel and external consultants, it generates a barrier of negative external factors. The administration should plan actions in order to develop clear and detailed guides in Spanish for HACCP system, with special attention being paid to hazard analysis and PRPs and their relation to the HACCP plan.

The food safety scientific literature suggests that the success of the development, implementation, monitoring and verification of an HACCP system depends on the commitment and involvement of the top management and on the way how the company overcomes the technical and organisational obstacles. Potential barriers to system implementation should be identified and analysed (Bas, Yuksel, & Cavusoglu, 2007).

The monitoring of the GMPs, the good hygiene practices and the HACCPs and production systems should be done to ensure food safety (Bas et al., 2007). Additionally, if possible, an FSMS should be integrated with the quality management one, thus reflecting the implementation of all stages of the food production chain – ‘from farm to table’ (Bas et al., 2007).

The use of risk analysis based on the CCPs and on the following seven internationally accepted principles – (1) conduct a hazard analysis, identify significant hazards and describe the preventive measures, (2) identify the CCPs in the process, (3) establish critical limits for preventive measures associated with each identified CCP, (4) institute CCP monitoring requirements and procedures to maintain process control, (5) enact corrective actions based on the established critical limits, (6) set up effective record-keeping procedures that document the company’s HACCP system and (7) install controls to verify that the HACCP system is working – is promoted by the Codex Alimentarius Commission (Bas et al., 2007).

Unlike the quality systems, the HACCP system is a preventive one in which food safety can be designed into the product and the process by which it is produced. It is a system of product design and process control. The HACCP system of food safety is very effective in controlling the identified hazards. Most importantly, it does not rely upon product testing to assure food safety.

Over the next three decades after its implementation, the HACCP system spread into the food processing industry of the USA and into other countries. Towards the end of this period, government regulatory agencies began to replace their inspection programmes, based on infrequent plant visits, with audit programmes, based on a review of continuous HACCP records, a development that led to the promulgation of several HACCP-based food safety rules.

During the 1990s, the National Advisory Committee on Microbiological Criteria for Foods and the Codex Alimentarius Commission Committee on Food Hygiene expanded the early HACCP applications and published documents on HACCP principles and guidelines for their implementation (Sperber, 2005).

The perspective of quality in the food industry is much more subjective than that of durable goods. While for durable goods quality can be objectively measured (life, maintainability, conformance to design specifications, etc.), in the food industry, quality is largely a matter of taste and preference. Thus, quality in the food industry is often based on what the consumers will buy, but not on the judgement of experts and connoisseurs (He and Hayya, 2002).

A large number of studies have analysed the impact of the implementation of an FSMS in organisations in different countries – Canada (Jayasinghe-Mudalige and Henson, 2007), Italy (Romano, Cavicchi, Rocchi, & Stefani, 2004) and Australia (Khatri & Collins, 2007). This could reflect the fact that there is a paucity of research studies on factors relevant to the successful implementation of an FSMS because the majority of the studies that have been conducted so far have mainly focused on how to implement the HACCP component of international standards without considering factors relevant to the whole system implementation. However, Trienekens and Zuurbier (2008) stated that adequate information should be available for planning, execution and monitoring functions. In addition to this, management support is also essential for successful implementation.

Ten years after the publication of the white paper on food safety of the European Commission, food business operators (FBOs) have made large efforts and investments in designing and implementing an FSMS in order to comply with requirements of the different stakeholders and to deliver safe food products (EU, 2000; Karipidis, Athanassiadis, Aggelopoulos, & Giompliakis, 2009; Küpper & Batt, 2009; Soderlund, William, & Mulligan, 2008). One of the challenges for FBOs is combining the requirements from the different stakeholders (e.g. governmental and hygiene legislation, retailers and consumer demands) into a company-specific and customised FSMS. An FSMS usually contains the elaboration of PRPs and HACCPs (Jacxsens, Devlieghere, & Uyttendaele, 2009). Furthermore, the European Union hygiene legislation (e.g. EU Regulation 853/2004) points out the hygiene and food safety objectives, but does not state as to how to achieve them.

This situation is different from that related to the revoked European legislation (EU Directive 2004/41), where detailed requirements were set regarding good practices (e.g. holding times, temperatures, etc.). The current FSMS are organised differently by individual food businesses and are audited by an external party. After an audit, the improvement opportunities that had been identified should be implemented (Jacxsens et al. 2009; Luning & Marcelis, 2009).

However, there is a need for tools to help the FBOs to diagnose and improve their FSMS. This is especially so for small and medium enterprises, as they do not always have the necessary skills (e.g. expertise), experience and/or resources (e.g. financial and staff capabilities) (Aggelogiannopoulos, Drosinos, & Athanasopoulos, 2007; Karipidis et al., 2009; Lo & Humphreys, 2000; Yapp & Fairman, 2006). While implementing an FSMS, the lack of financial and human resources together with high costs, the low personnel skills and time restrictions together with a general lack of knowledge and experience (Aggelogiannopoulos et al., 2007; Karipidis et al., 2009; Mondelaers & Van Huylenbroeck, 2008) are major constraints. Furthermore, according to Semos and Kontogeorgos (2007), Küpper and Batt (2009) and Aggelogiannopoulos et al. (2007), the lack of information and the insufficient support and guidance as well as the lack of management and employee commitment promote a lack of confidence in the system. Thus, companies should be really involved and motivated regarding the FSMS in order to achieve real and global benefits from it.

3. Research methodology

Our research methodology was supported by various phases as shown in Figure 1.

Based on the literature review carried out, we defined our research questions and we developed the first version of the questionnaire (draft one). This version was tested in January 2010 with the aim of identifying the issues that needed to be improved. This phase took place in a Portuguese consultancy company that implements FSMS according to the ISO 22000 standard.

Based on the suggestions and comments that have been collected during the pre-test phase, we improved the questionnaire and its final version was sent by e-mail to 144 ISO 22000-certified companies. The response rate was 37% (62 valid questionnaires).

The questionnaire consisted of six groups of questions. In the first group, our aim was to collect general information related to the respondent company (company's dimension and activity sector, if the company had integrated the ISO 22000 standard with other management standards, etc.). In the second group, our aim was to identify the motivations that lead the Portuguese organisations to implement and certify an FSMS according to the ISO 22000 standard. In the third group, our aim was to identify what have been the most important benefits derived from FSMS implementation. In the fourth group, we studied the difficulties and drawbacks of implementation. Additionally, companies had to identify which of the standard clauses and sub-clauses had been more difficult to implement. In the fifth group, we determined the costs of implementation and certification and evaluated the impact of ISO 22000 certification on the final consumer. Finally, in the sixth group, we tried to evaluate the evolution perspectives concerning ISO 22000 certification.

The scale adopted in the questionnaire was a five-point Likert scale.

4. Results

In this section, we present the main results of this research. The SPSS package version 18.0 was used to analyse the data.

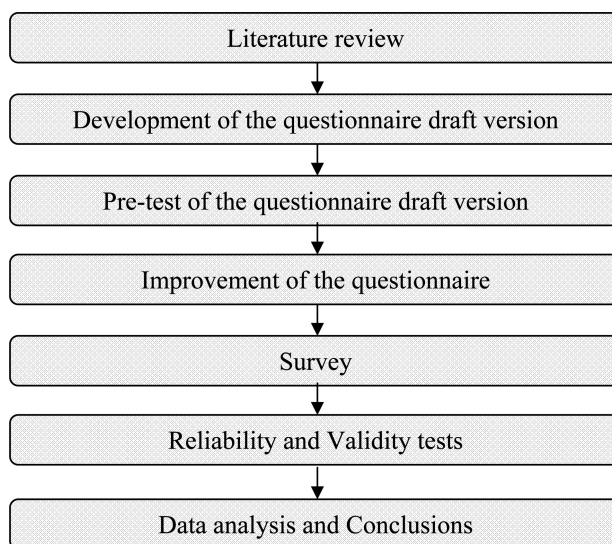


Figure 1. Research methodology.

4.1. Questionnaire Reliability and Validity

The questionnaire reliability and validity (content and construct) were tested. Reliability was assessed using Cronbach's alpha coefficient, which represents a measure of the questionnaire's internal consistency. Content validity and construct validity were also assessed.

Construct validity was tested using the 'principal components analysis'. The criterion that was used to retain the components in one group was the latent root, which considers a component for inclusion if its eigenvalue is greater than unity. Additionally, the Kaiser–Meyer–Olkin (KMO) indicator was calculated to assess sample size adequacy. The minimum acceptable level was 0.5 (Brash, 2002). The KMO scores for ISO 22000 areas of impact and evolution perspectives were, respectively, 0.63 and 0.709. As shown in Tables 1–5, we were able to extract three components in the benefits section and two components in the evolution scenarios section.

Cronbach's alpha, which represents the ratio between the true and observed variances (Yu, 2002), was used to measure the questionnaire internal consistency. A low value of alpha indicates that the data are not homogeneous or that the sample of items performs poorly in capturing the construct or component (Churchil, 1979). An acceptable Cronbach's alpha should be greater than 0.7 (Husain, 2001). With the exception of the 'human resources' benefits, the remaining do present a Cronbach's alpha greater than 0.7, thus reflecting that the questionnaire has internal consistency and that the scales are reliable (Tables 1–5).

Content validity is always subjectively evaluated by the researcher (Churchil, 1979). An instrument has content validity if it contains a representative collection of items and if sensible methods of the test construction are used (Yusof & Aspinwall, 2000). The questionnaire was designed after an extensive literature review and was based on comments

Table 1. Management benefits component.

Benefits	Cronbach's alpha
Cost reduction was verified	0.740
The system implementation and certification had allowed the company access to new markets	
Increase in the sales volume was verified	
Increase in the product shelf time was verified	

Table 2. Product benefits component.

Benefits	Cronbach's alpha
Reduction in food risks was verified	0.685
The product became safer	
The number of potential unsafe products decreased	

Table 3. Human resources benefits component.

Benefits	Cronbach's alpha
The collaborators are more committed to hygiene and food safety aspects	0.335
The collaborators are highly motivated	

Table 4. Component 1 for food safety evolution scenarios.

Evolution scenarios	Cronbach's alpha
Stagnation of the importance of food safety aspects/increase in the importance of food safety aspects	0.777
Stagnation of the importance of the Autoridade de Segurança Alimentar e Económica (ASAE)/Associação Nacional de Empresas de Segurança Alimentar (ANESA) in the diffusion of the food safety theme in Portugal/increase in the importance of the ASAE/ANESA in the promotion of the food safety theme in Portugal	
Reduced importance of food safety aspects in the Portuguese political agenda/increase in the importance of food safety aspects in the Portuguese political agenda	
Decrease in the credibility of food safety aspects/increase in the credibility of food safety aspects	

Table 5. Component 2 of food safety evolution scenarios.

Evolution scenarios	Cronbach's alpha
Diffusion of food safety standards/convergence for global and integrated food safety standards	0.802
Application of the FSMS current verification and improvement tools/development of new tools and methodologies	
Food safety professionals with low skills/food safety professionals with high competence and efficiency	

and suggestions of academics and company managers. Furthermore, the questionnaire was pre-tested and suggestions of the respondents were incorporated into the final design.

A test for possible bias from the respondents was also performed (Armstrong, 1977). The completed questionnaires were divided into two groups. The first group comprised those answered by the earlier respondents (40 questionnaires) and the second group comprised those answered by the latter ones (22 questionnaires). If there were significant differences between the characteristics of the answers of these groups, the same should be expected among the non-respondents, because extrapolation methods are based on the assumption that subjects who respond less readily are more like non-respondents. It would be unwise to generalise the findings of this study if the non-respondents had characteristics that were different from of the ones who had responded. No significant differences were detected, allowing us to conclude that the non-respondents had characteristics that were similar to those of the respondents.

4.2. General characterisation of the organisations

Figure 2 illustrates the organisation sample of our research. As had been verified, the majority of the surveyed companies were of medium dimensions (51.6%) – number of employees between 50 and 249.

Concerning the companies' activity sector, the majority of the respondent companies belonged to the group 'manufacture of other food products' (25.8%).

Furthermore, we surveyed the companies in order to determine if they had a certification in addition to the ISO 22000 one. Sixty-eight percent of the companies were certified according to other standards and 36% did present a certified quality management system.

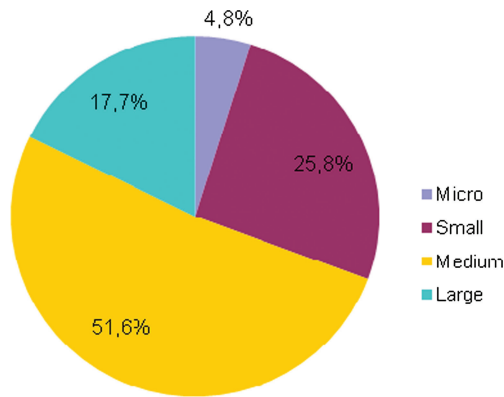


Figure 2. Company dimension.

As shown in Table 6, the majority of the companies became ISO 22000 certified in 2008 (27.4%) and 2009 (26.8%).

4.3. Motivations for ISO 22000 certification

As shown in Figure 3, the most important ISO 22000 motivation of the surveyed companies was ‘to guarantee the confidence of the consumers’ with a score of 50%, followed by ‘customer requirement’ (33.8%). ‘Market differentiation’ and ‘involvement in and commitment to the food chain in the product safety’ were also reported as important motivations for those companies that implemented an FSMS according to ISO 22000 standard with scores of, respectively, 32.3% and 32.2%. According to the results obtained, one could conclude that the most important ISO 22000 motivation among the certified Portuguese companies was of internal nature.

Based on the Pearson correlation coefficient, we verified if there was a significant statistical correlation between the ISO 22000 implementation motivations and the company dimension. Table 7 shows that the ‘cost reduction’ motivation is statistically correlated (positively), with a significance level of 0.05, with the company size.

4.4. Benefits of ISO 22000 certification

In Figure 4, the benefits of ISO 22000 certification are presented. As illustrated in the figure, the most common ISO 22000 benefit cited by the inquired companies was ‘improvement in food safety methodologies and practices and management system-related documentation’ (50%), followed by ‘improvement in customer satisfaction and

Table 6. Certification year.

Year	No. of organisations	(%)
2005	4	6.5
2006	5	8.1
2007	9	14.5
2008	17	27.4
2009	16	25.8
2010	5	8.1

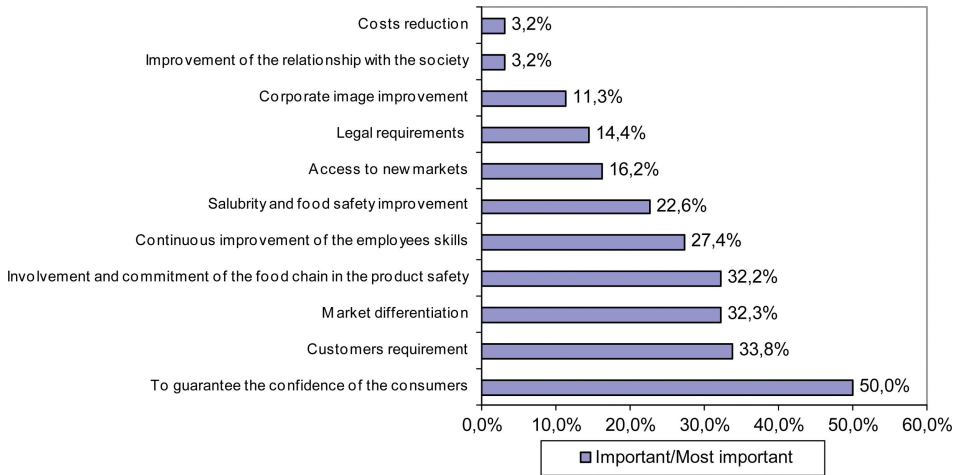


Figure 3. ISO 22000 certification motivations.

Table 7. Motivations versus size of the organisation.

Motivations shown in Figure 3	Pearson correlation coefficient	p-Value
Salubrity and food safety improvement	0.104	0.423
Differentiation in the market	0.017	0.895
Improvement in the relations and communication with the community	0.115	0.372
Reduction in costs	0.270	0.034
Involvement of all the food chains in the commitment to guarantee the security of the product	0.194	0.131
Fulfilment of the applicable legal requirements	0.097	0.451
Access to new markets	-0.153	0.235
Fulfilment of the requirements of the customers and other interested parties	0.169	0.189
Continuous improvement in the abilities	0.097	0.452
Guaranteeing the confidence of the consumers	0.093	0.470
Improvement in the corporative image	0.179	0.165

other interested parties’ satisfaction’ with a score of 32.2%. As verified for the ISO 22000 certification motivations, the most important benefit stated by the respondent companies was of internal nature.

Tables 8–10 present the areas where FSMS implementation had more impact. After the implementation of the system, the company workers had become more food safety oriented (4.50). Additionally, the product became safer (3.87), a decrease in the food risks (3.77) was verified and the company workers became more motivated (3.69). According to the respondent companies, FSMS implementation had no significant impact over the product shelf time (2.00).

From Table 11, it can be seen that there was a significant positive correlation between the ‘reduction or elimination of unsafe products’ and ‘improvement in food safety methodologies, practices and documentation’ motivations and company dimension.

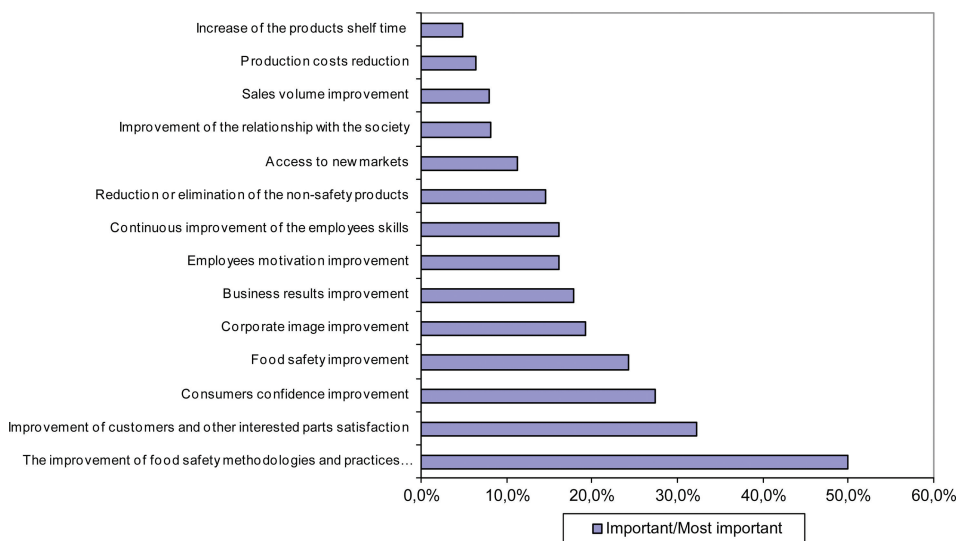


Figure 4. ISO 22000 certification benefits.

Table 8. FSMS impact.

Benefits	Average	Standard deviation
FSMS implementation and certification allowed access to new markets	3.02	1.408
Increase in the sales volume was verified	2.52	1.264
Reduction in the costs was verified	2.35	1.294
Increase in the shelf time of the products was verified	2.00	1.255

Table 9. Food safety product impact.

Benefits	Average	Standard deviation
The product became safer	3.87	0.877
Decrease in food risks was verified	3.77	1.015
The number of non-conforming products decreased	3.39	1.178

Table 10. Food safety human resources impact.

Benefits	Average	Standard deviation
The workers are more food safety oriented	4.50	0.594
Increase in workers' motivation was verified	3.69	0.934

4.5. Difficulties of ISO 22000 certification

In this section, we analyse the most important difficulties and drawbacks of the ISO 22000 certification. As illustrated in Figure 5, the most cited difficulty of the surveyed companies

Table 11. Benefits versus size of the organisation.

Benefits shown in Figure 4	Pearson correlation coefficient	p-Value
Reduction or elimination of potentially unsafe commodities	0.270	0.033
Increase in the volume of sales	0.108	0.402
Reduction in the production costs	0.150	0.245
Increase in the motivation of the collaborators (including the top management)	0.073	0.571
Improvement in the practical issues of food security and the existing documentation	0.393	0.002
Improvement in the relations and communication with the community	0.101	0.435
Increase in the business chances	-0.060	0.644
Increase in the shelf time of the commodities	0.221	0.084
Improvement in the image of the organisation	-0.078	0.548
Increase in safety product	0.050	0.701
Increase in the confidence on the part of the consumers	-0.121	0.348
Increase in the satisfaction of the clients and other interested people	-0.062	0.630
Continuous improvement in the abilities	0.174	0.177
Access to new markets	0.199	0.124

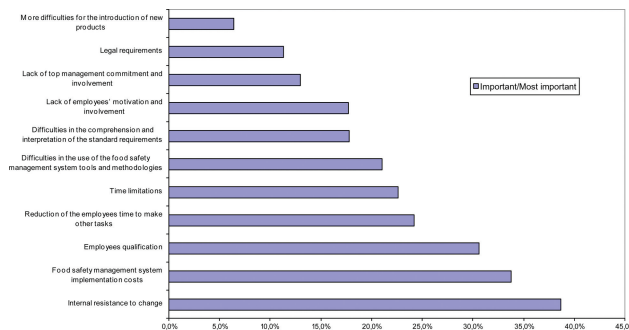


Figure 5. FSMS implementation difficulties.

was the ‘internal resistance to change’, with a score of 38.7%, followed by ‘FSMS implementation costs’ (33.8%) and ‘employees’ qualification’.

Concerning the implementation difficulties, there was a significantly negative statistical correlation between the ‘FSMS implementation costs’ and the company dimension and a positive one between the difficulty related to the introduction of new products and the company size (Table 12).

4.6. Difficulties in ISO 22000 clause implementation

Concerning the difficulty level of the implementation of ISO 22000 clauses, we were able to find the following top five factors: ‘verification plan’ (37.1%), ‘hazard analysis’ (33.9%), ‘human resources competence, awareness and qualification’ (30.6%), ‘implementation of an HACCP plan’ (25.8%) and ‘monitoring and measurement control’ (22.6%).

Table 12. Difficulties versus size of the organisation.

Difficulties shown in Figure 5	Pearson correlation coefficient	<i>p</i> -Value
Necessities for the formation of collaborators	0.228	0.074
Lack of motivation and involvement on the part of the collaborators	0.086	0.507
Costs associated with the implementation of ISO 22000	-0.272	0.032
Reduction in the time available to the collaborators for the accomplishment of other tasks	0.010	0.937
Reduction in the flexibility for the introduction of new commodities	0.262	0.042
Lack of involvement of the top management	0.058	0.652
Difficulties in understanding and interpretation of the requirements of the norm	0.195	0.128
Applicable fulfilment of the legislation and requirements	0.167	0.195
Limitations in time terms	-0.146	0.259
Existence of internal resistance to changes	0.157	0.223
Difficulty in the use of the verification tools and improvement of the FSMS	0.210	0.102

Based on Table 13, we could identify a significantly negative statistical correlation between the registered firm size and the 'product details' clause.

4.7. *FSMS benefits and company dimension*

In this section, we analyse if the FSMS benefits are related to the company dimension, in terms of the number of employees, for a significance level of 5%.

Table 13. Clauses/sub-clauses versus size of the organisation.

Clauses/sub-clauses	Pearson correlation coefficient	<i>p</i> -Value
<i>Management commitment</i>		
Food safety policy	-0.076	0.556
Planning of FSMS	-0.036	0.780
Communication	0.216	0.092
Competence, awareness and training	0.198	0.123
Document control	-0.025	0.849
Record control	-0.009	0.947
Safety product planning and realisation	-0.143	0.268
PRPs	0.221	0.085
Product characteristics	-0.302	0.017
Hazard analysis	-0.056	0.665
Implementation of an HACCP plan	0.135	0.294
Verification plan	-0.083	0.522
Monitoring system	0.174	0.177
Control of non-conformity	-0.161	0.212
Determination of corrective actions	-0.050	0.700
Treatment of potentially unsafe products	0.016	0.902
Control of monitoring and measurement	0.151	0.243
External audit	-0.240	0.060
Updating of FSMS	-0.161	0.212

From Table 14, it can be seen that there were significant statistical differences between micro and large companies concerning the access to new markets after the implementation and certification of the system. The average score was higher for the medium-sized companies (2.97) than for the large ones (2.45), allowing us to conclude that this is more beneficial for medium-sized companies.

Table 15 shows that there were significant statistical differences between micro (2.67) and small (3.81) companies and between micro (2.67) and medium (3.81) companies concerning the reduction in the food risks. According to the average values, the importance of this benefit increases with the company dimension.

As shown in Table 16, there were significant statistical differences concerning the commitment and involvement of the employees in the hygiene and food safety issues between the micro and medium companies and between the micro and large ones. The employee commitment was higher in the medium (4.56) and large (4.73) companies than in the micro ones (3.67).

4.8. Direct costs and financial benefits related to FSMS implementation and certification

The direct costs related to FSMS implementation and certification include employee qualification and training, technical support, ISO 22000 certification and equipment calibration.

Table 14. The results of the Student *t*-test for management impact category.

Benefits	Companies	Student's <i>t</i>	<i>p</i> -Value
Cost reduction was verified	Micro/large	-0.600	0.560
The system implementation and certification had allowed the company access to new markets	Micro/large	2.269	0.043
Increase in the sales volume was verified	Micro/large	0.389	0.704
Increase in the product shelf time was verified	Micro/large	-0.714	0.489

Table 15. The results of the Student *t*-test for product impact category.

Benefits	Companies	Student's <i>t</i>	<i>p</i> -Value
Reduction in food risks was verified	Micro/small	-2.489	0.023
The product became safer	Micro/small	2.048	0.056
The number of potential unsafe products decreased	Micro/small	0.718	0.482
Reduction in food risks was verified	Micro/medium	-2.466	0.019
The product became safer	Micro/medium	1.820	0.078
The number of potential unsafe products decreased	Micro/medium	0.435	0.666

Table 16. The results of the Student *t*-test for human resources impact category.

Benefits	Companies	Student's <i>t</i>	<i>p</i> -Value
The collaborators are more committed to hygiene and food safety aspects	Micro/medium	-2.625	0.013
The collaborators are highly motivated	Micro/medium	0.454	0.653
The collaborators are more committed to hygiene and food safety aspects	Micro/large	-3.342	0.006
The collaborators are highly motivated	Micro/large	0.350	0.732

As shown in Figure 6, 41.9% of the surveyed organisations did present implementation and certification costs less than €15,000.

Concerning the maintenance costs (equipment and technology, employee qualification and training, consultancy, certification and equipment calibration), 62.9% of the companies had stated costs less than €15,000 (Figure 7).

Additionally, we also analysed if the companies needed to implement any technological or equipment change as a result of FSMS implementation. As shown in Figure 8, 35.5% of the surveyed companies had indicated that they had implemented technological changes with a total cost of less than €15,000.

Concerning the financial benefits that were directly derived from FSMS implementation and certification, 75.81% of the companies stated that they were not able to quantify these improvements. Concerning the firms that were able to do this, as shown in Figure 9, the majority of them had reported financial benefits of less than €15,000 (11.3%).

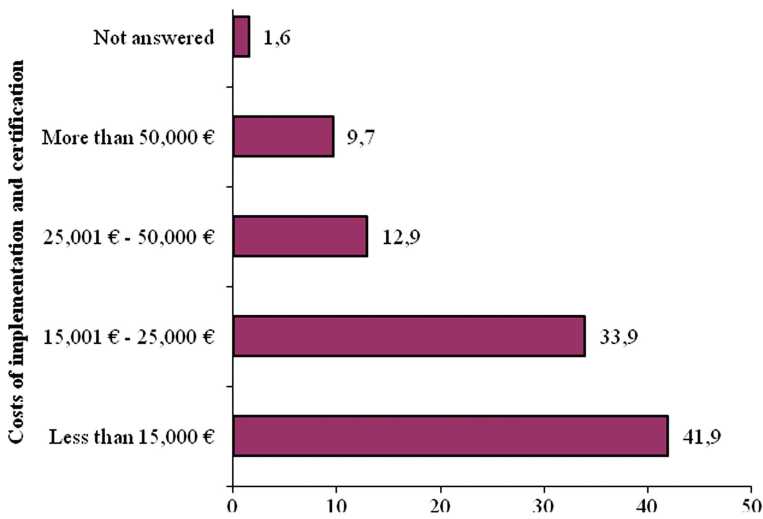


Figure 6. ISO 22000 implementation and certification costs.

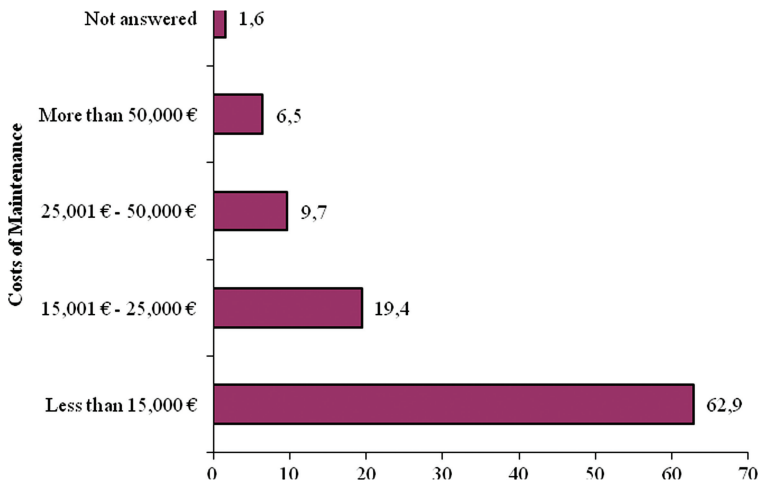


Figure 7. ISO 22000 maintenance costs.

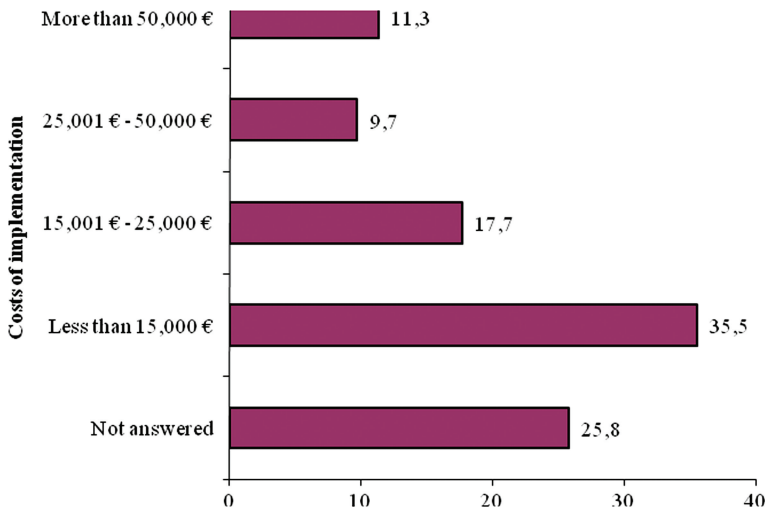


Figure 8. Implementation costs related to technological or equipment changes.

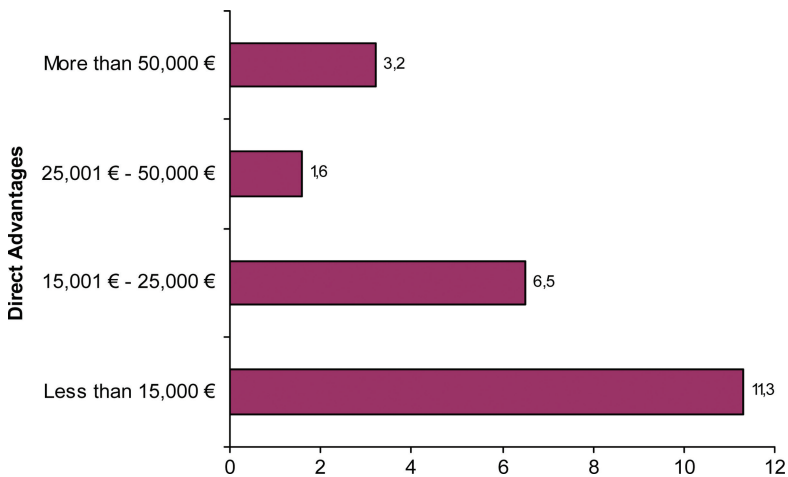


Figure 9. ISO 22000 implementation and certification financial benefits.

It is important to point out that 64.5% of the companies had achieved the expected benefits as a result of FSMS implementation. The organisations that did not achieve the expected benefits had given the following reasons: ‘the markets do not recognise the importance of ISO 22000 certification’ (9.7%), ‘the implementation and maintenance costs are higher than the benefits obtained’ (6.5%) and finally the ‘increase in the bureaucracy as a result of the FSMS implementation’ (3.2%).

In total, 53.2% of the companies stated that the benefits derived from ISO 22000 implementation were higher than the cost associated and 40.3% stated that ISO 22000 had an effect on the final consumer perspective.

Based on all the work developed in this project, we were able to derive the conceptual map illustrated in Figure 10, which is an attempt made to describe all the aspects related to FSMS adoption, implementation, certification and maintenance.

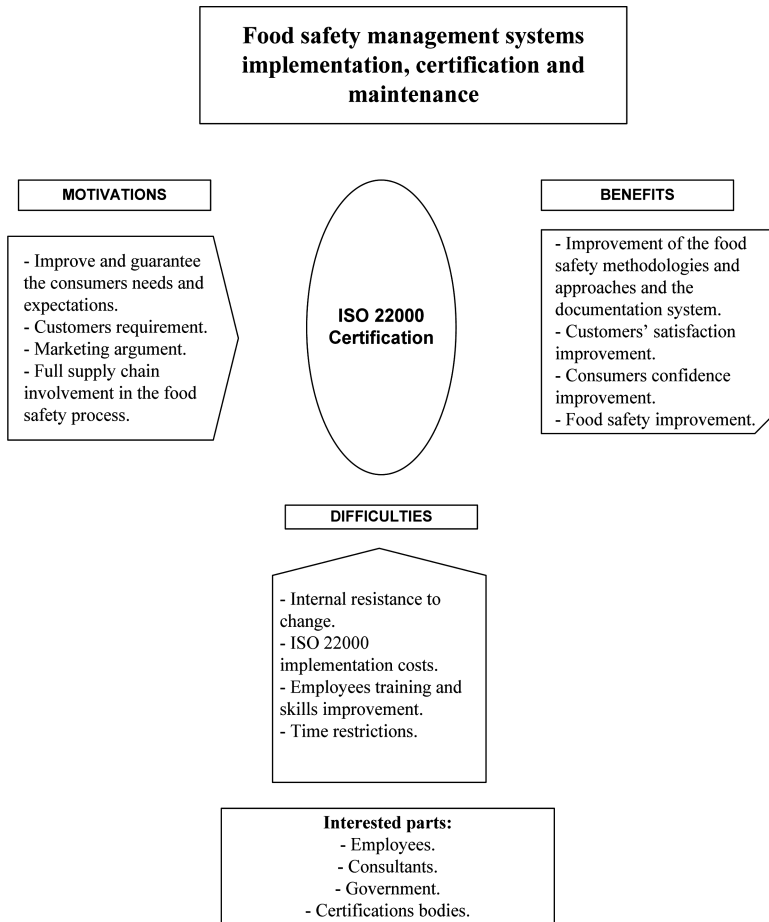


Figure 10. FSMS adoption, implementation, certification and maintenance.

4.9. The future of FSMS certification in Portugal

In the last section of the questionnaire, we analysed the ISO 22000-certified companies' perception concerning the future of FSMS. Thus, we were able to verify that, on average, for all the proposed scenarios, the companies' perception was more oriented towards the positive scenario (right side of Figure 11). With the exception of the 'application of the FSMS current verification and improvement tools/development of new tools and methodologies' scenario, the remaining did present average scores greater than 5.00. The scenario with the highest average score (8.40) was 'stagnation of the importance of food safety aspects/increase in the importance of food safety aspects'.

Additionally, we performed a set of statistical tests in order to verify if the companies' perception concerning the future of food safety depends on their dimension. We used a significance level of 5%.

As shown in Table 17, significant statistical differences were reported between small and medium companies for the scenario 'decrease in the importance of food safety aspects in the Portuguese political agenda/increase in the importance of food safety aspects in the Portuguese political agenda'. For the medium companies (6.97), the involvement of the

Diffusion of food safety standards					Convergence for global and integrated food safety standards				
1	2	3	4	5	6.92	7	8	9	10
Application of the food safety management systems current verification and improvement tools					Development of new tools and methodologies				
1	2	3	4	5.34	6	7	8	9	10
Stagnation of the importance of food safety aspects					Increase of the importance of food safety aspects				
1	2	3	4	5	6	7	8.40	9	10
Stagnation of importance of the ASAE/ANESA in the diffusion of the food safety theme in Portugal					Increase of importance of the ASAE/ANESA in the promotion of the food safety theme in Portugal				
1	2	3	4	5	6.32	7	8	9	10
Food safety professionals with low skills					Food safety professionals with high competence and efficient				
1	2	3	4	5	6	7.44	8	9	10
Decreasing of the importance of food safety aspects in the Portuguese political agenda					Increase of the importance of food safety aspects in the Portuguese political agenda				
1	2	3	4	5	6.63	7	8	9	10
Decrease of the credibility of food safety aspects					Increase of the credibility of food safety aspects				
1	2	3	4	5	6	7.60	8	9	10

Figure 11. Food safety evolution scenarios.

Table 17. The results of the Student *t*-test for food safety evolution scenarios (component 1).

Evolution scenarios	Companies	Student's <i>t</i>	<i>p</i> -Value
Stagnation of the importance of food safety aspects/ increase in the importance of food safety aspects	Small/medium	-0.873	0.387
Stagnation of the importance of the ASAE/ANESA in the diffusion of the food safety theme in Portugal/ increase in importance of the ASAE/ANESA in the promotion of the food safety theme in Portugal	Small/medium	-1.533	0.132
Decrease in the importance of food safety aspects in the Portuguese political agenda/increase in the importance of food safety aspects in the Portuguese political agenda	Small/medium	-2.201	0.033
Decrease in the credibility of food safety aspects/ increase in the credibility of food safety aspects	Small/medium	-1.535	0.132

Portuguese government in the food safety issues is more important than for the small ones (5.81), concerning the future of this area in Portugal.

From Table 18, it can be seen that there were significant statistical differences for the scenario 'food safety professionals with low skills/food safety professionals with high

Table 18. The results of the Student *t*-test for food safety evolution scenarios (component 2).

Evolution scenarios	Companies	Student's <i>t</i>	<i>p</i> -Value
Diffusion of food safety standards/convergence for global and integrated food safety standards	Small/medium	-1.400	0.168
Application of the FSMS current verification and improvement tools/development of new tools and methodologies	Small/medium	-0.732	0.468
Food safety professionals with low skills/food safety professionals with high competence and efficiency	Small/medium	-2.419	0.020

competence and efficiency' between the small and medium companies. The medium companies (7.78) required more competent and skilled employees than the small firms (6.44).

5. Conclusions

As far we are concerned, this research is a pioneering contribution to the food safety research area. Our aim was to study ISO 22000 certification among Portuguese companies using statistical analyses, qualitative and quantitative ones.

This research has some limitations, mainly the fact that it had been conducted only for Portuguese companies. However, this could be easily avoided by applying the questionnaire to a sample of international companies.

Concerning the main motivations of ISO 22000, we were able to observe that Portuguese companies become ISO 22000 certified mainly to improve consumer confidence and because this kind of registration is a requirement for satisfying customers and other interested parties. Regarding the benefits achieved, the surveyed companies had reported that an improvement in food safety methodologies and practices. As verified for the ISO 22000 certification motivations, the most important benefit stated by the respondent companies was of internal nature. Regarding the implementation barriers, two main difficulties were reported: 'internal resistance to change' and 'FSMS implementation costs'.

Some of the issues raised here deserve additional research and are at the core of the authors' future work, related to a global data-based analysis of the ISO 22000 certification worldwide phenomenon. Specifically, we are conducting research in order to

- extend the study to the companies' top management, with the aim of carrying out a comparative analysis of the respondents' different profiles;
- analyse the relationship between ISO 22000 certification and the companies' market value improvement;
- supported in a project investment analysis, clearly identify the direct costs and financial benefits related to FSMS implementation and certification; and
- extend the research project to ISO 22000-certified companies in other countries.

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