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Techno-managerial factors related to food safety management system in food businesses

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Techno-managerial factors related to food safety management system in food businesses

Techno-
managerial
factors

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Abstract

Purpose – The aim of this study is to evaluate the food safety management system (HACCP – type system) implemented in Greek food businesses, examine the techno-managerial factors influencing its application according to enterprises' opinion and correlate these answers to the HACCP evaluation results.

Design/methodology/approach – The study involved 33 slaughterhouses located throughout Greece. Two types of questionnaires were used (IF questionnaire – for the influencing factors and HE questionnaire – for HACCP evaluation). Reliability or item analysis and principal component analysis were applied to the data obtained from the survey.

Findings – The results showed that the companies identifying the benefits of HACCP implementation as very important have fully understood possible problems and had the best results as regards HACCP evaluation. Companies not identifying the benefits as important had poor score in HACCP evaluation. Businesses with HACCP certification for longer periods and especially those that were certified according to more than one standard had better performance in HACCP evaluation. In addition, slaughterhouses involved in rearing of animals as well, especially those slaughtering only one animal species, and which do not provide services for others, seem to have better performance as regards HACCP evaluation.

Originality/value – The findings of this study correlate the results of the HACCP evaluation with the factors that affect the implementation of a food safety management system using the hierarchical cluster analysis (HCA) and canonical correlation analysis (CCA) statistical technique.

Keywords Food safety, Management, Meat, Quality assurance, Quality management, Quantitative methods, Greece

Paper type Research paper



1. Introduction

It has been well documented that the proper application of the Hazard Analysis Critical Control Points (HACCP) system has positive results and benefits to food safety (Consuelo *et al.*, 2006; Gillespie *et al.*, 2001; Little *et al.*, 2003; Khatri and Collins, 2007; Mantovanelli *et al.*, 2001; Naugle *et al.*, 2006; Violaris *et al.*, 2008). Furthermore, HACCP

system provides a tool for auditing to the regulatory authorities (Eves and Dervisi, 2005). It can also be a useful tool for internal auditing by food industry itself. Therefore, HACCP application at food processing plants could improve food safety and lead to a reduction of food-borne diseases. HACCP evaluation is an important requirement in order to assess the proper application of the system, particularly whether it is accurate, well maintained and efficient (Tompkin, 1994). In this sense, a HACCP evaluation procedure should at least include hazard analysis procedure, implementation of control measures as well as implementation and maintenance of the system itself (Wallace *et al.*, 2005).

On the other hand, there are factors that influence the performance of a HACCP system. Lack of awareness of HACCP, no perceived benefits, lack of training, management regressions, variability of the production lines and individuality of each product, variability of the consumers demands (Adams, 2002; Panisselo *et al.*, 2000; Griffith, 2006) and small size of the enterprise have negative effects on the performance of HACCP system. Also, costs of development, application and maintenance of the system seem to be a severe constraint (Bata *et al.*, 2006; Semos and Kontogeorgos, 2007).

On the contrary, motivation for HACCP application provides improvement of processing procedures efficiency (Mazzocco, 1996; Jensen *et al.*, 1998), reduction of recalls (Mortarjemi and Kaferstein, 1999), regulatory demands, enhancement of firm reputation, costs reduction, customers' demands, previous experiences with food safety issues, trained staff, personnel training and management decision (Khatrri and Collins, 2007).

It is also important to point out that the European Legislation (Regulations (EC) 852/2004, 853/2004 and 854/2004) is very strict and thorough for HACCP implementation in slaughterhouses, as well as for the hygiene operation of the enterprise itself (Anonymous, 2004a, b, c). Slaughterhouses' operation is obligatorily supervised by an official veterinarian, whose duty is meat inspection and audit of good hygiene practices as well. On the other hand, many Greek slaughterhouses provide only slaughtering services to meat-traders without being themselves involved in meat trading.

Following a recent study (Milios *et al.*, 2011), on evaluation of control over microbiological contamination of carcasses in slaughterhouses where it is indicated that the hygiene performance of the enterprises was inadequate, the objective of the present study was to evaluate the Food Safety Management System (HACCP system) implemented in Greek food businesses (slaughterhouses) and to compare evaluation results to the operational model of the enterprises and possible certification of the system, in order to explore the influence of these parameters on the performance of HACCP system. Furthermore, this study aimed at examining the factors that influence the proper application of the system according to enterprises' opinion and correlating these answers to the HACCP evaluation results.

2. Methodology

2.1 Slaughterhouses

The present study took place at 33 slaughterhouses located throughout the Greek territory having an EU approval number by the Hellenic Ministry of Rural Development and Foods. In particular, four of them are located in Northern Greece

region, 17 in Western Greece, three in Central and nine in Southern Greece. Additionally, slaughterhouses participating in this study differed according to their operational model. Of them 11 provide only slaughtering services to meat-traders without being involved in meat trading or rearing of animals themselves, while 18 slaughterhouses are involved in meat trading and rearing of animals themselves as well as providing services to others. Four slaughterhouses do not provide services to others at all. Finally, according to HACCP certification, 23 of the slaughterhouses possess certification for their systems, while ten do not. Among the latter slaughterhouses seven provide only slaughtering services to meat-traders. All HACCP certification is according ISO 22000:2005 standards, while four food safety management systems have been certified according to BRC standard.

2.2 Questionnaires

A research questionnaire containing 52 questions was used as an evaluation tool for HACCP system in each slaughterhouse (see Table I). This questionnaire was used to investigate and evaluate the principles of HACCP application and, at the same time, the maintenance of prerequisite programs (Good Hygiene Practice and Good Manufacturing practice). An effort was also made to approach and evaluate the management of the system as well as its effectiveness. Therefore, questions 1-9 were used to evaluate the preliminary steps of HACCP plan, questions 10-22 the prerequisite programs and finally, questions 23-52 were used to evaluate the principles of HACCP application (Wallace *et al.*, 2005, Mortimore, 2000, Luning *et al.*, 2008, Luning *et al.*, 2009). Each question was graded with a seven-level scale (1 = none, 2 = hardly, 3 = little, 4 = moderate, 5 = high, 6 = very high, 7 = excellent). The questionnaires were completed after an onsite assessment of the HACCP system in each slaughterhouse by the same auditor.

Furthermore, a research questionnaire containing 32 questions (see Table II) was used to examine the opinions of slaughterhouse managers on possible motivation or disincentives for HACCP implementation. Each question was graded with a seven-level scale (1 = no importance, 2 = very low importance, 3 = low importance, 4 = medium importance, 5 = high importance, 6 = very high importance, 7 = absolute importance). The questionnaires were completed with the personal interview method by the same interviewer.

2.3 Statistical analysis

2.3.1 Reliability or item analysis and principal component analysis. The objective of the present study was to evaluate the Food Safety Management System (HACCP system) implemented in Greek slaughterhouses and to compare evaluation results to the operational model of the enterprises and possible certification of the system. Furthermore, this study aimed at examining the factors that influence the proper application of the system according to enterprises' opinion and correlating these answers to the HACCP evaluation results. In order to come to solid conclusions and obtain the ability to correlate independent data, an advanced statistical analysis was chosen aiming at creating groups of data with similar characteristics for both questionnaires creating groups of slaughterhouses with similar score in each dimension (groups of data) and correlating results between the data obtained from the two questionnaires.

Reliability or Item Analysis was applied to the data obtained from the survey of 33 slaughterhouses in order to create groups of data with similar characteristics for both

Item	Description
q1	Have all documents been numbered and dated?
q2	Does the documentation identify HACCP team members and the skills/functions they represent?
q3	Are all appropriate skill/functions represented?
q4	Is there any external training of the HACCP team?
q5	Are HACCP team meetings according to the programme and do include the reviewing of control procedures and monitoring?
q6	Has appropriate background information about the product been included?
q7	Does the process flow diagram include all the production range?
q8	Does the PFD include all raw materials, proceeding steps, storage and distribution?
q9	Is the PFD regularly verified?
q10	Is sophistication of hygienic design of equipment and facilities adequate?
q11	Are the cooling facilities adequate?
q12	Is the specificity of the sanitation program adequate?
q13	Is the extent of the personal hygiene requirements adequate?
q14	Are personnel responsible for monitoring CCPs adequately trained?
q15	Do the personnel understand the significance of food safety?
q16	Is the production equipment sufficient for the normal range of production?
q17	Is the maintenance program adequate?
q18	Is actual hygienic performance of equipment and facilities adequate?
q19	Have intervention procedures been established?
q20	Is actual performance of cooling facilities adequate to sustain the cooling chain?
q21	Does the production equipment actually work without malfunction?
q22	Is there specificity of calibration and verification program for measuring equipment?
q23	Have all hazards been identified?
q24	Does the hazard analysis cover all the steps in the Process Flow Diagram?
q25	Is hazard analysis based on gathering of data and information?
q26	Are listed control measures sufficient to prevent, eliminate or reduce each hazard?
q27	Have well documented procedures been established in order to conduct hazard analysis?
q28	Has brainstorming been used to identify hazards?
q29	Have sufficient bibliographic references been used to identify hazards?
q30	Has risk assessment been used to identify hazard significance and is this appropriate?
q31	Have all significant hazards been considered in the CCP identification procedure?
q32	Has a recognized decision tree been used in this process?
q33	Have all appropriate CCPs been identified?
q34	Have critical limits been established for each CCP? Are critical limits actually appropriate for the control of the specific hazard?
q35	Do the monitoring procedures actually detect any loss of control?
q36	Is monitoring set at an appropriate frequency?
q37	Has the monitoring been assigned to an appropriate person?
q38	Is validation of monitoring procedures based on scientific sources and data and well documented?
q39	Can the adequacy of the measuring and analytical equipment be proven?
q40	Will specified corrective actions secure the withdrawal of contaminated product?
q41	Will specified corrective actions repair the cause of failing?
q42	Are the corrective actions based on hygienic rules according to the standards of the enterprise?
q43	Is the availability of the recording sheets relevant to the monitoring procedures adequate?
q44	Are all records complete and signed?
q45	Is monitoring done at the appropriate frequency?

Table I.
Items initially included in
“Evaluation of the
HACCP system
implementation”
questionnaire (HE)

(continued)

Item	Description
q46	Are monitoring procedures valid and reliable?
q47	Is the HACCP plan systematically verified?
q48	Is appropriate corrective action carried out for non – conformities?
q49	Is the HACCP plan reviewed at an appropriate frequency?
q50	Have HACCP documents been updated?
q51	Is overall verification and maintenance plan appropriate for effective food safety management?
q52	Have all documents been numbered and dated?

Item	Description
q1	Regulatory requirements
q2	Reduction of costs
q3	Customers requirement
q4	Enhancing firm's reputation
q5	Previous experience with food safety issues
q6	Availability of trained staff
q7	Availability of HACCP training
q8	Management decision
q9	Capital costs
q10	Costs of developing the system
q11	Costs of staff training
q12	Costs of HACCP team training
q13	Costs of implementation
q14	Lack of awareness of HACCP
q15	No perceived benefits
q16	Risk assessment difficulties
q17	The regulators themselves
q18	Increase in sales
q19	Less rejections/reworked product
q20	Reduction in customers complaints
q21	Reduction in operating costs
q22	Increase in customers or markets
q23	Increased benefits to the supply chain
q24	Improved morale
q25	Investment in new equipment
q26	Payment of external consultant
q27	Cost of prerequisite programmes
q28	Cost of structural changes
q29	Cost of staff training during HACCP implementation
q30	Cost of hiring new personnel
q31	Cost of laboratory analysis
q32	Cost of staff training during HACCP maintenance
q33	Cost of operating quality department
q34	Cost of HACCP documentation
q35	Cost of supervising HACCP implementation

Table II.
Items initially included in
“Factors influencing the
HACCP system
implementation”
questionnaire (IF)

questionnaires. Reliability analysis, expressed by Cronbach's alpha coefficient, was performed on the nominal variables extracted from the two questionnaires: "Factors influencing the HACCP system implementation (IF)", 35 nominal variables; and "Evaluation of the HACCP system implementation (HE)", 52 nominal variables. Principal Component Analysis (PCA) was performed to check scales uni-dimensionality. In case that uni-dimensionality was not the case, reliability analysis expressed by Cronbach's alpha coefficient was performed for each dimension. The criteria used to include or exclude items based on the Reliability analysis were the following: the mean should be between 2.5-5.5, the standard deviation should be at least 1.5, all inter-item correlations should be positive and item-rest correlation or item-total correlation should be at least 0.30-0.40 (Blunch, 2008). PCA analysis was performed based on the following criteria: the analysis was performed based on the covariance matrix because all the variables were measured on the same scale, varimax rotation was used and absolute values less than 0.40 were suppressed (i.e. loading scores after rotation on each principal component) (Blunch, 2008). Reliability analysis and PCA was performed using the SPSS v15.0 (SPSS, Inc., Chicago, IL, USA) computer-based software.

2.3.2 Clustering. In order to get groups of companies to study or reveal similar characteristics, a hierarchical cluster analysis (HCA) was performed on the data (items remained) after the application of the PCA and reliability analysis. HCA was performed using the XLSTAT 2011 (Addinsoft, Paris, France), computer-based program, an add-in for Microsoft Excel 2007 (Microsoft, Redmond, WA, USA).

2.3.3 Relation between "Factors influencing the HACCP system implementation" and "Evaluation of the HACCP system implementation" questionnaires. In order to correlate the results between the data obtained from the two questionnaires; these were analysed together using the Canonical Correlation Analysis (CCA) (Rason *et al.*, 2007). As a result, new variables are formed known as canonical variables (CVs), which are linear combinations of the variables of each data set and therefore these CVs exhibit the highest correlation that can be found between the two data sets. The CCA was performed using the XLSTAT 2011 computer-based program.

3. Results and discussion

3.1 Reliability or item analysis and principal component analysis

The results obtained from the reliability analysis showed that the Cronbach's alpha coefficient was very satisfactory for both questionnaires (0.93 for the IF and 0.97 for the HE). The following 20 items were excluded during the analysis: q1, q8, q9, q10, q11, q13, q14, q15, q16, q25, q27, q28, q31, q34 and q35 for the IF questionnaire whereas no items were excluded for the HE questionnaire. Furthermore, all the inter-item correlations were positive and the smallest item-rest correlation was 0.33. Therefore, the reliability analysis was satisfactory according to common norms for both questionnaires. However, after investigating the correlation matrix (data not shown) there were, especially for the IF questionnaire, potential clusters with satisfying intra-cluster correlations but with very small correlations to other clusters. Hence, probably these parts of the scale measure different latent variables and maybe more. If this is the case, then the scale is not uni-dimensional despite the very satisfying alpha and probably it would be necessary to perform PCA in order to find out whether the items really compose a uni-dimensional scale and if not how many dimensions it contains.

As uni-dimensionality is a prerequisite for the calculation of the Cronbach's alpha coefficient, it is safest to perform the PCA on all the variables and not on the ones left after the reliability analysis. The scree plot obtained during the PCA indicated the existence of four (IF questionnaire) and three (HE questionnaire) dimensions.

For the IF questionnaire, the first component (PCF1) extracted 32.0 per cent of the variance, the second (PCF2) 17.6 per cent, the third (PCF3) 10.5 per cent and the fourth (PCF4) 6.1 per cent. Taking together the first four principal components these account for 66.2 per cent of the variance in the data. The following items were suppressed and excluded during the PCA: q1, q2, q34 and q35 (31 items were remained). The factors or latent variables constructed can be summarised as follows: the PCF1 could be considered as an expression of the management decisions, as well as the motives and benefits that forced the management to implement a HACCP system (nine items), the PCF2 is directly linked with the cost of developing and implementing a HACCP system (ten items), the PCF3 is some sort of the "implementation" dimension incorporating elements directly or indirectly linked with the developing and implementation of a HACCP system (six items), while iv) the PCF4 includes miscellaneous objects that were not positioned on any from the previous PCs (six items). As calculation of the Cronbach's alpha coefficient across different dimensions is meaningless, it is customary to perform a reliability analysis for each dimension. Therefore, reliability analysis was performed on each PC and eventually 27 nominal variables remained. The Cronbach's alpha coefficient for each PC after removing the unnecessary variables were the following: 0.92 for PCF1 (nine items), 0.89 for PCF2 (nine items excluding q27), 0.84 for PCF3 (six items) and 0.94 for PCF4 (three items excluding q9, q14, q31) (see Table III).

For the HE questionnaire, the first component (PCH1) extracted 44.3 per cent of the variance, the second (PCH2) 15.2 per cent and the third (PCH3) 6.9 per cent. Taking together the first three principal components these account for 66.4 per cent of the variance in the data. Item q1 was suppressed and excluded during the PCA. The factors or latent variables constructed were the following: the PCH1 could be considered that summarises the implementation of the HACCP principles (21 items), the PCH2 is directly linked with the prerequisites of implementing a HACCP system and the work needed to maintain the implemented HACCP system (22 items), while the PCH3 is some sort of the "Preliminary HACCP" dimension incorporating elements that required to be performed prior to the implementation of the core of a HACCP system (eight items). In addition, reliability analysis for each dimension was performed and eventually 51 nominal variables remained. The Cronbach's alpha coefficient for each

Principal component	Description	Items included
PCF1	"Management decisions, motives and benefits" dimension	q3, q4, q8, q15, q18, q19, q20, q22, q23
PCF2	"Costs" dimension	q5, q11, q12, q25, q28, q29, q30, q32, q33
PCF3	"Development and Implementation" dimension	q10, q13, q16, q17, q24, q26
PCF4	"Miscellaneous" dimension	q6, q7, q21

Table III.
Items eventually remained in "Factors influencing the HACCP system implementation" questionnaire (IF) after the application of the PCA and reliability analysis

PC after removing the unnecessary variables were the following: 0.97 for PCH1 (21 items remained; no item was excluded), 0.96 for PCH2 (22 items remained; no item was excluded) and 0.89 for PCH3 (eight items remained; no item was excluded) (see Table IV).

3.2 Clustering

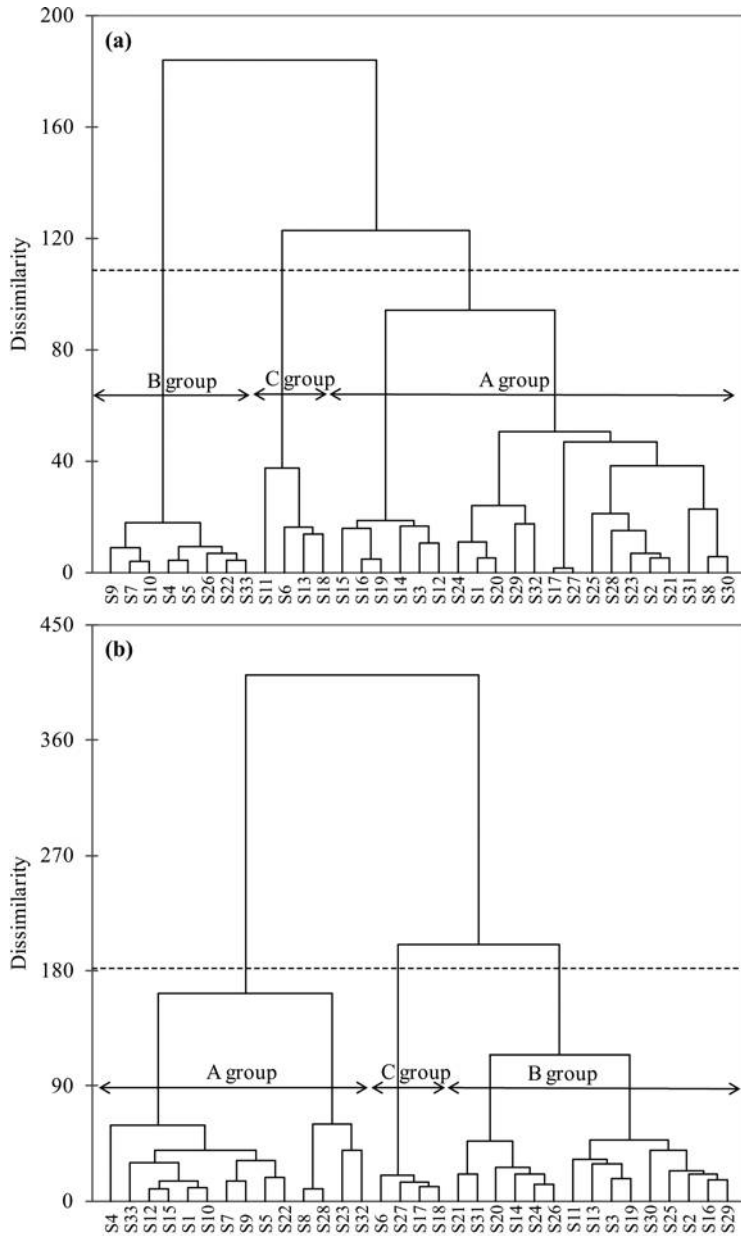
The dendrogram obtained by HCA on the data showed the segmentation of the 33 surveyed slaughterhouses in three groups for both questionnaires, i.e. the IF and HE: A, B and C group (see Figure 1). The dendrogram allowed the study of each group characteristics regarding the HACCP evaluation and the factors influencing its implementation, which corresponded to significant modalities for each group of HACCP implementation. Each group scored differently on each latent variable extracted from both questionnaires (see Table V).

For the IF questionnaire, the A group was mainly composed by slaughterhouses implementing a certified food safety management system (FSMS). This group included also a few companies without certified FSMS or being in process to implement one. However, these specific companies gave a relatively high score to the corresponding latent variables according to the HE questionnaire (i.e. they were in the B group based on the clustering applied on the HE questionnaire data). Finally, the A group included companies (ca. 1/3 of the total number of the companies belonging to the A group), which gave a relatively low score based on the HACCP evaluation questionnaire (i.e. they were in the A group). The second group (B group) was mainly composed by slaughterhouses without FSMS certification and few slaughterhouses implementing certified HACCP but these latter companies were included in the A group according to the HE questionnaire, i.e. they had scores relatively low in the different latent variables during the HACCP evaluation. Finally, C group included slaughterhouses with more than one standard implemented in the company. There were also two companies without FSMS certification but the score was relatively high (i.e. they were included in the B group) during the HACCP evaluation. It should be noted that the relatively high HE score of those companies without a FSMS certification (i.e. companies from the A and C groups) was due to the fact that they were in process to implement a HACCP system and also they highly met the Good Manufacturing Practices (GMP) and Good Hygiene Practices (GHP) standards.

The managers of the slaughterhouses that were grouped in group C (slaughterhouses with certification) identified as the most significant motive (score 6 – very high

Table IV. Items eventually remained in “Evaluation of the HACCP system implementation” questionnaire (HE) after the application of the PCA and reliability analysis

Principal component	Description	Items included
PCH1	“Implementation of HACCP principles” dimension	q23, q24, q25, q26, q27, q28, q29, q30, q31, q32, q33, q34, q35, q36, q37, q38, q39, q40, q41, q42, q43
PCH2	“HACCP prerequisites and maintenance” dimension	q10, q11, q12, q13, q14, q15, q16, q17, q18, q19, q20, q21, q22, q44, q45, q46, q47, q48, q49, q50, q51, q52
PCH3	“Preliminary HACCP” dimension	q2, q3, q4, q5, q6, q7, q8, q9



Notes: (a) Factors influencing the HACCP system implementation and (b) Evaluation of the HACCP system implementation questionnaires. Dashed bars show the level of statistical significance of the discrimination

Figure 1. Dendrogram derived from the HCA performed on the survey data

Table V.
Differences relative to HACCP evaluation and factors affecting its implementation associated to the 3 identified groups

Latent variables/characteristics	A	Score ^b /characteristics B	C
<i>IF questionnaire</i> ^a			
Management decisions, motives and benefits (PCF1)	4	2	6
Costs (PCF2)	3	2	4
Development and implementation (PCF3)	3	2	4
Miscellaneous (PCF4)	2	1	5
<i>IF companies characteristics</i>			
HACCP implementation-certification	Mainly companies with HACCP but also some companies without HACCP	Mainly companies without HACCP but also some with HACCP	Only companies with HACCP
<i>HE questionnaire</i> ^a			
Implementation of HACCP principles (PCH1)	3	5	6
HACCP prerequisites and maintenance (PCH2)	4	4	6
Preliminary HACCP (PCH3)	3	5	6
<i>HE companies characteristics</i>			
HACCP implementation certification	Yes: seven companies No: seven companies Only HACCP	Yes: eight companies No: seven companies Only HACCP	Yes: four companies No: seven companies Only HACCP
No. of certified FSMS being implemented ^c	< 3	3-5	Two standards at least > 5 in all standards
Years of HACCP and/or other standards certification ^c	HACCP: usually yes No HACCP: yes and no HACCP: 3 No HACCP: usually three HACCP: high percentage No HACCP: the most common activity	HACCP: yes and no No HACCP: no HACCP: 2-3 No HACCP: usually three HACCP: no No HACCP: only this activity is provided	HACCP: yes HACCP: only 1 HACCP: no
Animal rearing ^d			
No. of different animals slaughtered (i.e. ovine, bovine and porcine meat) ^d			
Services ^{d1, e}			

Notes: ^aIF: Factors influencing the HACCP system implementation; HE: Evaluation of the HACCP system implementation; ^bThe score for each latent variable is the mean value of all slaughterhouses belonging to that group. It should be noted that the companies composing each group are different for each questionnaire; ^cOnly for companies implementing certified HACCP and/or other standards; FSMS, Food Safety Management Systems; ^dHACCP indicates companies implementing a certified HACCP system and/or other standards while No HACCP indicates companies without HACCP system and/or other standards; ^eFacilities are used by the company for slaughtering its own animals (these companies own also processing plants producing meat products) and/or for providing services

importance) to implement a HACCP system possible benefits that are related to customers' demands, firm reputation prevalence, sale increase, less rejects or recalls and increase of benefits in supply chain. These factors are related to managerial decisions, motives and benefits. Similar results have been reported by other authors (Khatri and Collins, 2007; Eves and Dervisi, 2005). On the other hand, the same managers graded with score 4 (medium importance) the possible disincentives for HACCP implementation, such as the costs associated with the system (structural changes, training costs, equipment costs). These results corroborate the views of previous studies (Khatri and Collins, 2007; Semos and Kontogeorgos, 2007; Unnevehr and Jensen, 1999).

The possible disincentives emerging from the implementation costs were given score 4 (external consultant fee, costs of development and implementation of the system). It is interesting to point out the importance of the role of external consultants in Greece who develop the majority of the Food Safety Management Systems and support their operation. Similar attitudes were observed at Greek Food Industry in the study of Semos and Kontogeorgos (2007). Finally, motives like the availability of training and the reduction of the operational costs were given score 5 (high importance). It appears that managers of group C slaughterhouses have understood and adopted the possible benefits, estimate the costs, but have self-consciously made the choice to implement a HACCP system (see Table V).

Managers of the slaughterhouses that were assigned in group A (mainly slaughterhouses with certification, but also some without) equally identified as greatest motive for HACCP implementation factors related to managerial decisions, motives and benefits. On the other hand, they ranged with 3 – low importance the possible disincentives emerging from the system costs, such as implementation costs. Finally, as very low importance (score 2) were graded motives as the training availability and operational costs reduction. In conclusion, the managers of the group A slaughterhouses have understood less the possible benefits, as well as the costs of HACCP implementation. This could be related to the fact that these slaughterhouses belong mainly to the B group of the HACCP evaluation questionnaire, where they appear to have satisfactory, but yet lower than group C, results (see Table V).

The managers of the slaughterhouses that were grouped in group B (mainly slaughterhouses without certification) did not identify as important the benefits from HACCP implementation (score 2 – very low importance), nor the costs of the system (score 2 also). These slaughterhouses mainly belong to the A group of the HE questionnaire with medium or even poor results (see Table V). On the contrary, the results of the studies of Semos and Kontogeorgos (2007), regarding food industry in Greece, Khatri and Collins (2007), Eves and Dervisi (2005), outlined the importance, according to the companies opinion, of the benefits, especially those suiting customers' demands, firm reputation prevalence and sale increase and the costs of the system such as staff training cost. Moreover, having in mind the importance or staff training for proper HACCP implementation (Wallace *et al.*, 2005; Mortimore and Wallace, 1998; Williams *et al.*, 2003) we come to the conclusion that these companies do not have an adequate safety assurance system.

Despite these and the clustering of the companies according to their answers to the questionnaire, it is interesting to point out that the main motive for HACCP implementation has been regulatory demand (94 per cent of the answers were graded as absolute or very important. On the other hand, only the 45 per cent of the

participants characterised, as absolute or very important motive for HACCP implementation, the firm reputation prevalence and at even lower levels the demand of the customers was rated as a motive (only 24 per cent absolute or very important). The operational model of the slaughterhouses (in most cases providing only services and therefore, no direct trading responsibility for the quality of the product) leads to implementation of the HACCP system based primarily on compliance with the regulatory demands and secondly on understanding the benefits that can rise from it. Furthermore, the slaughterhouse managers graded highly as possible disincentives the implementation and development costs (43 and 40 per cent respectively characterised them as absolutely or very important), while 34 per cent answered that the lack of awareness of HACCP benefits do have absolute or very important consequences on HACCP implementation.

Regarding the HE questionnaire, the first group (A group) included companies with and without a FSMS. Companies with FSMS certification for less than three years implemented only the ISO 22000:2005 standard. These companies were also involved in livestock production or animal rearing. Livestock production was also observed for some companies without FSMS certification. The common characteristics between the A group companies (with and without FSMS certification) were: the fact that meat from different animal species were produced (i.e. ovine, bovine and porcine meat) and the slaughterhouses were highly used for providing services to other producers or companies without slaughtering facilities. The B group was also composed of slaughterhouses implementing a certified FSMS. In case of HACCP implementation, the company was certified only for the ISO 22000:2005 standard but for longer period (three to five years) compared to the previous group. Livestock production was also performed by certified companies but the number of the meat types produced was two and sometimes three. The companies without FSMS certification performed no livestock production and provided services (i.e. slaughtering) for all types of meat (ovine, bovine and porcine). On the contrary, no slaughtering services were provided by the FSMS-certified companies. The third group (C group) included only four companies certified for more than five years in two at least standards. These companies were involved in rearing of animals but no slaughtering services were provided to others. Finally, their slaughtering activity was limited to meat only from one species.

The evaluation of the HACCP systems of group C (slaughterhouses with certification according to more than one standards for more than five years), showed that the results were very satisfactory (score 6 – very high) at the fields of the HACCP principles implementation, prerequisite programs, maintenance, as well as the preliminary steps of the system. It is interesting to point out that these establishments slaughtering only one species of animal, are involved in rearing of animal as well and do not provide services to others.

The evaluation of the HACCP systems of group B (include eight slaughterhouses with certification according to one standard for three to five years and seven slaughterhouses without certification) showed that results were satisfactory (score 5 – high) at the fields of the HACCP principles implementation and the preliminary steps, while they were moderate (score 4) at the fields of prerequisite programmes and maintenance of the system. It is interesting to point out that these slaughterhouses mainly slaughter three species of animals and that the seven of them, which do not have certification, provide only service to others.

The evaluation of the HACCP systems of group A (includes seven slaughterhouses with certification according to one standard for less than three years and seven slaughterhouses without certification) showed that the results were moderate (score 4) at the fields of prerequisite programmes and maintenance of the system, while it was low (score 3) for HACCP principles implementation and preliminary steps. These slaughterhouses mainly slaughtering three species of animals, some of them are involved in animal rearing, but mainly provide services to others.

3.3 Relation between “Factors influencing the HACCP system implementation” and “Evaluation of the HACCP system implementation” questionnaires

The use of an assessment tool as a way of collecting information on HACCP progress has been suggested by many authors (Wallace *et al.*, 2005; Mortimore, 2000; Luning *et al.*, 2008; Luning *et al.*, 2009; Luning and Marcelis, 2009; Tompkin, 1994; Wilkinson and Wheelock, 2004; Van der Spigel *et al.*, 2005). On the other hand, there are many studies on the factors influencing HACCP system (Khatri and Collins, 2007; Semos and Kontogeorgos, 2007; Eves and Dervisi, 2005; Panisselo and Quantick, 2001). To the best of our knowledge, the findings of this study which correlate the results of the HACCP evaluation with the factors that affect the implementation of a FSMS using the Canonical Correlation Analysis (CCA) statistical technique do not exist in relevant literature and are reported for first time in the present work.

The potential correlation between the two data sets obtained from the questionnaires was studied using the CCA statistical technique to get insights to the relation between the factors that affect the implementation of a FSMS and the evaluation of such implementation. The results obtained revealed that the first two axes of the IF questionnaire were highly correlated with the first two axes of the HE questionnaire. The first two pairs of the canonical variates were correlated as reflected by their canonical correlation coefficients ($r_{CV1} = 0.71, p = 0.001; r_{CV2} = 0.60, p = 0.04$), indicating that the two data sets were significantly correlated.

So, the first canonical correlation was strong, at 0.71. This was primarily attributed to the relationship between PCF1 (IF) (management decisions, motives and benefits) (coefficient= 0.54) and PCH2 (HE) (HACCP prerequisites and maintenance) (coefficient= 0.72) with some contribution of PCH1 (HE) (implementation of HACCP principles) (coefficient= 0.20) and PCH3 (HE) (Preliminary HACCP) (coefficient= 0.26). This indicates that there were companies implementing GMP and GHP due to law requirements and/or because they actually understand the reasons and the benefits from the implementation of these programs but there are difficulties regarding the implementation of the HACCP principles and the preliminary work needed for the HACCP implementation. In fact, cluster analysis showed group of companies that highly scored in PCH2 (HE) but they scored low in PCH1 (HE) and PCH3 (HE) because either they did not implement any FSMS, but only the prerequisites programs or they had difficulties to perform the needed preliminary work such as right formation of the HACCP team, scientifically-based identification of the hazards, etc. So, these companies although they understand the value and the benefits derived from the implementation of a FSMS, as reflected by the application of the GMP and GHP, however, they lack to understand the core of a HACCP system, i.e. the implementation of its principles, constituting an important barrier to the right implementation of a FSMS (Mayes, 1998; Mayes, 1999; Quinn and Marriott, 2002). A number of other

authors have also identified the importance of management attitudes and commitment (Panisselo and Quantick, 2001; Eves and Dervisi, 2005; Khatri and Collins, 2007; Semos and Kontogeorgos, 2007) or law requirements (Khatri and Collins, 2007). Such relations and insights were not possible to investigate only through clustering.

The second canonical correlation was also relatively strong, at 0.60. The canonical variable was a contrast of PCF2 (IF) (Costs) (coefficient= 0.74) against PCF1 (IF) (Management decisions, motives and benefits) (coefficient= -0.73). This contrast was correlated with something resembling the difference between the PCH2 (HE) (HACCP prerequisites and maintenance) (coefficient= -0.82) and PCH3 (HE) (Preliminary HACCP) (coefficient= 1.00). This indicates that the main barrier for implementing a FSMS was the costs associated with it by ignoring the benefits derived from such implementation. In fact, clustering identified cluster of companies with relatively low scores in the latent variables PCH1 (implementation of HACCP principles) and PCH2 (preliminary HACCP) of the HE questionnaire.

The similarity maps defined by the CVs are displayed in Figure 2. The graph shows that the first canonical variates discriminated the companies (S1 to S33) surveyed according to their score in both types of the questionnaires. Indeed, companies marked by circle scored highly in all the latent variables, as identified from the questionnaires [PCF1 to PCF4 for the IF (but low scores for the PCF2 (Costs) and PCF3 (implementation) because the questions associated with these latent variables have a negative impact, and PCH1 to PCH3 for the HE], were discriminated from the others according to the first canonical variates.

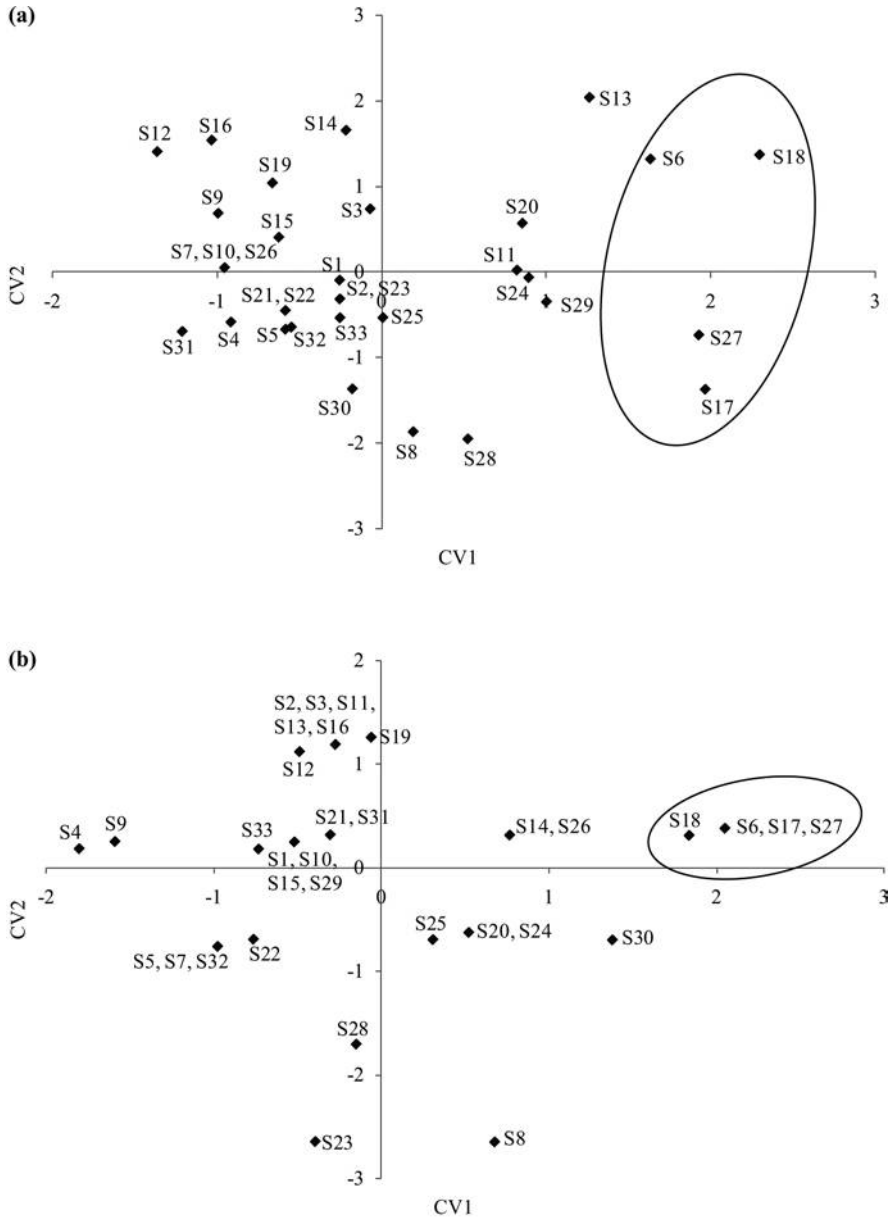
4. Conclusions

From the present study and the questionnaires data processing, including the evaluation of the HACCP systems implemented in 33 Greek slaughterhouses and the influencing factors, it was concluded that the managers of the companies who identified as very important the benefits of HACCP implementation, at the same time, fully understand possible problems, such as emerging costs. Moreover, they have the best results at HACCP evaluation.

On the other hand, companies that do not identify the benefits as important had poor score in HACCP evaluation and especially in sectors of implementation and preliminary steps. On the contrary, their performance is better as regards the prerequisites and maintenance of the system sectors, due to the fact that they are obliged to by the regulatory demands. In addition, some companies that identify a few benefits do not seem to have understood the core of the system function and therefore, have low performance in HACCP principal implementation.

The findings of this study demonstrate clearly that management commitment to food safety policies is essential for a proper HACCP implementation even in a sector where strict and thorough legislation is applied. Therefore, competent authorities, as well as certification bodies and consultants, should make more effort to persuade enterprises for the benefits of HACCP implementation. Companies themselves would benefit by developing a more conscious food safety policy, gaining market competitiveness.

Finally, it was shown that slaughterhouses with HACCP certification for longer period, especially those that are certified according to more than one standard, have better performance as regards HACCP evaluation. This is predictable, as third part



Notes: (a) IF and (b) HE questionnaire data. S1 to S33 are the slaughterhouses surveyed

Figure 2.
Similarity maps and
canonical variates (CVs) as
derived by the application of
the CCA

audits are a useful tool for HACCP verification and constant improvement. Similarly, slaughterhouses involved in rearing of animals as well, especially those slaughtering only one animal species and not providing services to others seem to have better performance in HACCP evaluation. As mentioned before, many Greek slaughterhouses provide only slaughtering services to meat-traders, without being involved in meat trading themselves. Therefore, market motivation for HACCP implementation is not of the same value as in the rest food production. On the other hand, slaughterhouses that trade meat under their label seem to implement HACCP systems more effectively, because of the direct trading responsibility for the quality of the product. This conclusion underlines the importance of market motivation for the proper Food Safety Management System application, despite legislation and authorities inspections.

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