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THE STABILITY AND COMPETITIVENESS OF CZECH FOOD PROCESSING ENTERPRISES

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Abstract

A necessary condition for the competitiveness of food processing enterprises and food supply chains is stability and resilience, which is conditioned by a flexible response to potential risks. This paper analyzes factors of competitive food production, factors of stability of food production, existing risks, and responses of companies to the past crisis related to the Russian-Ukrainian conflict. All these factors were evaluated in terms of the size of the enterprise. The survey took place between October and November 2023. 368 companies throughout the Czech Republic were sent the survey, and the return rate was 18.75%. The sample of respondents was 69 enterprises (N=69). The obtained data was evaluated using basic descriptive statistics. Nonparametric statistical analysis (Fisher's exact test) and Spearman's correlation coefficient were used. The survey results show that production costs are considered a critical factor in competitiveness, regardless of the company's size. The pillars of the stability of the entire food chain are food safety and process safety. In the period of the Russian-Ukrainian conflict, food companies were mostly faced with the risks of competition and changes in the market. The most common measures for the experienced crisis are process innovation, stock purchase, and fixing of supply prices in contracts.

Keywords: *Czech Republic, food industry, competitiveness, stability, risks*

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1 INTRODUCTION

The current times are characterized by a dynamic and challenging competitive environment that requires companies to constantly adapt, innovate, and think strategically to remain competitive. In order to increase their competitive position in the market, firms are creating supply chains. The backbone of these chains is stability and resilience. Stability requires efficient use of production resources in line with sustainability principles, monitoring, rapid response to potential risks, and flexibility throughout the chain. The food sector in the Czech Republic was chosen for this study. This environment has experienced the most significant disruption due to COVID-19 and the Russian-Ukrainian conflict. The food industry is critical in any economy, both from a micro and macro perspective. The study is a case study. The paper presents the current state of perception of stability and competitiveness of Czech food enterprises. We focused on mapping the situation in the food industry and the enterprises' perception of stability and competitiveness factors. We assume that awareness of these factors and related risks is the primary and crucial step towards better understanding and managing these risks or prevention. Therefore, the factors of competitive food production, the factors of stability of food production, the existing risks, and the reactions of enterprises to the Russian-Ukrainian conflict were analyzed. All these factors were considered in relation to the size of the enterprise.

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We recognized a scientific gap based on the analysis and synthesis of professional studies and research. There are not enough relevant studies that address the direct relationship between the implemented risk management system and its impact on competitiveness and resilience, especially in food producers.

The structure is divided into individual chapters. The introduction clarifies the issue and the definition of the research problem. The second part is devoted to theoretical foundations related to the stability and competitiveness of food producers. The third part is the research methodology. The fourth part presents and interprets the empirical results, including a discussion. The conclusion summarizes the research results and states its limits.

2 THEORETICAL BACKGROUND

A company that wants to thrive in the market must know the factors of competitiveness. The term "competitiveness" is one of the most commonly used concepts in economics, but it is not precise enough, which means that there is no generally accepted definition of competitiveness. In their study, Siudek and Zawojska (2014) provide definitions, measures and determinants of competitiveness. They conclude that classic factors such as division of labor and specialization, market share, cost/price, and productivity are increasingly being displaced by advances in technology and innovation, sustainability principles, and resourcing. All of these create new opportunities but also constraints in gaining, maintaining, and improving competitiveness against rivals in an increasingly complex, globalized economy . The factors of competitiveness are detailed by Zastempowski and Cyfert (2023), who state that capabilities such as competence, flexibility, responsiveness and speed are central to improving the competitive position of an SME (as measured by market share and profit). In order to survive and remain competitive in dynamic, hyper-competitive and unpredictable business environments, organizations must quickly adapt to changes and market conditions (Barlette & Baillette, 2022). In such circumstances, a critical factor in building competitive advantages is agility, which is the ability to operate in a competitive environment due to, and despite, constant changes, rapidly respond to changes and market movements, and create value for products and services value-based on customer satisfaction (Barlette & Baillette, 2022). Du et al. (2021) add that agility positively affects a company's sales, profitability, market share, customer satisfaction and speed to market. How individual companies perceive these competitiveness factors is the subject of many studies. This study focuses on small and medium-sized enterprises (SMEs) since these enterprises make up the majority of respondents. SMEs comprise over 99 % of European Union (E.U.) enterprises and are, therefore, the central part of the EU-27 economy (European Commission, 2024). European SMEs have faced significant challenges in recent years. Among the most significant challenges have been the COVID-19 pandemic, global supply chain disruptions, the Russia-Ukraine crisis, and rising input costs that have led to historically high inflation. All of this has threatened the stability of companies and chains.

SMEs make up the majority of the food sector in all E.U. countries. These enterprises are multifaceted and essential for a healthy, dynamic, resilient economy. Their importance lies primarily in job creation, innovation, local development, increasing competitiveness, specialization and flexibility, human capital development etc. SMEs also diversify the economy and reduce dependence on large corporations, contributing to economic resilience in times of crisis. This paper focuses on the food sector, where SMEs play a key role. The food products production sector is one of the traditional sectors of the processing industry and cooperates with other industries such as food engineering, packaging production and other food-related production. The overall characteristics of the monitored sector also include its macroeconomic position.

The main factors of competitiveness of food companies include several key areas: product quality, compliance with strict hygiene standards, production costs (their management and reduction), flexibility about customers, production productivity, efficient use of production data, product quality and safety, qualified personnel, and overall equipment effectiveness (OEE). These factors influence each other, and their combination determines the overall competitiveness of a food company in the market. The way Czech companies perceive the factors of competitiveness and stability is a partial objective of this paper. In recent years, the management of individual logistics processes has been directed towards managing the entire supply chain with the primary goal of satisfying the final customer's needs. The supply chain can then be understood as a system of manufacturers, subcontractors, suppliers, sellers, and customers between which a two-way logistics flow operates. The modern market is highly competitive. It has progressed from traditional competition between enterprises to competition between supply chains (Jiao et al., 2021). The supply chain can take on different shapes, forms, and structures, depending on the industry. In particular, globalization predetermines the complexity of chains, where the purchase of raw materials, partial production, assembly of products and distribution can occur in different parts of the world. Supply chain flexibility is essential to build a sustainable competitive edge in coping with uncertainty (Liao, 2020). From this point of view, pressure is placed on supply chains' flexibility and stability. As diseases, natural disasters and human-caused disturbances become more frequent and severe, increasing the resilience of processes and activities in the agri-food supply chain is an increasing challenge (Zhong et al., 2024). In particular, geopolitical events significantly impact the stability of food chains. These chains must then be able to develop a robust resilience strategy to accelerate recovery in the chain and mitigate the impacts of global food security (Belhadi, 2024). Food systems rely on natural resources for production, which causes their depletion (Allali et al., 2024). Everyone is under pressure from the principles of sustainability.

One of the essential factors of competitiveness and a necessary condition for staying in the market is food safety. Food safety is the main pillar of European food policy and is required throughout the entire food chain. From a market perspective, it is about the fact that consumers have access to safe and quality food products and are protected from risks. The significant aspects of ensuring food safety are sharing data, facts and figures, and standards to improve preventive control measures (Chauhan et al., 2023). Both laws and standards beyond legislative regulations ensure food safety. The most important documents at the level of state food safety include the Green Book on the General Principles of Food Law, the White Book on the Health Safety of Food and the Food Safety Strategy at the European Union and the Czech Republic. The private standards play an essential role in food safety governance and determine market access in international trade (Raymond & Shibu, 2023). Food manufacturers introduce food safety standards to increase their competitive position in the market. For a food manufacturing company, food safety plays a vital role in maintaining its reputation, so entrepreneurs adopt certification standard systems to safeguard consumers (Zanatta et al., 2023). However, food safety is conditioned by a practical approach to quality, risk and environmental management. Madilo (2024) discusses the importance and challenges of food safety. Standards are also implemented to improve business processes. ISO 9001, ISO 22000, BRC, IFS are among the most used in corporate practice. The use of risk management systems according to the ISO 31000 standard in the food industry has not yet been thoroughly enough studied. We believe

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that Czech food companies still underestimate the implementation of certificates. Therefore, attention was focused on this fact in the research.

Global food security has recently been seriously threatened by the rapid increase in world population, problems caused by climate change and the emergence of new pandemics (Thorakkattu et al., 2024). Due to the supply chain's (SC) increasing vulnerability, fragility, and operational failures, disruption management has become a critical issue in the food SC. Thus, companies try to improve their resilience in dealing with unexpected conditions (Sezer et al., 2024). The global food industry is essential for promoting sustainability, contributing to environmental degradation, and promoting positive change (Prasanna et al., 2024). However, the agri-food industry, dominated by SMEs in many countries, is susceptible to the benefits, costs and potential risks of sustainability-oriented innovations (Depetris-Chauvin et al., 2023). SMEs struggle with sustainable development. Their characteristics require different sustainability management approaches than those used by more considerable enterprises (Kuechler et al., 2024). The agri-food sector faces a significant challenge in decoupling its economic growth from energy consumption (Martzopoulou & Komninos, 2019). Due to the overly-convenient availability of food, rapid development, progressive prosperity, and trends in developed countries, many problems related to food waste and excess have appeared in society, and the situation is getting worse (Huang et al., 2020). As grocery delivery continues to grow in popularity, an increasing number of consumers are embracing this convenience as part of their lifestyle. However, the problem of food waste created by the food delivery industry has become an urgent problem for society (Xu et al., 2024). A sustainable food chain is capable of buffering against environmental damage and economic losses triggered by food waste (Iqbal & Kang, 2024). Xu et al. (2024) found a positive and statistically significant relationship between corporate resilience and implemented sustainability principles.

Based on the principles of sustainability and circular economy, it is necessary to implement sustainable approaches in food production. These directions are required not only by legislation but also by consumers themselves. Suppliers and wholesale chains are also increasingly demanding sustainable standards. This can strengthen the competitive position in the food market. The sustainable development goal (SDG) 12.3 calls for halving food waste at the retail and consumer levels and minimizing losses in food supply chains by 2030. There are already studies that aim to develop a roadmap of sustainability practices and evaluation mechanisms to advance the assessment of sustainable supply chain performance in the food supply chain (Bravo et al., 2021). The studies published to date contribute significantly to the emerging literature on ESG risk management and corporate sustainability in the agri-food industry by mapping such risks and summarizing the main practices agri-food companies use to manage them (Boiral et al., 2024). Gocer et al. (2024) addresses new risks related to the implementation of sustainability principles in food companies: managers identified and commented on new risks arising from sustainability initiatives. These sustainability-induced risks were perceived to threaten operational performance, drive increased costs, and negatively impact product quality and delivery performance. However, there are notable risks for SMEs, too. They require significant financial and human resources to keep pace with rapid innovation dynamics and may face difficulties in finding investors for scaling up. Strategies focused on reshoring or regionalizing supply chains may disrupt existing relationships and contracts with large companies outside the European Union. Furthermore, SMEs downstream in the value chain may face pressures to innovate and modernize their operations to remain competitive (European Commission, 2024). SMEs face various obstacles and barriers resulting from the turbulent environment (Virglerová et al., 2021). Such risks include cyber threats, natural disasters,

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changes in legislation, increasing competition in the market and related changes, disruption of business continuity, the emergence of new technologies, lack of skilled workers, and others. Publications on how SMEs perceive these risks have been published by, e.g., Virglerova et al. (2020) and Kljucnikov and Majkova (2018).

3 RESEARCH OBJECTIVE, METHODOLOGY AND DATA

This study analyzes factors of competitive food production, factors of stability of food production, existing risks, and companies' responses to the crisis related to the Russian-Ukrainian conflict. All these factors were evaluated in terms of the size of the enterprise. Initially, a literature search was performed, and weworked mainly with indexed Web of Science and Scopus articles and European Union directives. The scientific focus was on competitiveness and competitiveness factors, the importance of SMEs in the food industry, risks and sustainability of food chains. SMEs are defined in the EU recommendation 2003/361. The main factors determining whether an enterprise is a SME are staff headcount, turnover, or balance sheet total. For the purposes of our study, we categorized companies by number of employees: microenterprise <10 employment, small <50 employment, medium-sized <250 employment), and large enterprise with more than 250 employees (European Union, 2003). Data collection was carried out through a nationwide questionnaire survey in the Czech Republic. The questionnaire was distributed to 368 enterprises nationwide between October and December 2023. The questionnaire was distributed by Survio, e-mail address (online version), and SMEs were also contacted by phone. Statistical validation of the data was based on four research questions. The return rate was 18.75 %, and the sample of respondents was 69 enterprises, with medium-sized enterprises being the most represented (33.3%; 23 enterprises); see Table 1. The low return rate represents a methodological limitation that may reduce the validity of the tested hypotheses. Nevertheless, the research results can be considered a contribution and a novelty, as it brings completely unique insights from the food industry in relation to competitiveness and risks. Nonparametric statistical analysis (Fisher's exact test) and Spearman's correlation coefficient were used.

4 RESULTS AND DISCUSSION

This chapter summarizes the results of the questionnaire survey. In Table 1, the respondents are divided according to the size of the company, respectively the number of employees.

Tab. 1 – Breakdown of enterprises by size. Source: own research

Enterprises size by number of employees:	n	%
Micro enterprise 1-9 employees	13	18,8 %
Small enterprise 10-49 employees	17	24,6 %
Medium enterprise 50-249 employees	23	33,3 %
Large enterprise with more than 250 employees	16	23,2 %
Total	69	100,0 %

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Depending on the size of the company, four research questions (RQ) were formulated and evaluated, which were developed into hypotheses (null and alternative). The questions in the questionnaire survey were always tested in relation to the size of the company.

RQ1: Which competitiveness factors do food enterprises consider most important?

H0: There is no statistical relationship between the size of the enterprise and the perception of competitiveness factors.

HA: There is a statistical relationship between the size of the enterprise and the perception of competitiveness factors.

RQ2: Which factors condition the stability of the Food Supply Chain?

HO: There is no statistical relationship between the size of the company and the factors that determine the stability of the food chain.

HA: There is a statistical relationship between the size of the company and the factors that determine the stability of the food chain.

RQ3: What risks has your enterprise faced in response to the Russian-Ukrainian conflict?

HO: There is no statistically significant relationship between the size of the enterprise and the occurrence of the defined risks.

HA: There is a statistically significant relationship between the size of the enterprise and the occurrence of the defined risks.

RQ4: How is your enterprise responding to the current economic crisis?

HO: There is no statistically significant relationship between the size of the company and the response to the economic crisis.

HA: There is a statistically significant relationship between the size of the company and the response to the economic crisis.

The evaluation was performed at a significance level of $\alpha = 5\%$. Respondents answered the questions with Yes/No, Agree/Disagree response options. Only "Yes" answers are always shown in the tables.

The first research question was, "What do you currently consider to be a factor in competitive food production?". Table 2 shows the "yes" responses. The factor that has the greatest influence on the competitiveness of food production was production costs (their management and reduction). 100% of monitored companies agree with this factor, regardless of their size. As the study by Hamilton et al. (2024) notes, increasing costs in the transport and logistics processes in the agrarian sector significantly affected the allocation of production in the agricultural and food sectors. Among the other studies that correspond to the findings are Musayeva et al. (2024), which examines the dependence of production costs in achieving competitiveness of Ukrainian confectionery manufacturers. The second most frequently cited factor is production productivity. This factor was mentioned by 97.1% of enterprises - small, medium and large enterprises all mentioned this factor, and micro-enterprises accounted for 84.6% of enterprises (11 enterprises). The same overall share of companies also reported product quality and safety. 100% of micro and medium enterprises focus on this factor. For large enterprises, it is 93.8%. There are many ways companies can increase the productivity of their production and logistics processes, from the introduction of process standards, the use of elements of lean management

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to business process reengineering. A number of studies also deal with the relationship between industry 4.0 and performance in manufacturing. Studies that demonstrate the impact of industry 4.0 on the efficiency and productivity of food production include Yap and Al-Mutairi (2024) and Avilés-Sacoto et al. (2024). Manufacturing productivity should be the main performance objective to maintain competitiveness in the market. A modified Fisher's exact test was used to verify the hypotheses H0 and HA and to test differences between companies of different sizes (Table 3). The classical $\chi 2$ test of independence could not be used due to the large number of underrepresented categories. There are statistically significant differences between enterprises in the case of the factors: "flexibility in relation to customers" and "production productivity". In other cases, differences in the choice of factors between companies are not statistically significant. Based on the testing, H0 was confirmed.

Tab. 2 – Factors of competitive food production depending on the size of the enterprise. Source: created by the authors

RQ1 You currently consider the factor of competitive food production to be:	Enterprise size by number of employees				
	Micro enterprise 1-9 employees	Small enterprise 10-49 employees	Medium enterprise 50-249 employees	Large enterprise with more than 250 employees	Total
Total	13 (100 %)	17 (100 %)	23 (100 %)	16 (100 %)	69 (100 %)
production costs (their management and reduction)	13 (100 %)	17 (100 %)	23 (100 %)	16 (100 %)	69 (100 %)
flexibility in relation to customers	10 (76,9 %)	17 (100 %)	20 (87 %)	16 (100 %)	63 (91,3 %)
production productivity	11 (84,6 %)	17 (100 %)	23 (100 %)	16 (100 %)	67 (97,1 %)
efficient use of production data	10 (76,9 %)	13 (76,5 %)	18 (78,3 %)	16 (100 %)	57 (82,6 %)
product quality and safety	13 (100 %)	16 (94,1 %)	23 (100 %)	15 (93,8 %)	67 (97,1 %)
qualified staff	10 (76,9 %)	13 (76,5 %)	22 (95,7 %)	15 (93,8 %)	60 (87 %)
traceability	7 (53,8 %)	12 (70,6 %)	15 (65,2 %)	12 (75 %)	46 (66,7 %)
overall equipment efficiency	7 (53,8 %)	14 (82,4 %)	20 (87 %)	15 (93,8 %)	56 (81,2 %)

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Tab. 3 – Fisher's exact test. Source: created by the authors

Tab. 3 – Fisher's exact test	P-value
production costs (their management and reduction)	x
flexibility in relation to customers	0,048*
production productivity	0,033*
efficient use of production data	0,160
product quality and safety	0,549
qualified staff	0,154
traceability	0,675
overall equipment efficiency	0,053

Note: *statistically significant differences between enterprises in terms of size at the α = 5% significance level

Table 4 shows the "Yes, I agree" answers to question 2 – "The stability of the food supply chain (food chain from raw material to final customer) is conditioned." Overall, enterprises most frequently agree with the statement "Food safety (from raw material to final product at the customer)" and "Process safety." Safety in food production is a key requirement of legislative and legal regulations, and in recent years it has come to the forefront of consumer interests. This is also confirmed by Kumar et al. (2024), which points to the importance of compliance with legal and legislative regulations to ensure food safety. Based on hypothesis testing at the significance level α = 5%, H0 was confirmed. The only statistically significant difference in agreement with the statements is for flexibility, with 87% of medium-sized and 81.3% of large enterprises agreeing, but only 53.8% of micro and 52.9% of small enterprises. Muruvvet et al. (2024) proves that higher flexibility, information technology capability and integration of digitization elements significantly contribute to resilience and stability within the entire chain. The systemic concept of supply chains is conditioned by close ties and interaction between individual elements within the entire chain or the entire network. A study that emphasizes cooperation between elements of the food chain and indicates directions and possibilities for how managers can use cooperation to ensure stability in the chain Magoti et al. (2022).

Tab. 4 – Stability factors depending on company size. Source: created by the authors

RQ2 The stability of the food supply chain (the food chain from the raw material to the final customer) is conditioned by:	Enterprise size by number of employees				
	Micro enterprise 1-9 employees	Small enterprise 10-49 employees	Medium enterprise 50-249 employees	Large enterprise with more than 250 employees	Total
Total	13 (100 %)	17 (100 %)	23 (100 %)	16 (100 %)	69 (100 %)

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food safety (from raw material to final product at the customer's site)	11 (84,6 %)	16 (94,1 %)	22 (95,7 %)	16 (100 %)	65 (94,2 %)
food quality	11 (84,6 %)	14 (82,4 %)	22 (95,7 %)	15 (93,8 %)	62 (89,9 %)
process safety	12 (92,3 %)	17 (100 %)	19 (82,6 %)	15 (93,8 %)	63 (91,3 %)
flexibility	7 (53,8 %)	9 (52,9 %)	20 (87 %)	13 (81,3 %)	49 (71 %)
digital connection between supplier and customer	7 (53,8 %)	8 (47,1 %)	11 (47,8 %)	10 (62,5 %)	36 (52,2 %)
logistics	11 (84,6 %)	13 (76,5 %)	22 (95,7 %)	16 (100 %)	62 (89,9 %)
information sharing throughout the chain	10 (76,9 %)	12 (70,6 %)	14 (60,9 %)	12 (75 %)	48 (69,6 %)
more efficient use of resources throughout the chain	13 (100 %)	12 (70,6 %)	19 (82,6 %)	13 (81,3 %)	57 (82,6 %)

Tab. 5 – Fisher's exact test. Source: created by the authors.

Fisher's exact test	P-value
food safety (from raw material to final product at the customer's site)	0,460
food quality	0,522
process safety	0,293
flexibility	0,043*
digital connection between supplier and customer	0,826
logistics	0,081
information sharing throughout the chain	0,767
more efficient use of resources throughout the chain	0,206

Note: *statistically significant differences between enterprises in terms of size at the α = 5% significance level.

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The dynamic and turbulent environment of recent times has resulted in an economic crisis. In recent years, the global economy has gone through several significant crises. The COVID-19 pandemic (2020-2022) caused a global economic recession, leading to business closures, rising unemployment and disruption of supply chains. The government's response was to support businesses through extensive stimulus packages. This was followed by the energy crisis (2021-2022), which was caused by a combination of factors including the post-pandemic recovery and the Russian invasion of Ukraine. The whole of Europe was reeling under a rapid increase in energy prices. The third significant limit was the inflationary crisis (2021-2023). High inflation in many countries forced a response from central banks to raise interest rates. These crises had different impacts on different parts of the world, but generally led to economic uncertainty and volatility in global markets. Again, this paper focused on how food industry companies perceive risks and how they face them.

Research question 3 was "What risks did your society face in response to the Russian-Ukrainian conflict?" Overall, enterprises most frequently identified competition and market changes. This risk was mentioned by 88.4 % of all enterprises (61 enterprises). However, there are no differences in this risk between enterprise sizes (Tab. 6; Tab. 7). The studies of Choi and Cho (2024) and Bakke et al. (2022) deal with increasing foreign competition and its effect on company performance. The risk of changes in the market is also confirmed by Indap and Tanyas (2025), which point to price changes throughout the chain, as well as increased consumer perception in the area of food safety. The risk of changes in the market caused by the COVID-19 pandemic meant an increase in raw material and food prices for all agri-food chains. An example is the U.S. economy, where there has been the largest increase in food prices since 1970 (Volpe et al., 2024). Past crises, especially COVID-19, meant for food chains a change in the approach to traceability solutions and a higher rate of use of smart elements and applications. Chenyang and Jinbo (2024) show that the trends of digitalization and mechanization in food production, cold chain logistics, smart logistics, online shopping and health-conscious consumption that emerged during the pandemic will continue to persist and evolve in the post-pandemic era.

Based on the results presented above, only in the case of the risk of competition and changes in the market was HA confirmed, i.e., the statistical dependence between the investigated question and the size of the company. For other risks, H0 can be confirmed.

Different-sized enterprises see different perceptions of risk in the following risks: cyber threats, changes in legislation, emergence of new technologies and lack of skilled workers. In all these cases, medium and large enterprises are more likely to perceive these risks than small or micro enterprises.

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Tab. 6 – Chosen risks depending on the size of the company. Source: created by the authors

RQ3 Has your enterprise faced any of these risks?	Enterprise size by number of employees				
	Micro enterprise 1-9 employees	Small enterprise 10-49 employees	Medium enterprise 50-249 employees	Large enterprise with more than 250 employees	Total
Total	13 (100 %)	17 (100 %)	23 (100 %)	16 (100 %)	69 (100 %)
Cyber threats	2 (15,4 %)	1 (5,9 %)	1 (4,3 %)	7 (43,8 %)	11 (15,9 %)
Natural disasters	3 (23,1 %)	0 (0 %)	3 (13 %)	2 (12,5 %)	8 (11,6 %)
Changes in legislation	4 (30,8 %)	4 (23,5 %)	13 (56,5 %)	14 (87,5 %)	35 (50,7 %)
Competition, changes in the market	12 (92,3 %)	16 (94,1 %)	20 (87 %)	13 (81,3 %)	61 (88,4 %)
Disruption of business continuity	8 (61,5 %)	4 (23,5 %)	13 (56,5 %)	6 (37,5 %)	31 (44,9 %)
The advent of new technologies	2 (15,4 %)	2 (11,8 %)	6 (26,1 %)	9 (56,3 %)	19 (27,5 %)
Fires, explosions	0 (0 %)	0 (0 %)	1 (4,3 %)	1 (6,3 %)	2 (2,9 %)
Lack of qualified workers	7 (53,8 %)	6 (35,3 %)	15 (65,2 %)	14 (87,5 %)	42 (60,9 %)

Tab. 7 – Fisher's exact test. Source: created by the authors

Fisher's exact test	P-Value
Cyber threats	0,006*
Natural disasters	0,210
Changes in legislation	<0,001*
Competition, changes in the market	0,697
Disruption of enterprises continuity	0,108
The advent of new technologies	0,029*
Fires, explosions	0,833
Lack of qualified workers	0,018*

Note: *statistically significant differences between enterprises in terms of size at the $\alpha = 5\%$ significance level.

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The fourth research question looked at the reaction of enterprises to the economic crisis. The question was worded as follows: “Are the enterprises responding to the current economic crisis?” The results of the survey show that enterprises are most often innovating processes, buying inventory and fixing supply prices in contracts. Statistically significant differences in the approach of enterprises to the current economic crisis are as follows: purchasing inventories; automating operations due to lack of human resources; changes in the approach of production planning and implementation of risk management and business safety systems. The smallest enterprises most often opt for changes in the production planning approach, while large enterprises focus on price fixing, automation and also changes in the production planning approach. Overall, the data shows that small and micro enterprises choose fewer options than large enterprises, where all solution options are used by at least 62.5% of the large enterprises surveyed (Tab. 8; Tab. 9). Considering the results of the tested relationships, H0 has been proven. There is no statistical relationship between the size of the company and the response to the economic crisis.

Tab. 8 – Enterprises responses to the crisis by enterprise size. Source: created by the authors

RQ4 The enterprise is reacting to the current economic crisis:	Enterprise size by number of employees				
	Micro enterprise 1-9 employees	Small enterprise 10-49 employees	Medium enterprise 50-249 employees	Large enterprise with more than 250 employees	Total
Total	13 (100 %)	17 (100 %)	23 (100 %)	16 (100 %)	69 (100 %)
by purchasing stock	6 (46,2 %)	16 (94,1 %)	13 (56,5 %)	11 (68,8 %)	46 (66,7 %)
fixing prices and deliveries in contracts	6 (46,2 %)	11 (64,7 %)	14 (60,9 %)	14 (87,5 %)	45 (65,2 %)
automation of operations due to lack of human resources	4 (30,8 %)	8 (47,1 %)	18 (78,3 %)	14 (87,5 %)	44 (63,8 %)
changes in the production planning approach	8 (61,5 %)	7 (41,2 %)	15 (65,2 %)	14 (87,5 %)	44 (63,8 %)
process innovation	7 (53,8 %)	9 (52,9 %)	19 (82,6 %)	12 (75 %)	47 (68,1 %)
rationalisation of production using modern elements of industry 4.0	2 (15,4 %)	6 (35,3 %)	10 (43,5 %)	8 (50 %)	26 (37,7 %)

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introduction of a risk management and enterprises safety system	1 (7,7 %)	6 (35,3 %)	7 (30,4 %)	10 (62,5 %)	24 (34,8 %)

Tab. 1 – Fisher's exact test. Source: created by the authors

Fisher's exact test	P-value
by purchasing stock	0,017*
fixing pries and deliveries in contracts	0,110
automation of operations due to lack of human resources	0,003*
changes in the production planning approach	0,049*
process innovation	0,135
rationalisation of production using modern elements of industry 4.0	0,249
introduction of a risk management and business safety system	0,020*
Lack of qualified workers	0,018*

Note: *statistically significant differences between enterprises in terms of size at the α = 5% significance level.

Innovation in the form of digital transformation of processes and food supply chains to ensure the stability and sustainability of these chains is addressed by the studies of Wang et al. (2024), Bag et al. 2024, and Gomez and Lee (2023). Food quality and safety are a prerequisite for the stable functioning of not only the company itself, but also the chain as a whole. Weconsidered it important to map the level of implementation of certificates related to quality and safety. The most used in company practice are ISO 9001, ISO 22 000, BRC, and IFS. Figure 1 shows the implementation of certificates in Czech food enterprises. It is worrying that only 3 respondents out of 69 companies have ISO 31000. This standard allows for effective risk management, which increases the safety of operations both in one organization and in the entire chain.

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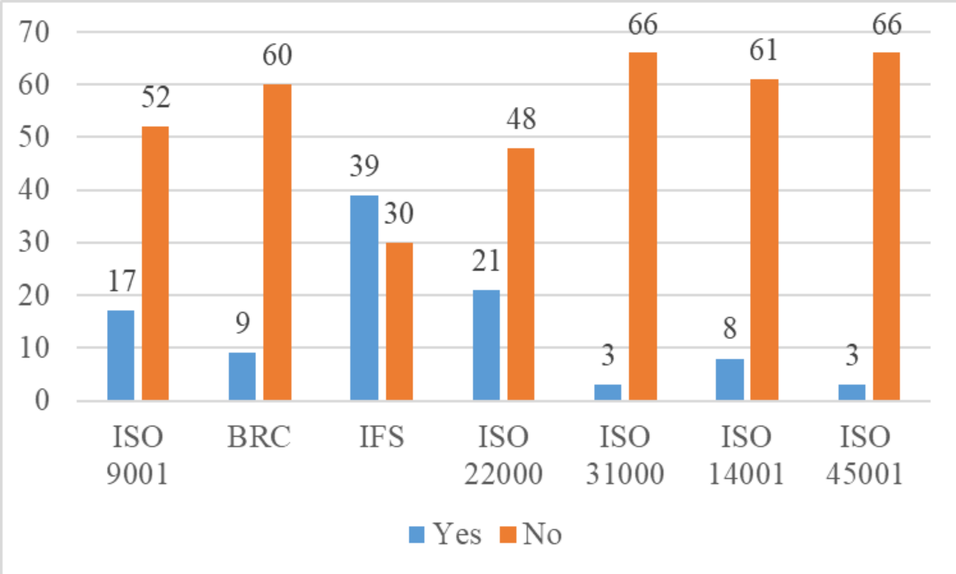

Fig. 1 – Number of certificates. Source: created by the authors

The certificate related to risk management is ISO 31 000. It is not surprising that, as the size of the company increases, the number of certificates awarded also increases (Spearman's correlation coefficient; R = 0.578; p-value <0.001).

Tab. 10 – Number of certificates by company size. Source: created by the authors

Number of certificates	Enterprise size by number of employees				
	Micro enterprise 1-9 employees	Small enterprise 10-49 employees	Medium enterprise 50-249 employees	Large enterprise with more than 250 employees	Total
Number	13	17	23	16	69
Average	0,5	1,0	1,5	2,7	1,4
Median	0,0	1,0	1,0	2,0	1,0
Minimum	0,0	0,0	0,0	1,0	0,0
Maximum	2,0	3,0	4,0	7,0	7,0
Standard deviation	0,8	0,9	0,9	1,9	1,4

The research questions were oriented towards the competitiveness and stability of food chains. A number of economic crises have disrupted these chains and created new potential risks that require specific measures. The aim of the research was to map and analyse the factors of competitive food production, factors of food production stability, existing risks and the responses of companies to the crisis related to the Russian-Ukrainian conflict. All these factors were assessed in relation to the size of the companies. The results of the survey show that production costs are considered a critical factor of competitiveness regardless of the size of the company. The pillars of the stability of the entire food chain are food safety and process safety. During the Russian-Ukrainian conflict, food companies are mostly confronted with the risks of competition and changes in the market. The most common measures for the experienced crisis are process innovation, purchasing supplies and fixing supplier prices in contracts. All these

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research questions were compared with current professional scientific articles as part of the discussion.

International comparison and discussion of the Czech findings

Competitiveness drivers and E.U. context

The finding that costs are the key driver of competitiveness is consistent with European and global evidence. In 2022-2023, the European Union experienced sharp increases in energy and other input prices related to the war in Ukraine and disruptions in agricultural commodity markets. The FAO Food Price Index peaked in March 2022 and has since fluctuated at lower levels. International surveys (ECB/SAFE; EIB; OECD) simultaneously document that firms across the European Union responded with greater investment caution, cost-saving measures, and automation. Among SMEs, financing constraints and cost pressures were more pronounced. These patterns closely mirror the Czech responses (automation, changes in production planning, price fixing, building inventories).

Stability pillars (food safety and process safety)

The view of Czech companies that stability is conditioned by food safety and process safety is fully consistent with the European General Food Law framework (Regulation (EC) No 178/2002) and with practices in E.U. member states. Emphasis on system-based safety management (HACCP, ISO 22000, IFS/BRC) and on traceability is consistently associated in international studies with resilience and access to markets.

Risk perception: competition, regulation, skills, cyber

Identifying competition and market changes as the dominant risk aligns with findings from other advanced markets (e.g., the United Kingdom, Germany and the European Union as a whole). In some countries, this is compounded by strong regulatory pressures (waste/packaging, environmental obligations) and skill shortages—patterns that are visible in our Czech sample particularly among medium-sized and large firms (statistically more frequent references to legislative changes, labour shortages and cyber risks).

Firms' responses in 2022-2023

The measures chosen by Czech firms are consistent with European practice during the 2022-2023 energy-inflation episode, when firms combined short-term demand and cost-side adaptation (savings, price fixing, inventory building) with investments in digitalisation/automation to reduce dependence on labour and energy and to raise productivity.

Certifications and risk management

International data (ISO Survey) confirmed high absolute numbers of ISO 9001/14001/22000 certifications in advanced economies and their concentration in larger firms. Our finding of low penetration of ISO 31000 in the food industry contrasts with best-practice recommendations and matches the broader European debate on strengthening enterprise risk management in SMEs. We therefore recommend that support programmes (industry associations, the Ministry of Industry and Trade, the Technology Agency of the Czech Republic) target the adoption of ISO 31000/27001 in food manufacturing, especially among SMEs, where cyber and operational risks accumulate.

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5 CONCLUSION

During the economic crises of COVID-19, the Russian-Ukrainian conflict, and the energy and inflation crises, the importance of the agri-food sector remained at the forefront. This is to ensure healthy, safe and affordable food. Competition is still high in this sector, including a wide range of domestic and foreign companies. What food companies were forced to deal with in 2021 were the prices of inputs, especially energy, fuel, packaging, and some agricultural raw materials. Food chains are made up of both large producers and regional micro-enterprises. The synergistic effect of the economy is achieved by linking individual subcontractors into a chain. The activities and processes of individual elements are then reflected in the competitiveness and stability of the entire chain. The subject of this paper was how individual companies perceive the factors of competitiveness, stability, and risks arising from the crises mentioned above. The research sample was food companies registered in the Ministry of Agriculture of the Czech Republic database. The limit is, therefore, the national area.

This research is a contribution to both theory and practical perception. The literature search analyzes factors of competitiveness and stability in food chains, the importance of SMEs for this agri-food sector, as well as directions for the future development of food companies in accordance with the principles of sustainability. The research results confirmed that production costs are the most important factor of competitiveness. Due to the inflationary crisis and the rise in food prices, there was an increase in production costs, which weakened the position of domestic food producers and, on the contrary, increased foreign competition. Another aspect affecting the competitiveness of food companies is production productivity. Food safety and process safety are considered the most important factors in the stability of food chains, which was also confirmed by other studies. Legislative and legal regulations require food safety. It can be supported by using one of the certificates, focused either on production safety or on process and risk management itself. Research has shown that this area is a weak point for Czech food producers. As a result of the Russian-Ukrainian conflict, enterprises faced the risk of competition and the risk of changes in the market. The most common measures were innovating processes, buying inventory, and fixing supply prices in contracts. For a future research project, we would like to focus on the degree of use of industry 4.0 and 5.0 in enterprises of this type, as these technologies can help to increase productivity and flexibility not only in the enterprise itself but also in the entire chain.

The limitation of this contribution is that the research questions are verified only at the national level. For a deeper understanding and expansion of the researched issue, it would be interesting to conduct research at the level of more economies, e.g. V4 countries. In addition, future studies could look at how introducing modern technologies, digital tools, and industry 4.0 and 5.0 principles contribute to sustainable food production and strengthen the competitiveness of producers. These aspects include, for example, innovative farming technologies, digitalization of processes, IoT monitoring, blockchain for supply chain transparency, or AI-based resource optimisation.

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