Food Control 114 (2020) 107238

Contents lists available at ScienceDirect

Food Control

journal homepage: www.elsevier.com/locate/foodcont

Comprehensive insight into the food safety climate in Central and Eastern Europe

Igor Tomasevic[a,*], Danijela Bursać Kovačević[b], Anet Režek Jambrak[b], Szendrő Zsolt[c], Antonella Dalle Zotte[d], Aleksandra Martinović[e], Mirko Prodanov[f], Bartosz Sołowiej[g], Alexandrina Sirbu[h], Jonel Subić[i], Svetlana Roljević[i], Anastasia Semenova[j], Miro Kročko[k], Viera Duckova[k], Andriy Getya[l], Oksana Kravchenko[m], Ilija Djekic[a]

[a] University of Belgrade, Faculty of Agriculture, Nemanjina 6, 11080, Belgrade, Serbia
[b] Faculty of Food Technology and Biotechnology, University of Zagreb, 10000, Zagreb, Croatia
[c] Kaposvár University, Faculty of Agricultural and Environmental Science, Guba Sándor Str. 40, Kaposvár, H-7400, Hungary
[d] Department of Animal Medicine, Production and Health, University of Padova, Viale dell'Università, 16, Legnaro, Padova, 35020, Italy
[e] University of Donja Gorica, Faculty for Food Technology, Food Safety and Ecology, Donja Gorica, Podgorica, Montenegro
[f] Food Institute, University "Ss. Cyril and Methodius" in Skopje, North Macedonia
[g] University of Life Sciences in Lublin, Faculty of Food Sciences and Biotechnology, Lublin, 20-704, Poland
[h] Constantin Brancoveanu University, FMMAE, Ramnicu Valcea, Romania
[i] Institute of Agricultural Economics, Volgina 15, Belgrade, 11060, Serbia
[j] Russian Academy of Sciences, Leninskiy Prospekt, 14, Moscow, Russia
[k] Slovak University of Agriculture, Faculty of Biotechnology and Food Sciences, Department of Technology and Quality of Animal Products, Tr. A. Hlinku 2, Nitra, 949 76, Slovakia
[l] National University of Life and Environmental Sciences of Ukraine, Heroiv Oborony Str., 12, Kyiv, 03041, Ukraine
[m] Department of Food Technology, Poltava State Agrarian Academy, 1/3 Skovorody, 36003, Ukraine

ARTICLE INFO

Keywords:
Food safety climate
National culture
Food safety culture
Food safety management systems
HACCP
Eastern Europe
Central Europe

ABSTRACT

This investigation provides an important insight into the Central and Eastern European food industry, beyond traditional food safety management and reflects on its food safety (FS) climate or the human route of its FS culture. Investigation was conducted in 10 Central and Eastern European countries involving more than 500 food companies. Overall FS climate was assessed as good. The availability of infrastructure was perceived the same in all countries although "resources" was the lowest scored climate component. Uncertainty avoiding national cultures had a stronger preference towards written FS procedures and instructions. FS climate was better assessed in bigger companies because small companies observed weaker availability of resources, smaller number of procedures and instructions and reduced risk awareness. FS communication and commitment were not affected by company size. The share of food companies without FS system was five times higher in small compared to big companies. No effect of FS management level or riskiness level on FS climate scores was apparent. Food companies seemed to avoid problems in cooperation and trust between FS leaders and other employees, since they have perceived FS climate similarly. The strongest FS climate segmentation in Central and Eastern Europe food companies was observed in terms of the EU membership status. EU operating food companies managed to develop a very good and distinctive FS climate, with better-perceived leadership, communication, commitment, resources and risk awareness than non-EU food companies. Transitional economic environment of non-EU countries have undesirably influenced the organisational and technological support in their companies and employees perceptions of FS climate.

1. Introduction

The first notion of culture in corporate and managerial terms happened almost 7 decades ago by Jaques (1952) who defined it as: „customary and traditional way of thinking and of doing things, which is shared to a greater or lesser degree by all its members, and which new members must learn, and at least partially accept". Corporate and national cultures are distinct but complementary concepts (G. Hofstede,

* Corresponding author.
E-mail address: tbigor@agrif.bg.ac.rs (I. Tomasevic).

https://doi.org/10.1016/j.foodcont.2020.107238
Received 18 January 2020; Received in revised form 10 March 2020; Accepted 12 March 2020
Available online 18 March 2020
0956-7135/

2005). Corporate cultures apply to an entire organization, group, or occupational unit provided there is a common history and member stability (Schein, 2001). When defining corporate culture in a more globalized way, such as in the western part of Europe, we must take into account that most of the organizations are clusters of various cultures and subcultures from all over Europe and the rest of the world. Because (economic) migrations within Europe predominantly occur in the East-West direction (Kahanec & Pytliková, 2017), Eastern European corporations are more likely to be homogenous in terms of nationality, number of ethnic and cultural groups.

We already know that there are evident impacts and consequences of national cultures on corporate cultures in organizations (G. Hofstede, 2005; Meyer, 2014). It has been acknowledged, based on the results from numerous investigations, that there is a strong connection between the type of corporate culture and financial performance (Denison, Hooijberg, Lane, & Lief, 2012; Kotter, 1992). In addition, it was also suggested that there is a relationship between national cultures and food safety culture (FS-culture) (Nyarugwe, Linnemann, Hofstede, Fogliano, & Luning, 2016). Although food industries have taken a profound interest in the concept of FS-culture (Nyarugwe et al., 2016) this important and emerging issue has been tested in practice on a national level only in couple of instances (De Boeck, Jacxsens, Mortier, & Vlerick, 2018; Nyarugwe, Linnemann, & Luning, 2020).

The estimates of foodborne disease in the European region are unique, and they show that the overall health burden is substantial (WHO, 2017). The issue is hazard specific and is not uniform across the European continent. The Eastern parts of Europe have the highest number of confirmed cases of foodborne illness combined with the number of foodborne disease outbreaks due to *Trichinella*, *Brucella* and *Yersinia* spp. (EFSA, 2018; Mirilović et al., 2019; Pozio, 2019). The same region has the highest prevalence of abdominal cystic echinococcosis and of the number of infected people (Tamarozzi et al., 2018). Therefore, there is the most pressing need to investigate the issue of FS-culture in Central and Eastern European food organizations. Its techno-managerial component, in which the food safety management system (FSMS) and it performance is essential (De Boeck, Jacxsens, Bollaerts, & Vlerick, 2015), has already been explored in the Western Balkan countries (Djekic, Tomasevic, & Radovanovic, 2011; Tomašević et al., 2016; Tomašević et al., 2013). It is evident that it had a positive impact not only on microbiological outputs of food establishments (Djekic et al., 2016; Smigic, Djekic, Tomasevic, & Miocinovic, 2012; Tomasevic et al., 2016), but also improved the control of chemical hazards like nitrites (Tomasevic et al., 2017), sulphites (Tomasevic et al., 2018) and aflatoxin M1 (Miocinovic et al., 2017; Tomasevic et al., 2015).

However, food safety (FS) research has shifted its focus from a techno oriented FSMS to its human component usually defined as “food safety climate”. This investigation aims to assess overall food safety climate (FS-climate) in Central and Eastern Europe and all of its components: leadership, communication, commitment, resources and risk awareness. We will also perform an analysis of the impact of national cultures on FS-climate in the context of the company's FS riskiness level and organizational characteristics. This investigation will seek for the possible FS-climate segmentation within the food companies of ten European countries based on the country of origin, food sector, size of the company, level of executed FSMS and individual FS-climate indicators. To the best of our knowledge, the results presented in this manuscript will provide the first ever insight into important issue of FS-climate in Central and Eastern Europe food companies.

2. Material and methods

2.1. Participants and sampling

Survey was conducted during 2019 using online platform (Slido®) directed at more than 500 food companies in 10 Central and Eastern European countries (Croatia, Hungary, Montenegro, North Macedonia, Poland, Romania, Russia, Serbia, Slovakia and Ukraine) available in local languages (Fig. 1). A purposive sampling strategy was used (Palinkas et al., 2015) which was required to attain a representative and qualified sample in terms of the number of employees, type of food industry, country, implemented level of FSMS and respondents' position in the company (Table 1).

2.2. FS-climate assessment model

A validated model of a FS-climate self-assessment tool (De Boeck et al., 2015) that was already used in other studies (De Boeck, Jacxsens, Bollaerts, Uyttendaele, & Vlerick, 2016; De Boeck, Mortier, Jacxsens, Dequidt, & Vlerick, 2017) was deployed. The model consisted of five components: leadership, communication, commitment, resources and risk awareness. By pinpointing 15 indicators with the highest level of relevance and importance, as assessed by experts during the validation of the model (De Boeck et al., 2015), it was possible to create a self-assessment survey with fewer questions. Company representatives had the option to rate their degree of agreement according to a five-point Likert scale from 1 ′strongly disagree’, 2 ‘disagree’, 3 ′no opinion’, 4 ‘agree’ to 5 ′strongly agree’. The respondents were not informed about the topic of the survey beforehand and they were asked to fill it individually and anonymously. It took them less than 15 min to fill it out.

2.3. Data on national values

At present, there are at least six models of national cultures that continue to be widely cited and utilized in the organizational research literature. These include models proposed by Kluckhohn and Strodtbeck, Hofstede, Hall, Trompenaars, Schwartz, and House and his GLOBE associates. A major challenge in working with cultural differences is determining how best to assess or measure such differences for purposes of research and theory development. Some culture models, like Hofstede and Trompenaars, offer country-specific numeric scores for each of their cultural dimensions. Without such numbers, it is argued, comparisons by both researchers and managers become problematic (Nardon & Steers, 2009).

This is why we have used Hofstede's model with six dimensions of national cultures: power distance index, individualism vs. collectivism, uncertainty avoidance, masculinity vs. femininity, long-term orientation vs. short-term orientation and indulgence vs. restraint (G. Hofstede, 2005). This the most widely used model for of cultural differences in the organizations literature (Nardon & Steers, 2009) and for FS culture investigations (Nyarugwe et al., 2020; Nyarugwe, Linnemann, Ren, et al., 2020). Model allows international comparison between cultures, also called comparative research, which was one of the goals of our research. The country comparisons was accessed from Hofstede Insights (www.hofstede-insights.com) were used to typify the national values. The cultural dimensions are presented as index scores and given as absolute values ranging between 0 and 100 to get an insight into the country score (Geert Hofstede & Minkov, 2005).

2.4. Statistical processing

Likert scale data were considered as ordinal values and non-parametric statistical tests were used since data were not normally distributed. The Mann-Whitney *U* test has been performed to compare the statements between two groups-categorical variables, such as EU status of the country and position of interviewees. The Kruskal-Wallis H test was carried out to compare statements between more than two groups, such as country, size of company, food sector and FSMS status. The level of statistical significance was set at 0.05. Statistical processing was performed using Microsoft Excel 2010 and SPSS Statistics 21.0. A cluster analysis was employed in order to classify companies according to the relative level of agreement they attach to 15 statements linked with FS-climate. A two-cluster solution was selected, and Mann-

Fig. 1. Map of Europe indicating the location of the ten countries evaluated.

Whitney *U* test uncovered statistically significant differences between the clusters ($p < 0.05$).

3. Results and discussion

3.1. Size and organizational characteristics of the sample

With 294,000 companies, operating only in EU, it is almost impossible to make a truly representative sample in any kind of study in terms of its size, type of food sector or demography. However, with 503 food business companies surveyed our investigation is unprecedented in its scale. The difficulty of increasing the sample size in this type of research was already explained by De Boeck et al. (2017) in their FS-culture study that included two Belgian vegetable processing companies. Other authors carried out similar investigations on bigger samples, including nine Zimbabwean (Nyarugwe et al., 2020) or 136 Belgian food organizations (De Boeck et al., 2018). Even when an international analysis of food safety culture was presented (Nyarugwe, Linnemann, Ren, et al., 2020) the study was conducted in four countries and 17 participating companies.

In terms of demography of our sample, every participating country had a minimum of 30 food companies involved in the investigation (Table 1). Where possible, and according to the total number of food companies operating within the country, this number was increased. With a higher share of plant origin food producing companies (POFPC) (fruits, beverages, drinks) than animal origin food producing companies (AOFPC) (meat, dairy, poultry, fish), our sample was also representative in terms of the number of companies in EU food and drink industry by food sector (FoodDrinkEurope, 2019, p. 30). We are aware that our sample is biased in terms of the company size, because the share of big companies is quite high (23.1%) (Table 1), especially considering that small and medium-sized companies represents 99.1%

Table 1
Demographic profile and frequencies (%) of participating food companies by countries.

	Overall (N = 503) (%)	HR (n = 52) [%]	HU (n = 30) [%]	ME (n = 33) [%]	MK (n = 30) [%]	PL (n = 31) [%]	RO (n = 116) [%]	RU (n = 32) [%]	RS (n = 56) [%]	SK (n = 66) [%]	UA (n = 57) [%]
Company size											
Small	214 (42.5%)	28.8	40.0	78.8	56.7	25.8	46.5	15.6	23.2	56.1	47.4
Medium	173 (34.4%)	30.8	46.7	12.1	33.3	35.5	44.0	21.9	28.6	34.8	36.8
Big	116 (23.1%)	40.4	13.3	9.1	10.0	38.7	9.5	62.5	48.2	9.1	15.8
Food business type											
Animal origin food [a]	189 (37.6%)	32.7	36.7	54.5	60.0	32.3	21.6	56.2	33.9	28.8	59.6
Plant origin food [b]	235 (46.7%)	59.6	46.7	27.3	33.3	54.8	61.2	34.4	42.9	51.5	24.6
Food service [c]	79 (15.7%)	7.7	16.6	18.2	6.7	12.9	17.2	9.4	23.2	19.7	15.8
Food safety system											
Not certified	86 (17.1%)	5.8	3.3	39.4	10.0	9.6	12.1	15.6	10.7	22.7	40.3
HACCP	106 (21.1%)	34.6	26.7	42.4	46.7	12.9	10.3	12.5	23.2	18.2	12.3
FSMS	311 (61.8%)	59.6	70.0	18.2	43.3	77.4	77.6	71.9	66.1	59.1	47.4
Respondents position											
Management	149 (29.6%)	26.9	30.0	57.6	36.7	19.4	24.1	18.8	12.5	50.0	28.1
Operation	354 (70.4%)	72.1	70.0	42.4	63.3	80.6	75.9	81.2	87.5	50.0	71.9

Country legend: HR – Croatia; HU – Hungary; ME – Montenegro; MK – North Macedonia; PL – Poland; RO – Romania; RU – Russia; RS – Serbia; SK – Slovakia; UA – Ukraine.
HACCP – Hazard Analysis and Critical Control Point; FSMS – Food safety management system (e.g. ISO 22000, BRC, IFS, GlobalGAP).
[a] Animal origin food sector covers primary production and food processing of meat and poultry, fish, dairy and eggs.
[b] Plant origin food sector covers primary production and food processing of fruit, vegetables and beverages.
[c] Food service sector covers storage, distribution, wholesale, retail and other food services.

of food and drink industry, at least in EU terms (FoodDrinkEurope, 2019, p. 30). However, this bias was created because in some of the participating countries (Croatia, Poland, Russia and Serbia) big companies were much more willing to participate compared to small and medium-sized companies.

Using a purposive sampling strategy, we have avoided biasing our sample in terms of exclusive involvement of pro-active and FS oriented companies since it consisted of 17.1% non-certified and 21.1% of HACCP-only FS systems (Table 1). This bias is quite usual in this kind of investigation, as shown in previous research such as research of Luning et al. (2015), Jacxsens, et al. (2015) and De Boeck et al. (2018). However, our sample can be considered representative in terms of implemented and certified FS systems in both Central (Dzwolak, 2019) and Eastern parts of Europe (Tomašević et al., 2013). Unlike the study of De Boeck et al. (2018) we have also avoided biasing our results by not taking into account the FS-climate perceptions of food personnel/operators. Conveniently, our sample comprised of 29.6% managerial and 70.4% operational positions (Table 1).

3.2. National values

3.2.1. Leadership

It was explained before that all organizational climates, including the FS one, has a pyramidal structure with their leaders on top of it (Griffith, 2010a). The FS-climate "leadership" component was investigated using three different indicators. The initial indicator was trying to assess whether the performance of a FS system was measurable or not, against the clear objectives set by the leaders. The answers from the respondents in Central and Eastern European food companies ranged from agreeing (3.95) in Poland to strongly agreeing (4.63) with the statement as observed in Hungary. The level of agreement between all the other investigated countries was not statistically significant (Table 2).

A good FS leader would distinguish its activities from a good FS manager (that is focusing only on sustaining the already existing FSMS in practise) by being able to motivate and encourage all personnel to work in a hygienic and food safe way (De Boeck et al., 2015). It was already reported that there is an influence of power distance on leadership behaviours and styles. Leaders in high power distance indexed national cultures tend to adopt a more directive leadership style, while leaders from lower power indexed national cultures adopt a participative leadership style (Goolaup & Ismayilov, 2012). We could argue that this participative leadership style was the reason why Hungarian food employees strongly agreed (4.5) that they were motivated by their leaders (Table 2). Hungary had the lowest power distance score (46) of all the countries we have surveyed. However, the former observation is only hypothetical since no significant difference was observed between the levels of motivation provided by the leaders in other countries, in spite of clear differences in their "power distance" scores (www.hofstede-insights.com). In addition, Polish respondents that are working in the national culture with second lowest power distance score (68), least agreed (3.81) to the statement.

Leaders' striving for continuous improvement regarding hygiene and FS might denote strong leaders' ambition and reflect the importance of hygiene and FS in the organization (De Boeck et al., 2015). Again, Hungary was the only country that strongly agreed (4.60) that their leaders are striving for the continuous FS improvement, while all the other countries agreed to the statement, including Montenegro (4.00) that scored the lowest (Table 2). Overall, the leadership FS-climate component in Central and Eastern European food processing companies was assessed as good (4.27) and even slightly better in comparison to their Belgium equivalents (4.0) (De Boeck et al., 2018).

3.2.2. Communication

We can learn a lot about a FS-culture of an organization by the way it communicates FS instructions and share FS issues among all levels of employees. In a modern food business environment, there are multiple tools to achieve this important task, including oral, written and visual communications and variety of mediums like signs, posters, leaflets, flyers, company intranet sites and even company run television channels (Yiannas, 2009). Overall, the second FS-climate "communication" component for Central and Eastern food producing companies was assessed as good (4.14) (Table 1) and again slightly better in association to their Belgium equivalents (4.0) (De Boeck et al., 2018). It was

Table 2
Food safety climate indicators deployed in terms of country (N = 503).

Food safety climate indicators	Mean ± StD[1]	HR	HU	ME	MK	PL	RO	RU	RS	SK	UA
Leaders set clear objectives concerning hygiene and food safety	4.28 ± 0.89	3.98 ± 1.16^{a,b}	4.63 ± 0.56^{a}	4.39 ± 0.83^{a,b}	4.27 ± 0.78^{a,b}	3.90 ± 1.04^{b}	4.48 ± 0.87^{a,b}	4.31 ± 0.93^{a,b}	4.32 ± 0.90^{a,b}	4.11 ± 0.70^{a,b}	4.21 ± 0.77^{a,b}
Leaders are able to motivate employees to work in a hygienic and food safe way.	4.24 ± 0.85	4.37 ± 0.69^{a,b}	4.50 ± 0.68^{a}	4.24 ± 1.00^{a,b}	4.33 ± 0.71^{a,b}	3.81 ± 0.75^{b}	4.40 ± 0.84^{a,b}	4.38 ± 0.66^{a,b}	4.23 ± 0.91^{a,b}	3.98 ± 0.95^{a,b}	4.12 ± 0.93^{a,b}
Leaders strive for a continuous improvement of hygiene and food safety	4.29 ± 0.82	4.29 ± 0.75^{a,b}	4.60 ± 0.62^{a}	4.00 ± 1.25^{b}	4.47 ± 0.63^{a,b}	4.13 ± 0.56^{a,b}	4.46 ± 0.69^{a,b}	4.28 ± 0.99^{a,b}	4.29 ± 0.87^{a,b}	4.14 ± 0.80^{a,b}	4.11 ± 0.86^{a,b}
Leadership	**4.27 ± 0.71**	**4.21 ± 0.72$^{a,-}_{b,c}$**	**4.58 ± 0.53^{a}**	**4.21 ± 0.78$^{a,-}_{b,c}$**	**4.36 ± 0.57$^{a,-}_{b,c}$**	**3.95 ± 0.56^{c}**	**4.45 ± 0.69^{a,b}**	**4.32 ± 0.70$^{a,-}_{b,c}$**	**4.28 ± 0.84$^{a,-}_{b,c}$**	**4.08 ± 0.64^{b,c}**	**4.15 ± 0.76$^{a,-}_{b,c}$**
Leaders communicate with staff about hygiene and food safety	4.30 ± 0.79	4.21 ± 0.89^{a,b}	4.47 ± 0.68^{a,b}	4.18 ± 1.13^{a,b}	4.43 ± 0.50^{a,b}	3.94 ± 0.77^{a}	4.50 ± 0.69^{b}	4.19 ± 0.90^{a,b}	4.30 ± 0.93^{a,b}	4.21 ± 0.54^{a,b}	4.21 ± 0.77^{a,b}
Operators communicate about hygiene and food safety with leaders	4.04 ± 0.91	4.15 ± 0.72^{a,b,c}	4.20 ± 0.76^{b,c}	3.76 ± 1.15^{a,b}	4.30 ± 0.53^{b,c}	3.58 ± 0.89^{a}	4.41 ± 0.78^{c}	3.94 ± 1.01^{a,b,c}	3.91 ± 1.08^{a,b,c}	3.70 ± 0.82^{a,b}	3.96 ± 0.91^{a,b,c}
Importance of hygiene and food safety is present by means visual communication (hygiene and food safety posters, signs and/or icons)	4.08 ± 0.93	4.04 ± 0.97^{a,b,c}	3.70 ± 0.75^{a}	3.67 ± 1.14^{a}	4.33 ± 0.61^{b,c}	3.84 ± 0.90$^{a,-}_{b,c}$	4.40 ± 0.83^{c}	4.25 ± 0.67^{a,b,c}	4.41 ± 0.89^{c}	3.82 ± 0.89^{a,b,c}	3.77 ± 1.09^{a,b}
Communication	**4.14 ± 0.71**	**4.13 ± 0.73$^{a,-}_{b,c}$**	**4.12 ± 0.56$^{a,-}_{b,c}$**	**3.87 ± 0.92^{a}**	**4.36 ± 0.46^{b,c}**	**3.78 ± 0.58^{a}**	**4.43 ± 0.62^{c}**	**4.13 ± 0.65$^{a,-}_{b,c}$**	**4.21 ± 0.82$^{a,-}_{b,c}$**	**3.91 ± 0.56^{a,b}**	**3.98 ± 0.82$^{a,-}_{b,c}$**
Leaders set a good example concerning hygiene and food safety	4.24 ± 0.88	4.19 ± 0.91^{a,b}	4.23 ± 1.07^{a,b}	4.18 ± 1.16^{a,b}	4.40 ± 0.77^{a}	3.77 ± 0.92^{b}	4.42 ± 0.78^{a}	4.28 ± 0.99^{a,b}	4.29 ± 0.91^{a,b}	4.15 ± 0.73^{a,b}	4.14 ± 0.77^{a,b}
Leaders act quickly to correct hygiene and food safety problems/issues	4.28 ± 0.82	4.29 ± 0.94^{a,b}	4.37 ± 0.81^{a,b}	4.39 ± 0.90^{a,b}	4.40 ± 0.72^{a,b}	3.84 ± 0.78^{a}	4.46 ± 0.76^{b}	4.16 ± 0.92^{a,b}	4.41 ± 0.80^{b}	4.21 ± 0.69^{a,b}	4.00 ± 0.85^{a,b}
Employees are actively involved by leaders in hygiene and food safety	4.10 ± 0.81	3.94 ± 1.04^{a,b}	3.93 ± 0.83^{a,b}	4.18 ± 0.85^{a,b}	4.20 ± 0.66^{a,b}	3.81 ± 0.87^{a}	4.44 ± 0.62^{b}	4.31 ± 0.54^{b}	4.12 ± 0.82^{a,b}	3.94 ± 0.72^{a,b}	3.88 ± 0.91^{a,b}
Commitment	**4.21 ± 0.71**	**4.14 ± 0.89^{a,b}**	**4.18 ± 0.77^{a,b}**	**4.25 ± 0.82^{a,b}**	**4.33 ± 0.61^{a}**	**3.81 ± 0.75^{b}**	**4.44 ± 0.63^{a}**	**4.25 ± 0.68^{a,b}**	**4.24 ± 0.69^{a,b}**	**4.10 ± 0.56^{a,b}**	**4.01 ± 0.70^{a,b}**
Sufficient staff is available to follow up hygiene and food safety	3.77 ± 1.02	3.83 ± 0.98^{a,b}	3.40 ± 1.04^{a}	3.67 ± 1.19^{a,b}	3.80 ± 1.00^{a,b}	3.42 ± 1.09^{a}	4.23 ± 0.73^{b}	3.69 ± 1.06^{a,b}	3.36 ± 1.20^{a}	3.59 ± 0.98^{a,b}	3.86 ± 0.97^{a,b}
Infrastructure (e.g. good workspace, good equipment …) is available to be able to work in a hygienic and food safe way	4.10 ± 0.84	4.25 ± 0.81	3.97 ± 0.85	3.82 ± 1.07	4.27 ± 0.64	3.84 ± 1.00	4.34 ± 0.67	4.03 ± 1.03	4.14 ± 0.82	4.03 ± 0.72	3.86 ± 0.91
Good hygiene and food safety procedures/ instructions are in place	4.28 ± 0.76	4.38 ± 0.72^{a}	4.40 ± 0.81^{a}	3.73 ± 1.07^{b}	4.27 ± 0.64^{a}	4.19 ± 0.79^{a,b}	4.49 ± 0.58^{a}	4.38 ± 0.55^{a}	4.27 ± 0.90^{a}	4.15 ± 0.64^{a,b}	4.14 ± 0.85^{a,b}
Resources	**4.05 ± 0.71**	**4.15 ± 0.67^{a}**	**3.92 ± 0.75^{a,b}**	**3.74 ± 0.98^{b}**	**4.11 ± 0.60^{a,b}**	**3.82 ± 0.75^{b}**	**4.35 ± 0.54^{a}**	**4.03 ± 0.75^{a,b}**	**3.92 ± 0.81^{a,b}**	**3.92 ± 0.58^{a,b}**	**3.95 ± 0.74^{a,b}**
Risks related to hygiene and food safety are known	4.27 ± 0.73	4.44 ± 0.61^{a}	4.50 ± 0.82^{a}	4.09 ± 0.84^{a,b}	4.43 ± 0.50^{a,b}	3.97 ± 0.71^{b}	4.38 ± 0.64^{a,b}	4.25 ± 0.44^{a,b}	4.32 ± 0.96^{a,b}	4.21 ± 0.69^{a,b}	3.98 ± 0.79^{b}
Risks related to hygiene and food safety are under control	4.21 ± 0.75	4.33 ± 0.68^{a,b}	4.47 ± 0.73^{a}	3.91 ± 0.91^{b}	4.40 ± 0.50^{a,b}	3.97 ± 0.80^{a,b}	4.38 ± 0.61^{a,b}	4.34 ± 0.48^{a,b}	4.21 ± 0.89^{a,b}	4.08 ± 0.77^{a,b}	3.93 ± 0.86^{b}
Leaders have a realistic picture of the potential problems and risks related to hygiene and food safety	4.21 ± 0.78	4.21 ± 0.91^{a}	4.40 ± 0.77^{a}	4.06 ± 0.93^{a,b}	4.43 ± 0.57^{a}	3.68 ± 0.79^{b}	4.34 ± 0.71^{a}	4.16 ± 0.77^{a,b}	4.21 ± 0.89^{a}	4.12 ± 0.60^{a,b}	4.19 ± 0.72^{a,b}
Risk awareness	**4.23 ± 0.64**	**4.33 ± 0.63^{a,b}**	**4.46 ± 0.69^{a}**	**4.02 ± 0.82^{b,c}**	**4.42 ± 0.47^{a,b}**	**3.87 ± 0.66^{c}**	**4.37 ± 0.56^{a,b}**	**4.25 ± 0.41$^{a,-}_{b,c}$**	**4.25 ± 0.79$^{a,-}_{b,c}$**	**4.14 ± 0.55$^{a,-}_{b,c}$**	**4.04 ± 0.63^{b,c}**
OVERALL	**4.18 ± 0.59**	**4.19 ± 0.62^{a,b}**	**4.25 ± 0.58^{a}**	**4.02 ± 0.72^{a,b}**	**4.32 ± 0.44^{a}**	**3.85 ± 0.56^{b}**	**4.41 ± 0.51^{a}**	**4.20 ± 0.55^{a,b}**	**4.18 ± 0.67^{a,b}**	**4.03 ± 0.47^{a,b}**	**4.02 ± 0.63^{a,b}**

Country legend: HR – Croatia; HU – Hungary; ME – Montenegro; MK – North Macedonia; PL – Poland; RO – Romania; RU – Russia; RS – Serbia; SK – Slovakia; UA - Ukraine.
[1] The Mean values ± Standard deviations and modes were obtained from the raw data. Note: Items denoted with different letters are significantly different at the level of 5%. Likert scale: (1) “Strongly disagree”, (2) “Disagree”, (3) “No opinion”, (4) “Agree”, (5) “Strongly agree”.

already stipulated that in countries with high power distance scores, food handlers are not free to approach and communicate with their bosses (Nyarugwe et al., 2020). In addition, in countries with low power distance scores there is evidence of a greater level of FS information sharing (Wallace, 2009). However, our investigation provided no results that can support such claims, since Romania scored the highest FS communication marks (4.40) (Table 2) and it is a country with a very high power distance score (90) (www.hofstede-insights.com). Communication was not assessed significantly different from Hungary (4.12) and that was a country with the lowest power distance score (46) in our investigation. Montenegro (3.87) and Poland (3.78) were on the lower end of the self-assessed FS communication scale.

3.2.3. Commitment

The significance of leading by personal example or role modelling (Yaffe & Kark, 2011) and how important it is in making a good leader (Gächter, Nosenzo, Renner, & Sefton, 2012) was already discussed. This is why this issue is the first indicator of FS-climate component named "Commitment". Romanians (4.42) and Macedonians (4.40) agreed the most that they have FS leaders that are leading their companies by personal example (Table 1). Romanian (4.46) and Serbian (4.41) FS leaders were the quickest to correct hygiene and FS problems. In a masculine national cultures decision-making is more centralised (Nyarugwe et al., 2020) while femininity is more inclined to achieve FS goals by working in teams and decision making by consensus (Wallace, 2009). Therefore, it is not surprising that in our investigation countries that belong to a less masculine national cultures, like Russia (36), Romania (42) and Serbia (43), all agreed above average (4.10) that their employees are actively involved by leaders in hygiene and FS decision making. What is surprising is the fact that the most feminine, Ukrainian national culture with the lowest masculinity score (27) of all the countries surveyed, was least inclined (3.88) to the FS team working (Table 2). On average, FS commitment of Central and Eastern European food companies was self-assessed as very good (4.21), with Romanian food organizations achieving the highest scores (4.44).

3.2.4. Resources

The first indicator of the FS-climate component named "resources" is trying to assess the availability of staff in food companies. This is important since it assures that every employee is capable of dealing with FS issues in a timely manner. It also prevents replacements of staff due to the sickness or leave of becoming a problem and possible FS issue (De Boeck et al., 2015). It seems that Serbian (3.36), Hungarian (3.40) and Polish (3.42) food companies were ambiguous about the extent of human resources in their companies. Romanians agreed the most (4.23) about the statement that the lack of staff is not a problem in terms of FS and hygiene (Table 1). Food producing organization should also provide sufficient support to their human resources in terms of necessary infrastructure, modern equipment, appropriate working places and financial resources to upkeep hygiene and matters (De Boeck et al., 2015). Although Montenegrin (3.82), Polish (3.84) and Ukrainian (3.86) companies achieved the lowest scores, we must conclude that there was no significant differences in self-assessed availability of FS infrastructure between the 10 investigated countries. Almost all of the countries included in our survey belong to the national cultures that prefer to avoid uncertainties with Hofstede index scores above 80. The only exception is Slovakia with uncertainty avoidance index of 51. It is expected that uncertainty avoiding national cultures will have a strong preference towards written (food) safety procedures and instructions (Burke, Chan-Serafin, Salvador, Smith, & Sarpy, 2008). Our investigation confirmed (in general) this standpoint, since the existence of FS procedures and instructions was, on average, the best-assessed "Resource" indicator (4.28) off all. It remains to be explained why and how Slovakian self-assessment score was not significantly different to the scores of other, more uncertainty avoiding, national cultures. Although "Resources" was the weakest FS-climate component for Central and Eastern European food organizations, on average they agreed that resources were not lacking (4.05) (Table 2). It is interesting to note that this is similar to the resource situation observed in Belgium food producing companies (3.9) (De Boeck et al., 2018).

3.2.5. Risk awareness

We know for more than a decade that national cultures affect the way in which FS risks are perceived (Wallace, 2009). Since the recent investigation of Nyarugwe, Linnemann, Ren, et al. (2020) we also know how. The authors conclude, based on their intercontinental investigation, that FS and hygiene risks are better perceived in national cultures with lower power distance and long-term orientation but with higher individualism and uncertainty avoidance. The only country included in our survey, that fits this "description" would be Hungary with average power distance (46) and long term orientation (58) indexes and relatively high individualism (80) and uncertainty avoidance (82) scores (www.hofstede-insights.com). Indeed, Hungarian FS-climate "risk-awareness" component score (4.46) was the highest and above average (4.23) of all the other countries assessed (Table 2). However, our results are not that straightforward in this regard, since the Russian "risk-awareness" component (4.25) was not significantly different to the Hungarian one (4.46). In contrast to Hungary, Russian national culture is characterized with high power distance (93) and long-term orientation (81) indexes, coupled with low individualism (25) but also high uncertainty avoidance (95) scores. This is why we must conclude that we have not perceived a clear influence of national cultures on FS risk-awareness. In general, this FS-climate component in Central and Eastern European countries was self-assessed as very good (4.23) (Table 2) and similar to the same FS-climate component in some Western European countries (De Boeck et al., 2015; De Boeck et al., 2018).

3.3. Operational company characteristics

It was already noted in the US by Ungku Fatimah, Strohbehn, and Arendt (2014) that operational company characteristics like company size, food production characteristics (product riskiness) and FSMS employed could influence FS-culture. We wanted to explore if the same can be concluded for the food companies operating in Central and Eastern Europe and their perception of FS-climate components and their indicators.

3.3.1. Size

We have hypothesized that smaller food companies would have a better self-assessment scores on both "leadership" and "communication" FS-climate components, because in large companies FS leaders/managers are often dislocated from production facilities (Daft, Murphy, & Willmott, 2010) and the communication is more difficult and needs to be structured and accomplished by more trained people (Luning et al., 2015). As expected, smaller companies have provided significantly lower scores on the "leadership" component (4.16), compared to medium (4.39) and big sized (4.30) companies (Table 3). However, it seemed that quality of FS communication within food organizations was assessed as very good (> 4.00) regardless of the company size. This finding contradicts the argument of Van de Ven, Vlerick, and de Jonge (2008) and its implication proposed by De Boeck et al. (2016), that there is a lack of time in large food companies to discuss FS issues and communicate them with fellow employees and/or leaders. It was also assumed that managers and employees working in smaller food companies would exhibit a higher level of commitment to their FS responsibilities because of a substantial personal connection to their (mostly local) customers (Berlin, Lockeretz, & Bell, 2009; Verraes et al., 2015). However, our results revealed that there were no significant differences between small, medium and big food companies in any of the commitment indicators evaluated (Table 3). Regardless of the size of the company the commitment FS-climate component was

Table 3
Food safety climate indicators deployed in terms of company size, food business type and type of certified food safety system (N = 503).

Company size					Food business type [a]			Certified food safety system			Position	
Food safety climate indicators	Mean ± StD[1]	Small	Medium	Big	Animal	Plant	Service	No	HACCP	FSMS	Management	Operation
Leaders set clear objectives concerning hygiene and food safety	4.28 ± 0.89	4.21 ± 0.87[a]	4.39 ± 0.80[b]	4.24 ± 1.02[a]	4.23 ± 0.89	4.32 ± 0.87	4.27 ± 0.92	4.15 ± 1.02	4.31 ± 0.84	4.30 ± 0.86	4.32 ± 0.85	4.26 ± 0.9
Leaders are able to motivate employees to work in a hygienic and food safe way.	4.24 ± 0.85	4.11 ± 0.91[a]	4.34 ± 0.86[b]	4.34 ± 0.70[b]	4.12 ± 0.90[a]	4.29 ± 0.85[b]	4.41 ± 0.73[b]	4.17 ± 0.95	4.24 ± 0.91	4.27 ± 0.81	4.22 ± 0.82	4.25 ± 0.87
Leaders strive for a continuous improvement of hygiene and food safety	4.29 ± 0.82	4.15 ± 0.89[a]	4.43 ± 0.67[b]	4.32 ± 0.84[b]	4.19 ± 0.88	4.38 ± 0.74	4.24 ± 0.84	4.07 ± 1.04	4.33 ± 0.74	4.33 ± 0.76	4.35 ± 0.81	4.26 ± 0.82
Leadership	**4.27 ± 0.71**	**4.16 ± 0.75a**	**4.39 ± 0.66[b]**	**4.30 ± 0.69[b]**	**4.18 ± 0.73**	**4.33 ± 0.68**	**4.30 ± 0.71**	**4.13 ± 0.88**	**4.29 ± 0.70**	**4.30 ± 0.65**	**4.30 ± 0.68**	**4.26 ± 0.72**
Leaders communicate with staff about hygiene and food safety	4.30 ± 0.79	4.22 ± 0.85	4.36 ± 0.70	4.33 ± 0.80	4.23 ± 0.88	4.34 ± 0.73	4.34 ± 0.71	4.20 ± 0.85	4.29 ± 0.86	4.32 ± 0.75	4.34 ± 0.68	4.28 ± 0.83
Operators communicate about hygiene and food safety with leaders	4.04 ± 0.91	4.05 ± 0.85	4.03 ± 0.95	4.04 ± 0.94	3.94 ± 0.91[a]	4.10 ± 0.90[b]	4.11 ± 0.88[b]	3.92 ± 0.96	3.97 ± 1.03	4.10 ± 0.84	3.96 ± 0.89	4.07 ± 0.91
Importance of hygiene and food safety is present by means visual communication (hygiene and food safety posters, signs and/or icons)	4.08 ± 0.93	3.91 ± 0.98[a]	4.10 ± 0.92[b]	4.34 ± 0.80[c]	3.97 ± 1.04	4.10 ± 0.86	4.25 ± 0.87	3.86 ± 1.10[a]	3.90 ± 0.95[b]	4.20 ± 0.86[c]	3.98 ± 0.90[a]	4.12 ± 0.94[b]
Communication	**4.14 ± 0.71**	**4.06 ± 0.73**	**4.17 ± 0.69**	**4.24 ± 0.69**	**4.05 ± 0.79**	**4.18 ± 0.65**	**4.24 ± 0.66**	**3.99 ± 0.80**	**4.05 ± 0.77**	**4.21 ± 0.66**	**4.09 ± 0.67**	**4.16 ± 0.73**
Leaders set a good example concerning hygiene and food safety	4.24 ± 0.88	4.15 ± 0.92	4.32 ± 0.81	4.28 ± 0.89	4.20 ± 0.99	4.24 ± 0.80	4.32 ± 0.81	4.14 ± 0.94	4.22 ± 0.93	4.27 ± 0.85	4.34 ± 0.74	4.20 ± 0.93
Leaders act quickly to correct hygiene and food safety problems/issues	4.28 ± 0.82	4.29 ± 0.76	4.32 ± 0.81	4.20 ± 0.93	4.17 ± 0.91	4.37 ± 0.72	4.27 ± 0.86	4.22 ± 0.74	4.26 ± 0.92	4.30 ± 0.81	4.38 ± 0.75	4.24 ± 0.85
Employees are actively involved by leaders in hygiene and food safety	4.10 ± 0.81	4.08 ± 0.81	4.14 ± 0.79	4.08 ± 0.85	4.03 ± 0.91	4.14 ± 0.73	4.18 ± 0.78	3.98 ± 0.84	4.14 ± 0.89	4.13 ± 0.77	4.19 ± 0.71	4.06 ± 0.84
Commitment	**4.21 ± 0.71**	**4.18 ± 0.70**	**4.26 ± 0.70**	**4.18 ± 0.76**	**4.14 ± 0.82**	**4.25 ± 0.63**	**4.25 ± 0.68**	**4.11 ± 0.69**	**4.21 ± 0.82**	**4.23 ± 0.68**	**4.30 ± 0.61**	**4.17 ± 0.75**
Sufficient staff is available to follow up hygiene and food safety	3.77 ± 1.02	3.71 ± 1.02	3.91 ± 0.97	3.66 ± 1.09	3.69 ± 1.05	3.85 ± 0.97	3.72 ± 1.10	3.64 ± 1.12	3.65 ± 1.04	3.85 ± 0.98	3.83 ± 0.99	3.74 ± 1.04
Infrastructure (e.g. good workspace, good equipment …) is available to be able to work in a hygienic and food safe way	4.10 ± 0.84	4.03 ± 0.83	4.18 ± 0.77	4.10 ± 0.95	4.02 ± 0.92	4.14 ± 0.76	4.20 ± 0.87	3.95 ± 0.88	4.07 ± 0.86	4.15 ± 0.82	4.22 ± 0.74	4.05 ± 0.87
Good hygiene and food safety procedures/instructions are in place	4.28 ± 0.76	4.12 ± 0.81[a]	4.39 ± 0.64[b]	4.40 ± 0.79[b]	4.18 ± 0.87[a]	4.29 ± 0.66[a]	4.46 ± 0.73[b]	4.08 ± 0.81[a]	4.24 ± 0.90[a,b]	4.34 ± 0.69[b]	4.26 ± 0.69	4.29 ± 0.79

(*continued on next page*)

Table 3 (*continued*)

Food safety climate indicators	Mean ± StD[1]	Company size: Small	Medium	Big	Food business type[a]: Animal	Plant	Service	Certified food safety system: No	HACCP	FSMS	Position: Management	Operation
Resources	**4.05 ± 0.71**	**3.96 ± 0.71^{a}**	**4.16 ± 0.64^{b}**	**4.05 ± 0.80^{b}**	**3.96 ± 0.78**	**4.09 ± 0.65**	**4.13 ± 0.71**	**3.89 ± 0.79**	**3.98 ± 0.76**	**4.11 ± 0.67**	**4.10 ± 0.65**	**4.03 ± 0.74**
Risks related to hygiene and food safety are known	4.27 ± 0.73	4.19 ± 0.73^{a}	4.34 ± 0.73^{b}	4.33 ± 0.73^{b}	4.24 ± 0.79^{a,b}	4.36 ± 0.60^{a}	4.08 ± 0.89^{b}	4.14 ± 0.69	4.18 ± 0.92	4.34 ± 0.66	4.31 ± 0.62	4.25 ± 0.77
Risks related to hygiene and food safety are under control	4.21 ± 0.75	4.10 ± 0.74^{a}	4.27 ± 0.77^{b}	4.34 ± 0.73^{b}	4.18 ± 0.76	4.26 ± 0.72	4.15 ± 0.83	4.06 ± 0.73^{a}	4.16 ± 0.86^{a,b}	4.27 ± 0.71^{b}	4.22 ± 0.66	4.21 ± 0.79
Leaders have a realistic picture of the potential problems and risks related to hygiene and food safety	4.21 ± 0.78	4.12 ± 0.81^{a}	4.30 ± 0.71^{b}	4.22 ± 0.80^{a,b}	4.21 ± 0.80	4.22 ± 0.75	4.18 ± 0.80	4.19 ± 0.69	4.07 ± 0.95	4.26 ± 0.73	4.25 ± 0.64	4.19 ± 0.83
Risk awareness	**4.23 ± 0.64**	**4.14 ± 0.63^{a}**	**4.30 ± 0.63^{b}**	**4.30 ± 0.66^{b}**	**4.21 ± 0.68**	**4.28 ± 0.58**	**4.14 ± 0.71**	**4.13 ± 0.59^{a}**	**4.14 ± 0.82^{a}**	**4.29 ± 0.58^{b}**	**4.26 ± 0.54**	**4.22 ± 0.68**
OVERALL	**4.18 ± 0.59**	**4.10 ± 0.59^{a}**	**4.25 ± 0.58^{b}**	**4.21 ± 0.61^{b}**	**4.11 ± 0.65**	**4.23 ± 0.54**	**4.21 ± 0.59**	**4.05 ± 0.63**	**4.13 ± 0.66**	**4.23 ± 0.55**	**4.21 ± 0.53**	**4.16 ± 0.62**

[1] The Mean values ± Standard deviations and modes were obtained from the raw data. Note: Items denoted with different letters are significantly different at the level of 5%. Likert scale: (1) "Strongly disagree", (2) "Disagree", (3) "No opinion", (4) "Agree", (5) "Strongly agree.

[a] Animal origin food sector covers primary production and food processing of meat and poultry, fish, dairy and eggs; Plant origin food sector covers primary production and food processing of fruit, vegetables and beverages; Food service sector covers storage, distribution, wholesale, retail and other food services; HACCP – Hazard Analysis and Critical Control Point; FSMS – Food safety management system (e.g. ISO 22000, BRC, IFS, GlobalGAP).

self-assessed as very good (> 4.10). Numerous authors already established that dealing with FS issues is much more challenging for the small size food companies mostly because of the lack of resources including personnel, finance and expertise (Karabasil et al., 2018; Tomašević et al., 2016; Tomašević et al., 2013). As expected, small food companies in our survey scored FS-climate "resources" component significantly lower (3.96) than medium (4.16) and big sized companies (4.05) (Table 3). They exhibited the lowest level of agreement (4.12) with the presence of FS procedures and instructions. This could be explained by the fact that 28% of small food companies had no certified FS system in place, while the same was the case in 11% of medium and only 6% of big companies surveyed. In the same time, less than a half of small companies (43%) had a certified FSMS (Table 4). Finally, smaller food companies agreed to a lesser extent compared to medium and big food companies to the statement that FS risks are known and that they are under control. This resulted in significantly lower "risk awareness" FS-climate component scores for small (4.10) compared to medium and big (4.30) food companies (Table 3). Overall, FS-climate was scored significantly higher in big (4.21) and medium (4.25) companies compared to small ones (4.10) contradicting the findings of De Boeck et al. (2018) observed in Belgium.

3.3.2. Riskiness profile

AOFPC were classified as high-risk and POFPC as medium-risk FS companies (Jacxsens et al., 2015). Food services, including food retailers were classified as low-risk FS companies because they are perceived as contemporary drivers for FS standards (Havinga, 2013). We have not observed any significant differences in overall FS-climate score between the AOFPC (4.11), POFPC (4.23) and food service (4.21) companies (Table 3). Our findings are in the concurrence with the results of Nyarugwe et al. (2020) that were also unable to find differences in FS-culture in terms of product riskiness. In addition, our results are corroborated by De Boeck et al. (2018) who did not find a significant distinction between the AOFPC and POFPC and FS-climate.

Leaders should be taken responsible for the foundation of good (if possible excellent) overall FS-culture (Yiannas, 2009) and FS-climate as its important element (De Boeck et al., 2018). This is because all employees (old and new) will embrace the principal FS behaviours by learning them from their leaders (Griffith, 2010b), and because companies with a positive FS-culture can have a better FS performance (Nyarugwe, Linnemann, Nyanga, Fogliano, & Luning, 2018). This will increase their potential to reduce the burden of foodborne disease, which is the major responsibility of every FS leader. According to our findings it seems that leadership FS-climate component was perceived as good (all scores > 4.00) and not significantly different between Central and Eastern European AOFPC (4.18), POFPC (4.33) or food services (4.30) (Table 3).

Different studies provided scientific evidence that greater importance to FS requirements exists in companies producing high-risk food products (e.g. meat and dairy) (Djekic et al., 2011; Karaman, Cobanoglu, Tunalioglu, & Ova, 2012) necessarily requiring higher

Table 4
Level of implemented FSMS according to size, food sector and country EU status.

	NO	HACCP	FSMS	TOTAL
Small	60 (28.0%)	62 (29.0%)	92 (43.0%)	214 (100%)
Middle	19 (11.0%)	34 (19.7%)	120 (69.4%)	173 (100%)
Big	7 (6.0%)	10 (8.6%)	99 (85.3%)	116 (100%)
Animal origin	38 (20.1%)	42 (22.2%)	109 (57.7%)	189 (100%)
Plant origin	40 (17.0%)	43 (18.3%)	152 (64.7%)	235 (100%)
Food Service	8 (10.1%)	21 (26.6%)	50 (63.3%)	79 (100%)
EU	36 (12.2%)	54 (18.3%)	205 (69.5%)	295 (100%)
non-EU	50 (24.0%)	52 (25.0%)	106 (51.0%)	208 (100%)

quality and organization of FS communication. However, the overall communication score in Central and Eastern European food business companies seems to be unaffected by their associated level of riskiness. Unexpectedly, the only exception was our observation that food operators are communicating significantly less with their FS leaders in AOFPC (3.94) than in POFPC (4.10) and food service business (4.11) (Table 3). Luning et al. (2011) recognised that companies with a high-risk FS profile that are more vulnerable to FS problems need to be more committed and have advanced control and assurance patterns when compared to those with a low-risk FS profile. Our study revealed that FS-climate "commitment" component was equally assessed as good, irrespective of the FS risk profile of the organization surveyed. In addition, there were no significant differences on how AOFPC, POFPC or food service operators perceived the availability of their resources or the level of their risk awareness (Table 3).

It is expected that high-risk (fish, meat or dairy) FS profile companies are expected to have a more robust, more elaborated and fit-for-purpose FSMS compared to non-animal product processing companies (e.g. fruit/vegetables and potato processing) (De Boeck et al., 2018; Jacxsens et al., 2015). However, in our investigation and for the Central and Eastern part of Europe the opposite was observed. POFPC had a larger share of entities with more elaborated FSMS (64.7%) than AOFPC (57.7%) and smaller percentage of companies with no FSMS (17%) compared to AOFPC (20.1%) (Table 4). We already know that POFPC which have some form of implemented or certified FS program tend to be more complacent because they believe in their systems (Nyarugwe et al., 2020). This might explain why we did not find differences in the prevailing FS-climate between the companies with different FS riskiness levels.

3.3.3. FSMS level

FSMS was already a part of FS-culture assessments (De Boeck et al., 2016; Griffith, Jackson, & Lues, 2017; Nyarugwe et al., 2016). We are aware that having a FSMS is no guarantee of a good FS-climate and FS performance (De Boeck et al., 2015).

We have not observed any significant differences in how FS leadership was self-assessed between food companies with certified FSMS (4.30), with only HACCP (4.29) or without FS system (4.13) (Table 3). Overall, the FS-climate "communication" component was also perceived as good (scores in range of 3.99–4.21) and not significantly different between the companies with different levels of FSMS. Because it is a mandatory requirement in ISO 22000, BRC, IFS and GlobalGAP standards (Djekic, Tomasevic, Zivkovic, & Radovanovic, 2013; Djekic et al., 2014; Tomašević et al., 2013), the presence of FS signs, posters and icons was the highest in companies with elaborated FSMS (4.20), compared to companies with only HACCP (3.90) or without certified food system at all (3.86). FS commitment score was higher in companies with higher level of FSMS (4.23), but the observed difference was not significant compared to HACCP only (4.21) or no certified FS system (4.11) companies. It seems that respondents from FSMS implemented companies agree more (4.27) that risks related to hygiene and FS are under control compared to companies without certified FS system (4.06) and to the extent of making significant difference in overall risk awareness FS-climate component scores (Table 3).

Implementation of FSMS is more challenging for small and medium sized food enterprises mainly due to a lack of resources (Dora, Kumar, Van Goubergen, Molnar, & Gellynck, 2013; Walker, Pritchard, & Forsythe, 2003). Because smaller companies in our research agreed less about the sufficiency of resources compared to big companies (Table 3), it is only plausible that the share of small companies (28.0%) without any FSMS was relatively high and almost five times bigger than the share of big companies (6.0%) (Table 4). Like with the cross-European study of Luning et al. (2015), we have also demonstrated that some small (43.0%) and majority of medium (69.4%) food companies manage to have an advanced FSMS. However, none of these observed differences had an impact on the overall FS-climate score in all types of food companies surveyed in regard to the level of implemented FSMS. This is in contrast with the findings of De Boeck et al. (2016) where a higher FS-climate score was followed by a more elaborated/fit-for-purpose FSMS. Whether the interaction between higher FS-climate and well-elaborated FSMS can be responsible for the higher hygiene and safety status remains to be discovered.

The share of food companies that have adopted a more advanced FSMS in the EU countries we have surveyed was 69.5% while in the non-EU countries it was only a fraction above the half (51%) of entire sample (Table 4). This relatively low percentage observed for non-EU countries could be increased by the demand for compliance with firm voluntary FS standards in order to export food to EU (Jessica Nanyunja et al., 2016), when these countries are granted the permission to do so.

Our results are in accordance with the findings of De Boeck et al. (2018) where third party certification may have predisposed FSMS design and its implementation but not the associated FS-climate. However, the underlying motivation for obtaining a certified and more elaborated FSMS may have played a role in the perception of individual FS-climate components and their indicators, as it was the case with risk awareness or FS procedures and visual communication in our investigation.

Two-thirds (61.8%) (Table 4) of Central and Eastern European food companies had an elaborated FSMS. Positive FS-climate (all scores > 4.00) (Table 3) was percieved irespectable of the FSMS level. Therefore, we can say that all important prerequisites are in place for them to achieve a good FS performance as well (De Boeck et al., 2015; Powell, Jacob, & Chapman, 2011).

3.3.4. Employee position

Both managers (4.21) and operational employees (4.16) perceived a similar and very good overall FS-climate within their food business companies. Evaluation of the five mean FS-climate component scores between management and operational employees revealed no significant differences also (Table 3). This might suggest that both managerial and operational levels of the companies are "on the same wavelength" (De Boeck et al., 2015) since no meaningful perceptual differences were observed for 14 out of 15 individual FS-climate indicators. The only exception was that the managerial staff less agreed (3.98) about the sufficiency of visual FS communication aids (posters, signs, icons) compared to the level of agreement of operational employees (4.12) regarding the same issue. Because leaders and their followers had similar and high perceptions of the FS-climate, higher operational employee FS performance and overall organizational FS commitment could be expected (Cogliser, Schriesheim, Scandura, & Gardner, 2009). Since no discrepancies between FS-climate perceptions were observed in terms of respondent's job position, it seems that Central and Eastern European food companies are effectively avoiding problems in cooperation and trust between different organizational levels that could also affect FS performance of their food production facilities (Luria, 2010).

3.4. Cluster analysis

In order to make deeper insight into FS-climate determinants and below the level of national cultures, a hierarchical cluster analysis was performed based on (15) individual indicator FS-climate scores (Table 5). Two clusters, dividing the sample almost in half in terms of its size, were identified. First cluster contained all the food companies (100%) operating outside EU and from Montenegro, North Macedonia, Russia, Serbia and Ukraine. The number of non-EU food companies was 208 and represented 85% of the overall number of companies (243) enclosed in the Cluster 1. Out of 35 food companies, that originated from EU countries and belonged to Cluster 1, the biggest number came from Poland (10) and Slovakia (10). These 35 EU companies in Cluster 1 represented only 11.9% of all the EU companies (503) included in our survey (Table 5). Therefore, this cluster could be named as 'non-EU

Table 5
Description of the two clusters in terms of country, EU Status, company size, food sector and food safety status (N = 503).

		Cluster 1 (243)	Cluster 2 (260)	Total (503)
Country	Croatia	6 (11.5%)	46 (88.5%)	52 (100%)
	Hungary	3 (10.0%)	27 (90.0%)	30 (100%)
	Montenegro	33 (100.0%)	0 (0.0%)	33 (100%)
	North Macedonia	30 (100.0%)	0 (0.0%)	30 (100%)
	Poland	10 (32.3%)	21 (67.7%)	31 (100%)
	Romania	6 (5.2%)	110 (94.8%)	116 (100%)
	Russia	32 (100.0%)	0 (0.0%)	32 (100%)
	Serbia	56 (100.0%)	0 (0.0%)	56 (100%)
	Slovakia	10 (15.2%)	56 (84.8%)	66 (100%)
	Ukraine	57 (100.0%)	0 (0.0%)	57 (100%)
EU status	EU member state	35 (11.9%)	260 (88.1%)	295 (100%)
	Non-EU state	208 (100.0%)	0 (0.0%)	208 (100%)
	Small size company	106 (49.5%)	108 (50.5%)	214 (100%)
Size	Medium size company	68 (39.3%)	105 (60.7%)	173 (100%)
	Big company	69 (59.5%)	47 (40.5%)	116 (100%)
	Animal origin food	117 (61.9%)	72 (38.1%)	189 (100%)
Food sector [a]	Plant origin food	90 (38.3%)	145 (61.7%)	235 (100%)
	Food service	36 (45.6%)	43 (54.4%)	79 (100%)
	Food safety system not certified	57 (66.3%)	29 (33.7%)	86 (100%)
FSMS status	HACCP certified	60 (56.6%)	46 (43.4%)	106 (100%)
	FSMS certified	126 (40.5%)	185 (59.5%)	311 (100%)
Position	Top management	67 (45.0%)	82 (55.0%)	149 (100%)
	Operating line	176 (49.7%)	178 (50.3%)	354 (100%)
Validated food safety climate indicators		**Cluster 1 (243)**	**Cluster 2 (260)**	**Mean ± StD[1]**
Leaders set clear objectives concerning hygiene and food safety		4.12 ± 0.97[a]	4.42 ± 0.77[b]	4.28 ± 0.89
Leaders are able to motivate employees to work in a hygienic and food safe way.		4.08 ± 1.00[a]	4.40 ± 0.66[b]	4.24 ± 0.85
Leaders strive for a continuous improvement of hygiene and food safety		4.09 ± 0.98[a]	4.47 ± 0.57[b]	4.29 ± 0.82
Leadership		**4.10 ± 0.84[a]**	**4.43 ± 0.52[b]**	**4.27 ± 0.71**
Leaders communicate with staff about hygiene and food safety		4.13 ± 0.92[a]	4.45 ± 0.60[b]	4.30 ± 0.79
Operators communicate about hygiene and food safety with leaders		3.83 ± 1.02[a]	4.23 ± 0.74[b]	4.04 ± 0.91
Importance of hygiene and food safety is present by means visual communication (hygiene and food safety posters, signs and/or icons)		3.93 ± 1.05[a]	4.22 ± 0.79[b]	4.08 ± 0.93
Communication		**3.96 ± 0.83[a]**	**4.30 ± 0.53[b]**	**4.14 ± 0.71**
Leaders set a good example concerning hygiene and food safety		4.02 ± 1.07[a]	4.44 ± 0.59[b]	4.24 ± 0.88
Leaders act quickly to correct hygiene and food safety problems/issues		4.08 ± 0.97[a]	4.47 ± 0.59[b]	4.28 ± 0.82
Employees are actively involved by leaders in hygiene and food safety		3.92 ± 0.91[a]	4.28 ± 0.66[b]	4.10 ± 0.81
Commitment		**4.01 ± 0.85[a]**	**4.39 ± 0.49[b]**	**4.21 ± 0.71**
Sufficient staff is available to follow up hygiene and food safety		3.51 ± 1.14[a]	4.01 ± 0.84[b]	3.77 ± 1.02
Infrastructure (e.g. good workspace, good equipment …) is available to be able to work in a hygienic and food safe way		3.86 ± 0.98[a]	4.33 ± 0.60[b]	4.10 ± 0.84
Good hygiene and food safety procedures/instructions are in place		4.07 ± 0.89[a]	4.47 ± 0.55[b]	4.28 ± 0.76
Resources		**3.81 ± 0.82[a]**	**4.27 ± 0.50[b]**	**4.05 ± 0.71**
Risks related to hygiene and food safety are known		4.12 ± 0.81[a]	4.42 ± 0.61[b]	4.27 ± 0.73
Risks related to hygiene and food safety are under control		4.01 ± 0.87[a]	4.40 ± 0.56[b]	4.21 ± 0.75
Leaders have a realistic picture of the potential problems and risks related to		4.03 ± 0.92[a]	4.37 ± 0.56[b]	4.21 ± 0.78
Risk awareness		**4.05 ± 0.73[a]**	**4.40 ± 0.48[b]**	**4.23 ± 0.64**
OVERALL		**3.99 ± 0.69[a]**	**4.36 ± 0.40[b]**	**4.18 ± 0.59**

[1] The Mean values ± Standard deviations and modes were obtained from the raw data. Note: Items denoted with different letters are significantly different at the level of 5%. Likert scale: (1) "Strongly disagree", (2) "Disagree", (3) "No opinion", (4) "Agree", (5) "Strongly agree".

[a] Animal origin food sector covers primary production and food processing of meat and poultry, fish, dairy and eggs; Plant origin food sector covers primary production and food processing of fruit, vegetables and beverages; Food service sector covers storage, distribution, wholesale, retail and other food servic

companies' cluster. No other distinctive characteristics of the Cluster 1 could be observed. It encompassed 49.5% of small, 39.3% of medium and 59.5% of big companies from the inclusive sample of 503 food companies. Out of 243 companies in Cluster 1, 117 were AOFPC (48%) and 90 were POFPC (37%), while 36 companies (15%) belonged to the food service sector. Half of the companies in Cluster 1 (126) had a certified FSMS and quarter of them (60) had only HACCP while the other quarter (57) had no food system at all (Table 5). More than two thirds of respondents (176) within this cluster were operational employees and almost a third (67) were FS managers.

All of the 260 food companies contained in Cluster 2 were operating within the boundaries of EU and represented 88.11% of the EU member state operating companies from the original sample (Table 5). Therefore, the Cluster 2 could be named as 'EU companies' cluster. This cluster had a larger share of medium sized (60.7%), POFPC (61.7%) and FSMS certified (59.5%) food companies compared to Cluster 1. However, none of these organizational characteristics was so dominant to make a significant distinction between clusters. We would say that the only and obvious distinction between the clusters was that first comprised mostly of the 'non-EU' food companies operating in countries with transition economies, while the second was made of EU food companies exclusively operating in countries with more or less developed economies.

Companies from 'non-EU' cluster agreed significantly lower to the statements about the successfulness of their leaders to set clear FS objectives, to motivate employees to work in a food safe way and to strive for a continuous improvement of hygiene and FS, compared to EU only cluster companies (Table 5). They have also made significantly lower marks on all FS communication indicators, resulting in a significantly lower overall "communication" indicator score (3.96) compared to EU only companies (4.30). It seems that leaders in Cluster 2 are also making better examples concerning FS (4.44), acting quicker to correct FS problems (4.47) and are better in actively involving operational employees in FS matters (4.28). As a result, 'EU companies' self-assessed their FS-climate as significantly more committed to FS (4.39), compared to 'non-EU companies' (4.01). A FS approach can range from "end-of-pipeline" (reactive) (as is evident in many transitioning countries) to "prevention-oriented" (proactive) approach as is within the EU (Luning et al., 2015; Pederson & Hernández, 2014). It was also reported that operating in transitioning economies might lead to inefficient addressment of FS issues compared to non-transitioning countries (Kussaga, Jacxsens, Tiisekwa, & Luning, 2014). We argue that these factors also influenced the perceptions in FS leadership, communication and commitment between the clusters in our investigation.

Non-EU cluster companies agreed significantly less about the sufficiency of resources (3.81) compared to EU companies (4.27). They have not agreed that sufficient staff (3.51) nor infrastructure (3.86) is available to them. This is in concurrence with the findings of Nyarugwe et al. (2020) who also concluded that economic environment have influenced the organisational and technological S support, therefore also influencing FS-climate perceptions of the employees. Non-EU food companies also agreed less (4.07) compared to EU companies (4.47) that FS procedures and instructions are in place. This is explained by the fact that EU companies had a more elaborated FSMS in general (Table 4) and because almost a fourth (23%) of non-EU cluster companies (57) had no FS system in place while only 52% of them had a certified FSMS (126) compared to 71.1% implemented in EU cluster food companies (185) (Table 5). Our results are in agreement with the observation made by Nyarugwe et al. (2020) and J. Nanyunja et al. (2015) that in transition economies FS legislation and its enforcement are feeble, limiting the development of FSMS and depressingly affecting FS-culture. Companies from Cluster 1 also agreed less that risks related to FS are known and under control compared to companies from Cluster 1 (Table 5). Consequently, the complete risk awareness was better scored in EU (4.40) than in non-EU (4.05) cluster companies.

Total FS-climate scores and total component scores separately were all significantly higher in Cluster 2 compared to cluster 1. Companies in EU cluster perceived the FS-climate to be on a higher level (4.36) than companies in non-EU cluster (3.99) (Table 5). We would agree with the observation of De Boeck et al. (2018) that differences in budget for maintaining and developing FS seemed to be related to significant differences in FS-climate. In addition, more stable political and economic situation in EU than in non-EU countries also could have influenced FS-climate perceptions of respondents (Nyarugwe et al., 2020).

4. Study limitations

First limitation of this study is that all FS-climate indicators were measured evenly important in the assessment. We also knew that there is a relation between the FS-climate perceptions and conscientiousness of every individual, his/hers feelings of burnout, as well as job demands and associated stress levels at his/hers working position. However, these factors were not taken into account in our investigation because of questionnaire length that could negatively affect response rates and quality of answers provided. Finally, at the time of writing this manuscript the data on Hofstede's cultural dimension for North Macedonia and Montenegro were not available. Because of its strong temporal dimension, the data for (former) Yugoslavia relating to these two countries was considered outdated and inoperative.

5. Conclusions and future perspectives

This investigation provided an important insight into the Central and Eastern European food industry, beyond traditional FS management and reflected on the human route of its FS-culture. The model used for the FS-climate assessment might not have given objective measurements since it relied on personal perceptions of the survey respondents, but it was already validated by FS experts and it did met nine of the 12 National Research Council guidelines (Jespersen, Griffiths, & Wallace, 2017) for the quality and trustworthiness of the scientifically based culture evaluation systems.

No conclusive evidence for the influence of national culture on the prevailing FS-climate was detected. Instead, significant FS-climate differences between EU and non-EU operating food establishments were observed. EU has adopted extensive FS legislation and strict enforcement practices. Because of this, it has also managed to develop a very good and distinctive EU-FS-climate that supersedes the influence of individual national cultures. Companies working in EU member states, at least those encompassed in our survey, successfully instilled their FS-culture values in their employees eliminating the potential discrepancies originating from national practices and preventing FS practices being altered according to their (national) traditions. Eastern European food companies working in countries with transition economies are inevitably operating in a constantly changing external environment. This seems to have undesirable effect on their FS-climate perceptions and all of its individual components. Of all countries investigated, Poland was assessed with the lowest and Romania with the highest FS-climate scores.

Further research is needed to unveil the (eventual) relation between the (subjective) FS-climate assessment in Central and Eastern European food companies and FS behaviour of their employees alongside (objective) measurements of their FS output.

CRediT authorship contribution statement

Igor Tomasevic: Formal analysis, Writing - review & editing, Data curation, Methodology, Investigation. **Danijela Bursać Kovačević:** Data curation, Investigation. **Anet Režek Jambrak:** Data curation, Investigation. **Szendrő Zsolt:** Data curation, Investigation. **Antonella Dalle Zotte:** Data curation. **Aleksandra Martinović:** Data curation, Investigation. **Mirko Prodanov:** Data curation, Investigation. **Bartosz Sołowiej:** Data curation, Investigation. **Alexandrina Sirbu:** Investigation. **Jonel Subić:** Data curation, Investigation. **Svetlana Roljević:** Data curation, Investigation. **Anastasia Semenova:** Data curation, Investigation. **Miro Kročko:** Data curation, Investigation. **Viera Duckova:** Data curation, Investigation. **Andriy Getya:** Data curation, Investigation. **Oksana Kravchenko:** Data curation, Investigation. **Ilija Djekic:** Data curation, Methodology, Investigation.

References

Berlin, L., Lockeretz, W., & Bell, R. (2009). Purchasing foods produced on organic, small and local farms: A mixed method analysis of new England consumers. *Renewable Agriculture and Food Systems, 24*(4), 267–275.

Burke, M. J., Chan-Serafin, S., Salvador, R., Smith, A., & Sarpy, S. A. (2008). The role of national culture and organizational climate in safety training effectiveness. *European Journal of Work & Organizational Psychology, 17*(1), 133–152.

Cogliser, C. C., Schriesheim, C. A., Scandura, T. A., & Gardner, W. L. (2009). Balance in leader and follower perceptions of leader–member exchange: Relationships with performance and work attitudes. *The Leadership Quarterly, 20*(3), 452–465.

Daft, R. L., Murphy, J., & Willmott, H. (2010). *Organization theory and design: Cengage learning EMEA*.

De Boeck, E., Jacxsens, L., Bollaerts, M., Uyttendaele, M., & Vlerick, P. (2016). Interplay between food safety climate, food safety management system and microbiological hygiene in farm butcheries and affiliated butcher shops. *Food Control, 65*, 78–91.

De Boeck, E., Jacxsens, L., Bollaerts, M., & Vlerick, P. (2015). Food safety climate in food processing organizations: Development and validation of a self-assessment tool. *Trends in Food Science & Technology, 46*(2), 242–251 Part A.

De Boeck, E., Jacxsens, L., Mortier, A. V., & Vlerick, P. (2018). Quantitative study of food safety climate in Belgian food processing companies in view of their organizational characteristics. *Food Control, 88*, 15–27.

De Boeck, E., Mortier, A. V., Jacxsens, L., Dequidt, L., & Vlerick, P. (2017). Towards an extended food safety culture model: Studying the moderating role of burnout and jobstress, the mediating role of food safety knowledge and motivation in the relation between food safety climate and food safety behavior. *Trends in Food Science & Technology, 62*, 202–214.

Denison, D., Hooijberg, R., Lane, N., & Lief, C. (2012). *Leading culture change in global organizations: Aligning culture and strategy, Vol. 394*. John Wiley & Sons.

Djekic, I., Kuzmanović, J., Anđelković, A., Saračević, M., Stojanović, M. M., & Tomašević, I. (2016). Effects of HACCP on process hygiene in different types of Serbian food establishments. *Food Control, 60*, 131–137.

Djekic, I., Tomasevic, I., & Radovanovic, R. (2011). Quality and food safety issues revealed in certified food companies in three Western Balkans countries. *Food Control, 22*(11), 1736–1741.

Djekic, I., Tomasevic, I., Zivkovic, N., & Radovanovic, R. (2013). Types of food control and application of seven basic quality tools in certified food companies in Serbia. *Quality Assurance and Safety of Crops & Foods, 5*(4), 325–332.

Djekic, I., Tomic, N., Smigic, N., Tomasevic, I., Radovanovic, R., & Rajkovic, A. (2014). Quality management effects in certified Serbian companies producing food of animal origin. *Total Quality Management and Business Excellence, 25*(3–4), 383–396.

Dora, M., Kumar, M., Van Goubergen, D., Molnar, A., & Gellynck, X. (2013). Food quality management system: Reviewing assessment strategies and a feasibility study for European food small and medium-sized enterprises. *Food Control, 31*(2), 607–616.

Dzwolak, W. (2019). Assessment of HACCP plans in standardized food safety management systems – the case of small-sized Polish food businesses. *Food Control, 106*.

EFSA (2018). The European Union summary report on trends and sources of zoonoses, zoonotic agents and food-borne outbreaks in 2017. *EFSA Journal, 16*(12), e05500.

FoodDrinkEurope (2019). *Data & trends of the European food and drink industry 2019.* (Brussels).

Gächter, S., Nosenzo, D., Renner, E., & Sefton, M. (2012). Who makes a good leader? Cooperativeness, optimism, and leading-by-example. *Economic Inquiry, 50*(4), 953–967.

Goolaup, S., & Ismayilov, T. (2012). *The influence of power distance on leadership behaviours and styles: Case studies of Japanese and French companies operating in Sweden*.

Griffith, C. J. (2010a). The assessment of food safety culture. *British Food Journal, 112*(4), 439–456.

Griffith, C. J. (2010b). Food safety culture: The evolution of an emerging risk factor? *British Food Journal, 112*(4), 426–438 2010 v.2112 no.2014.

Griffith, C. J., Jackson, L. M., & Lues, R. (2017). The food safety culture in a large South African food service complex: Perspectives on a case study. *British Food Journal, 119*(4), 729–743.

Havinga, T. (2013). *Food retailers as drivers for food safety standards.* Available at: SSRN 2331869.

Hofstede, G. (2005). *Cultures and organizations : Comparing values, behaviors, institutions, and organizations across nations.* Thousand Oaks: Sage Publications.

Hofstede, G., & Minkov, M. (2005). *Cultures and organizations: Software of the mind, Vol. 2*. Citeseer.

Jacxsens, L., Kirezieva, K., Luning, P. A., Ingelrham, J., Diricks, H., & Uyttendaele, M. (2015). Measuring microbial food safety output and comparing self-checking systems of food business operators in Belgium. *Food Control, 49*, 59–69.

Jaques, E. (1952). *The changing culture of a factory.* Oxford, England: The Dryden Press.

Jespersen, L., Griffiths, M., & Wallace, C. A. (2017). Comparative analysis of existing food safety culture evaluation systems. *Food Control, 79*, 371–379.

Kahanec, M., & Pytliková, M. (2017). The economic impact of east–west migration on the European Union. *Empirica, 44*(3), 407–434.

Karabasil, N., Bošković, T., Tomašević, I., Vasilev, D., Dimitrijević, M., Katanić, N., et al. (2018). Production of traditional meat products in small and micro establishments in Serbia: Current status and future perspectives. *Acta Veterinaria Brno, 68*(4), 373–390.

Karaman, A. D., Cobanoglu, F., Tunalioglu, R., & Ova, G. (2012). Barriers and benefits of the implementation of food safety management systems among the Turkish dairy industry: A case study. *Food Control, 25*(2), 732–739.

Kotter, J. P. (1992). *Corporate culture and performance.* New York: Free Press.

Kussaga, J. B., Jacxsens, L., Tiisekwa, B. P., & Luning, P. A. (2014). Food safety management systems performance in african food processing companies: A review of deficiencies and possible improvement strategies. *Journal of the Science of Food and Agriculture, 94*(11), 2154–2169.

Luning, P. A., Kirezieva, K., Hagelaar, G., Rovira, J., Uyttendaele, M., & Jacxsens, L. (2015). Performance assessment of food safety management systems in animal-based food companies in view of their context characteristics: A European study. *Food Control, 49*, 11–22.

Luning, P. A., Marcelis, W. J., Rovira, J., van Boekel, M. A. J. S., Uyttendaele, M., & Jacxsens, L. (2011). A tool to diagnose context riskiness in view of food safety activities and microbiological safety output. *Trends in Food Science & Technology, 22*, S67–S79.

Luria, G. (2010). The social aspects of safety management: Trust and safety climate. *Accident Analysis & Prevention, 42*(4), 1288–1295.

Meyer, E. (2014). *The culture map: Breaking through the invisible boundaries of global business.* Public Affairs.

Miocinovic, J., Keskic, T., Miloradovic, Z., Kos, A., Tomasevic, I., & Pudja, P. (2017). The aflatoxin M1 crisis in the Serbian dairy sector: The year after. *Food Additives and Contaminants: Part B Surveillance, 10*(1), 1–4.

Mirilović, M., Tajdić, N., Vejnović, B., Đurić, S., Mirilović, N., Maris, S., et al. (2019). Distribution of Trichinella infections in pigs and Trichinellosis in humans in Serbia from 1994 to 2018. *Veterinarski Glasnik, 73*(2), 133–143.

Nanyunja, J., Jacxsens, L., Kirezieva, K., Kaaya, A. N., Uyttendaele, M., & Luning, P. A. (2015). Assessing the status of food safety management systems for fresh produce production in east africa: Evidence from certified green bean farms in Kenya and noncertified hot pepper farms in Uganda. *Journal of Food Protection, 78*(6), 1081–1089.

Nanyunja, J., Jacxsens, L., Kirezieva, K., Kaaya, A. N., Uyttendaele, M., & Luning, P. A. (2016). Shift in performance of food safety management systems in supply chains: Case of green bean chain in Kenya versus hot pepper chain in Uganda. *Journal of the Science of Food and Agriculture, 96*(10), 3380–3392.

Nardon, L., & Steers, M. (2009). The culture theory jungle: Divergence and convergence in models of national culture. In R. Bhagat (Ed.). *Cambridge handbook of culture, organizations, and work*. Cambridge: Cambridge University Press.

Nyarugwe, S. P., Linnemann, A., Hofstede, G. J., Fogliano, V., & Luning, P. A. (2016). Determinants for conducting food safety culture research. *Trends in Food Science & Technology, 56*, 77–87.

Nyarugwe, S. P., Linnemann, A. R., & Luning, P. A. (2020a). Prevailing food safety culture in companies operating in a transition economy - does product riskiness matter? *Food Control, 107*, 106803.

Nyarugwe, S. P., Linnemann, A., Nyanga, L. K., Fogliano, V., & Luning, P. A. (2018). Food safety culture assessment using a comprehensive mixed-methods approach: A comparative study in dairy processing organisations in an emerging economy. *Food Control, 84*, 186–196.

Nyarugwe, S. P., Linnemann, A. R., Ren, Y., Bakker, E.-J., Kussaga, J. B., Watson, D., et al. (2020b). An intercontinental analysis of food safety culture in view of food safety governance and national values. *Food Control, 111*, 107075.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and policy in mental health, 42*(5), 533–544.

Pederson, R., & Hernández, G. (2014). *Food safety: State-of-play, current and future challenges.* 282, 014 http://www.europarl.europa.eu/RegData/etudes/IDAN/2014/536287/IPOL_IDA.

Powell, D. A., Jacob, C. J., & Chapman, B. J. (2011). Enhancing food safety culture to reduce rates of foodborne illness. *Food Control, 22*(6), 817–822.

Pozio, E. (2019). Trichinella and trichinellosis in Europe. *Veterinarski Glasnik, 73*(2), 65–84.

Schein, E. H. (2001). Corporate culture. In N. J. Smelser, & P. B. Baltes (Eds.). *International encyclopedia of the social & behavioral sciences* (pp. 2788–2792). Oxford: Pergamon.

Smigic, N., Djekic, I., Tomasevic, I., & Miocinovic, J. (2012). Implication of food safety measures on microbiological quality of raw and pasteurized milk. *Food Control, 25*(2), 728–731.

Tamarozzi, F., Akhan, O., Cretu, C. M., Vutova, K., Akinci, D., Chipeva, R., et al. (2018). Prevalence of abdominal cystic echinococcosis in rural Bulgaria, Romania, and Turkey: A cross-sectional, ultrasound-based, population study from the HERACLES project. *The Lancet Infectious Diseases, 18*(7), 769–778.

Tomasevic, I., Dodevska, M., Simić, M., Raicevic, S., Matovic, V., & Djekic, I. (2017). The use and control of nitrites in Serbian meat industry and the influence of mandatory HACCP implementation. *Meat Science, 134*, 76–78.

Tomasevic, I., Dodevska, M., Simić, M., Raicevic, S., Matovic, V., & Djekic, I. (2018). A decade of sulphite control in Serbian meat industry and the effect of HACCP. *Food Additives and Contaminants: Part B Surveillance, 11*(1), 49–53.

Tomasevic, I., Kuzmanović, J., Anđelković, A., Saračević, M., Stojanović, M. M., & Djekic, I. (2016). The effects of mandatory HACCP implementation on microbiological indicators of process hygiene in meat processing and retail establishments in Serbia. *Meat Science, 114*, 54–57.

Tomasevic, I., Petrović, J., Jovetić, M., Raičević, S., Milojević, M., & Miočinović, J. (2015). Two year survey on the occurrence and seasonal variation of aflatoxin M1 in milk and milk products in Serbia. *Food Control, 56*, 64–70.

Tomašević, I., Šmigić, N., Dekić, I., Zarić, V., Tomić, N., & Rajković, A. (2013). Serbian meat industry: A survey on food safety management systems implementation. *Food Control, 32*(1), 25–30.

Tomašević, I., Šmigić, N., Đekić, I., Zarić, V., Tomić, N., Miocinovic, J., et al. (2016). Evaluation of food safety management systems in Serbian dairy industry. *Mljekarstvo, 66*(1), 48–58.

Ungku Fatimah, U. Z. A., Strohbehn, C. H., & Arendt, S. W. (2014). An empirical investigation of food safety culture in onsite foodservice operations. *Food Control, 46*,

255–263.
Van de Ven, B., Vlerick, P., & de Jonge, J. (2008). The interplay of job demands, job resources and cognitive outcomes in informatics. *Stress and Health, 24*(5), 375–382.
Verraes, C., Uyttendaele, M., Clinquart, A., Daube, G., Sindic, M., Berkvens, D., et al. (2015). Microbiological safety and quality aspects of the short supply chain: SWOT analysis of the Belgian case study. *British Food Journal, 117*(9), 2250–2264.
Walker, E., Pritchard, C., & Forsythe, S. (2003). Hazard analysis critical control point and prerequisite programme implementation in small and medium size food businesses. *Food Control, 14*(3), 169–174.
Wallace, C. A. (2009). *The impact of personnel, training, culture and organisational factors on application of the HACCP system for food safety management in a multinational organisation.* University of Central Lancashire.
WHO (2017). In H. Kruse (Ed.). *The burden of foodborne diseases in the who european region.* Copenhagen: World Health Organization.
Yaffe, T., & Kark, R. (2011). Leading by example: The case of leader OCB. *Journal of Applied Psychology, 96*(4), 806–826.
Yiannas, F. (2009). Communicating food safety effectively. *Food safety culture: Creating a behavior-based food safety management system* (pp. 1–7). New York, NY: Springer (New York).