

THESES OF THE DOCTORAL (PhD) DISSERTATION

OPPORTUNITIES FOR INCREASING CONSUMER TRUST IN FOOD, WITH A PARTICULAR FOCUS ON SHORT SUPPLY CHAINS' CONSUMERS

Csordás Adrián

Supervisor:

Dr. habil. Füzesi István

Associate Professor



UNIVERSITY OF DEBRECEN

Károly Ihrig Doctoral School of Management and Business

Debrecen

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1. RESEARCH BACKGROUND

The world and the economy are changing rapidly, so businesses need to be able to adapt to a dynamic environment. Information technology and the internet, in particular, have become an integral part of life. The use of these is now essential for businesses. The successful players seek sustainable and multi-sourced competitive advantage, which they expect to derive mainly from introducing new technologies and innovative solutions, which puts increasing emphasis on knowledge and R&D.

While today anyone can afford the software technology (and the hardware) that supports the efficient use of the large amounts of information and data generated by business organizations, the business application of the computer was initially the innovation itself. The competition in the field of hardware prices still has been going (more powerful, less expensive, even smaller hardware for the same price), but the priority tends to move on the software development.

IT has been supporting the use of business data since the 1960s when computers were first used in corporate environments. While initially computers were only used to process data, today they are also used to improve the efficiency of management, to gain business benefits, and to exploit intelligent online solutions. One effective tool for data management is an integrated Enterprise Resource Planning system that models business processes. It supports Customer Relationship Management (CRM) and Supply Chain Management (SCM) in addition to the core functions. Business intelligence (BI) tools are increasingly available to enterprises for decision support, either as embedded or stand-alone systems.

Getting the right information at the right time is a primary condition for decision support. In the years of Industry 4.0, communication between different systems is no longer a vision, nor is the use of robotic solutions in many areas. Although various sensor-based, networked devices were used in the past, thanks to software advances, these Internet of Things now provide businesses with even more accurate and faster access to their data and eliminate the possibility of human mistakes. This data can also contain sensitive business information, which must be properly encrypted. At the same time, some business data can also be shared with consumers as added value, so the correct allocation of rights is essential.

Shortly, several new solutions could help to overcome this difficulty. One of them is blockchain technology. Recent publications emphasize that this innovation could take data sharing to a new, higher level. This technology could revolutionize product tracking and encrypting, however, blockchain is immature, so its costs and returns can only be estimated imprecisely. Although most research stresses the potential to revolutionize product tracking of blockchain, there are already several alternatives for sharing higher volumes and quality of product information. These less technology-based solutions are more likely to go back to the "old days". These alternatives eliminate the need for long, multi-actor food supply chains, where the extent of information sharing is only determined by legal requirements.

The situation of food supply chains is special in many ways. They are more vulnerable than other industries due to several factors (natural disasters, food safety concerns, social incidents, changing consumer attitudes), making sustainable economic development more difficult to achieve.

The dissertation examines the food safety risks that may drive consumers towards new food sources. First, I simulated the change in the number of potential consumers interested in the technological solution. Because blockchain-based food traceability is not only hampered by the implementation and the associated technical and financial difficulties but also by the lack of global consumer interest. Considering that the production and sharing of additional information about food are assumed to be only locally feasible and profitable, I also study a form of response to this phenomenon from a 'logistical' approach. Therefore, a significant part of the thesis is devoted to alternative food supply chains. One of the solutions facing the global supply chain is the network of farm shops. These can be operated by farmers engaged in agricultural activities. The primary objective of these shops is to sell their own products directly to the final consumer without the involvement of intermediaries.

Given that food purchasing habits can be influenced by several factors. Therefore my dissertation also analyses the characteristics of the farmer shops' potential consumers'. Knowing customer preferences is also essential because different marketing communication tools may be needed to target different consumer groups effectively. The central question of the research is how farmer shops communicate with their potential customers, how they

share information, and how they integrate modern online solutions into their business processes to ensure long-term competitive advantage.

2. OBJECTIVES

Nowadays, consumers are increasingly asking questions about the safety and origin of food. This phenomenon could be partly explained by globalization, which has led to the production of large quantities of these products worldwide. These goods' transport, distribution, and use in producing other products are carried out through a complex global food supply chain. Given that the consumer does not have sufficient knowledge of the conditions under which food is produced to make a credible distinction between the products on offer, the consumer's trust in the producer can be decisive when making a purchase. Building trust can depend on many factors, but the role of marketing is essential. Not only are manufacturers using the internet to build their own brands or to reach consumers, but unfortunately, there is also an increasing amount of fake news circulating, which can be used to create panic or even undermine trust in competitors. Considering the amount of data that is generated today, it would require a considerable amount of research to verify its credibility. In addition to real food safety risks, news from uncertain sources based on measurements that are difficult to verify further reduces perceived global food safety levels. To gain consumers' confidence, manufacturers are showing a willingness to share extra information with customers beyond the legal requirements. This could be necessary because more and more consumers are health-conscious and want to buy quality food. Several studies have shown that these consumers consider traceability closely related to quality. In order to provide the additional information needed for traceability throughout the global food supply chain, producers have to share information and knowledge with other actors in the supply chain. To do so, it is necessary to define the level of integration in their processes and the depth of cooperation to avoid any possible abuses that could jeopardize their competitiveness. Blockchain technology offers solutions to these problems that were not previously possible at such a high level. At the same time, the costs of implementation and payback are uncertain or, in many cases, complicated to estimate. Companies are likely to expect consumers to bear at least part of the financial burden of introducing this technology. In response to possible price increases, consumers interested in more information may move towards alternatives where legal regulations guarantee the origin and quality of products rather than technological standards. The regulation of the examined farmer shops is also quite strict. These shops can only sell raw or processed products produced on the farm and,

to a limited extent, sell products from third parties (these origins are also known). In addition to the legal conditions, it is also possible to establish a personal relationship with the producer, allowing consumers to obtain more information about the product. Figure 1 illustrates the logical structure of the research covering the above topics.

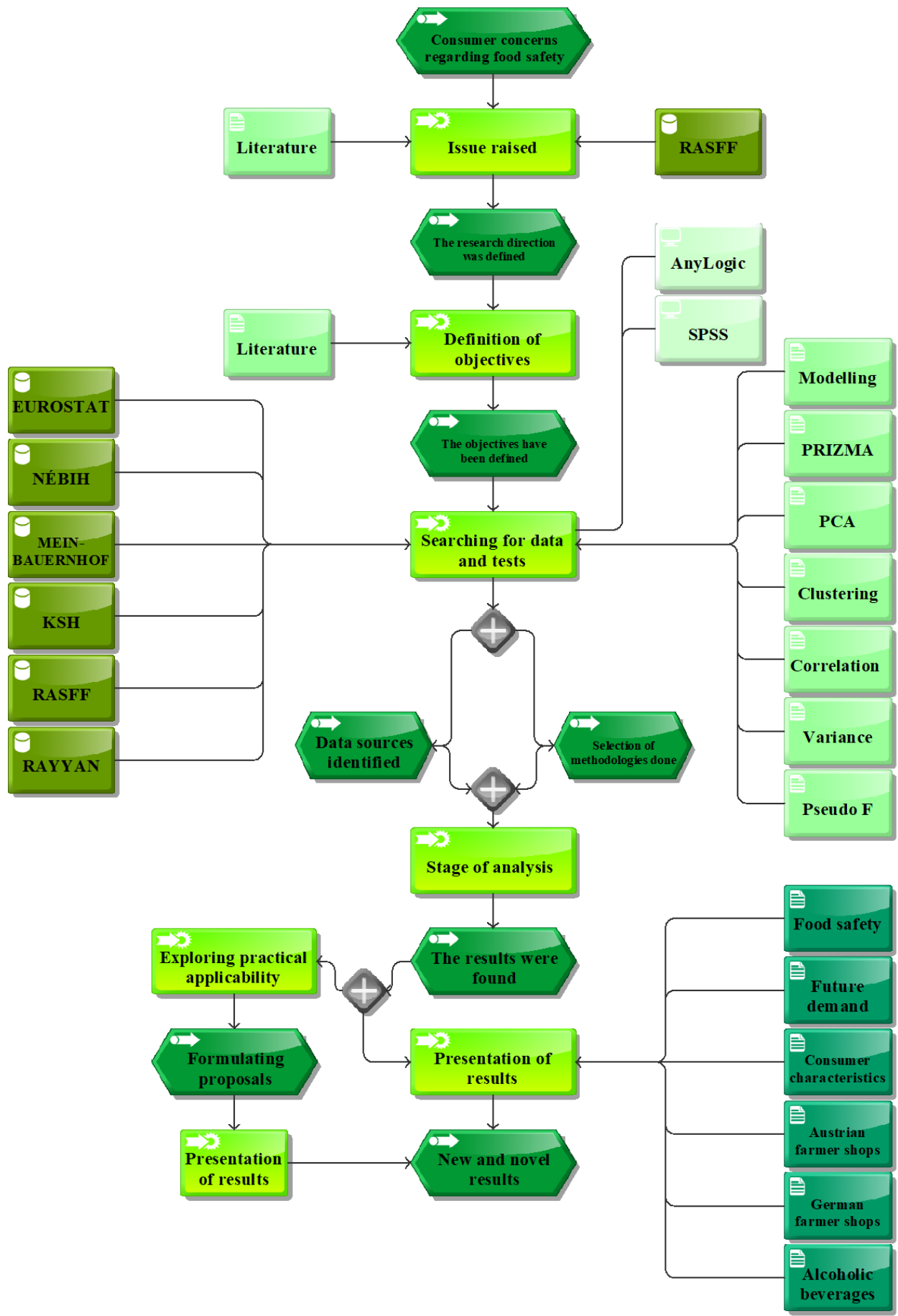


Figure 1: Logical structure of the research

Source: own elaboration, 2022

The overall objective of my thesis is to analyze the above shortly described type of alternative food supply channels' offer in Hungary, Austria, and Germany. The dissertation also studies the consumers who purchase from alternative sources to reveal those factors that could influence their preference for food purchasing. Taking into account the increasing trend of online shopping and the appearance of the coronavirus, the role of online ordering and home delivery has been increasing further. In addition to the existence of an online store, the availability of product information is essential for online ordering. Therefore, I looked not only at these online ordering opportunities but also at farm websites.

The online image of producers is also crucial for sales. For this reason, I included this aspect of branding in the research. The study of online shops was also a significant part of the dissertation. In addition, I added the examination of social media usage because the customers need to be not only addressed but also informed and retained. This is one of the areas that the SMARTCHAIN (2022) project identified, where significant improvement for producers involved in SFSC (short supply chain) is needed. The project also stresses the importance of sharing more information regarding the origin and production of food, which can be a way to increase consumer trust. Therefore, the dissertation's results are intended to provide suggestions to the producers on how to improve their online marketing performance at a low cost significantly.

Numerous studies have investigated the characteristics that influence consumers' food purchasing (LAURETI and BENEDETTI, 2018; KOEN et al., 2018). In addition to organic food (LE-ANH and NGUYEN-TO, 2020), novel food (GALATI et al., 2021; GALATI et al., 2019) and GMO (BOCCIA et al., 2018) products are also increasingly analyzed. The studies usually include socio-demographic factors to investigate the decisions of different consumer groups. One possible source of food purchasing is the producer who offers direct sales. Domestic studies show that for smaller farms, the transfer (inheritance) of the farm is a problem, as well as the shrinking and aging customer base and the lack of public support (KISS et al., 2020; KERÉNYI and TÖRÖK, 2019). The number of Hungarian farmers' markets has been stagnating or slightly increasing for years (MÉSZÁROS et al., 2019), and this low growth rate rather offers better opportunities for mainly (offline) sales, especially in the capital city area (KISS et al., 2020).

Austria is one of the greenest countries in the world (WORLD POPULATION REVIEW, 2022), and the environmental awareness of its population plays a major role in this. This is reflected, among other things, that a significant proportion of consumers prefer local and sustainably produced products when buying food (JEYAKUMAR NATHAN et al., 2021). Furthermore, small farms as a source of food supply, enjoy not only the support of consumers but also the government (SCHERMER, 2015). Social media offer the opportunity to increase support (comments that demonstrate satisfaction) and promotion (public and information-rich profile). Given that Facebook ads in Austria reach almost 40% of the population and YouTube ads almost 90% (DATAREPORTAL, 2022), it can be assumed that the already popular farm shops are present in this segment of the digital space in some form. Research by STOCKINGER et al., (2013) revealed that Austrian direct sellers are most present on Facebook in terms of social media. YouTube and Twitter are much less popular. Germany and Austria are only a few places behind each other on the list of the world's greenest countries (WORLD POPULATION REVIEW, 2022). However, the German online consumers, who can also be described as environmental-friendly when it comes to food purchases (MOSER, 2016), buy higher proportion of physical goods than Austrian consumers (NETS, 2020). Given the significant size of the German market, this 4% difference is presumably also reflected in the online presence of farm shops. Indeed, based on previous research, it is known that in 2018, 25% of German retailers (HANDELSVERBAND DEUTSCHLAND, 2021), while only 22% of Austrian retailers (2017) operated their own online shops (GITTENBERGER and ZINIEL, 2018).

Online sales can be influenced not only by the proportion of consumers who buy online but also by the characteristics of the product. The study by ROGUS et al., (2019) highlighted that consumers prefer to buy non-perishable food online.

Based on these findings, I defined the following objectives

1. To investigate what food safety risks may be driving consumers towards alternative food sources.
2. To analyze the likely future demand for products offering more accurate traceability.
3. To study the characteristics of consumers who purchase from alternative food supply chains.

4. To analyze the network of farmers' shops as a variant of alternative food supply chains based on Hungarian, Austrian and German data.
5. To determine the level of online presence of farm shops, which may have a major impact on their success and sustainability.

3. MATERIAL AND METHODS

The general aim of this dissertation is to investigate what kind of alternatives could be chosen for the consumers who are dissatisfied with traditional products, to receive higher food safety (or trust in the producer), higher food quality, and more product information in addition to the possibility of online shopping. The research starts by identifying the root cause of the trust deficit, i.e., the different food safety risks. In this way, I aim to identify one of the possible roots of the problem. Furthermore, based on international analyses, to identify the difficulties perceived by consumers that the alternatives may be successful in addressing. The dissertation also explores alternative directions that are or are likely to be available in some form to meet consumers' food purchasing preferences. Stricter legislation on the production and labeling of organic products is one of them. This is covered by regulation 2018/848 OF EURÓPAI PARLAMENT (2018). This requires more product information to be shared than for traditional products. However, even this extra information does not provide better, more accurate information on the origin of the product and the conditions under which it was produced. It rather guarantees that the food cannot be produced under certain conditions.

Blockchain-based systems can offer a solution for enhancing traceability through the technological approach in the case of large-scale production. However, overcoming the problem of providing additional information can be a significant challenge for companies. Firstly, there is no standard against which supply chain actors of different profiles and sizes can implement such a system. Consequently, implementation costs and return on investment are not quantifiable or even estimable. Given the systemic change, it is likely that this would be a significant burden for supply chain actors. However, even at this cost, the switch could be worthwhile if consumer demand for products with additional information would be solvent. Due to the lack of studies related to the consumers' willingness to pay, I have conducted a simulation analysis regarding the expected future number of them. This is particularly important because the other alternatives could be real options if there is no possibility of developing a (technological) solution at a global level.

I also studied the alternatives offered by logistics. Alternative food supply chains could be one of the successful directions. Through the sale of locally grown and/or produced products, they are opposed to selling goods from traditional global food supply chains, i.e., products from foreign countries with unknown "story". However, alternative food supply chains generally do not offer the possibility for the consumer to have direct contact with the producer and thus gain access to more information. Alternative solutions that achieve the sale of food by completely cutting out the mediators are collectively referred to as short food supply chains. This is important because the established global networks' actors, stores, and brands are well-known to consumers. However, the marketing possibilities of small producers are rather limited. To increase their competitiveness, they need to know the consumers' purchasing preferences. Targeting the right consumer base is possible using a variety of marketing tools, of which digital marketing tools are the most common. The analysis of the use of these technical solutions is the central issue of this dissertation.

3.1. Food safety issues

The entries in the RASFF (Rapid Alert System for Food and Feed) database come from the national food safety authorities of the EU Member States, the European Commission, Switzerland, Liechtenstein, Norway, Iceland, EFSA (European Food Safety Authority) and ESA (European Space Agency) (EUROPEAN COMMISSION, 2020). The research is based on the recorded notification of RASFF from 11. 03. 2020 to 11. 03. 2021. This period formed the basis of the analysis. The starting date was chosen according to the WHO's Covid-19 pandemic proclamation (WORLD HEALTH ORGANIZATION, 2020). The length of the study period is one year because this allows us to compare the results with the RASFF annual reports' findings. The database included information not only on food but also on food contact materials, feed, animals, and plants since these can indirectly affect human health.

3.2. Factors affecting the demand for traceable products

At the time of writing (February 2022), no comprehensive study was available that had examined consumers' attitudes towards blockchain-based food traceability in such a general approach. Therefore, publications and statistics from the field of marketing were collected

that contain related data. There may be different phenomena behind the secondary data from different areas, which may also pose serious limitations when interpreting the results and drawing conclusions. However, the variables included in the research may still be suitable for investigating simpler trends.

3.3. Analysis of short food supply chains' consumers' attitude

In order to access the largest number of articles related to SFSC (short food supply chain) and thus to conduct the most comprehensive literature review, I used five prominent online databases to collect scientific publications, which were Scopus, Web of Science, JSTOR, ProQuest and Science Direct. The keyword used was "short food supply chain". This term had to appear in the title, the abstract, or one of the keywords. The article included in the research had to contain empirical data. The search was limited to studies in English. Reports published by the European Commission, FAO, United Nations, and Strength2Food (EU-funded project) were also included as potential sources. None of the online databases, such as the FADN Public Database, Eurostat, or the OECD, contained information related to this topic. It was not possible to extend the systematic literature review with references of the analyzed articles since each of the publications that met the criteria dealt with a special phenomenon. Along these criteria, the literature review presents the short food supply chains' consumers based on 22 scientific publications and 1 (other) study. The used works were published up to the beginning of October 2021.

3.4. The database of the Hungarian, Austrian, and German farmer shops

The Ministry of Agriculture and the National Food Chain Safety Office (Nébih) jointly announced in April 2020 that they create an online advertising platform to support local producers. This will help to build relationships with potential consumers. To register, a form has to be filled with the following details: name, region, address, contact details (here only email address and phone number could be added), delivery options (yes or no), offered products, and FELIR ID (Food Chain Identification Register). From the database of the NÉBIHs' website (NÉBIH, 2022), the producer can request the modification or remove their information. The online "local producer search" is updated every working day between 8 and 10 am. At the time of writing this thesis (28.01.2022), the database contains 270 registrations. The available data can be filtered using the fields mentioned above. In

Hungary, food markets are the most common alternative food source. There are also farmers' markets in the country, which can be listed through the Nemzeti Agrárgazdasági Kamara (NAK). However, the most similar data to the Western countries' data could be collected from the NÉBIH platform. Unfortunately, the latter platform contains producers and not family/small businesses. In addition, it should be noted that these individuals are only rarely available on an interface that is clearly linked to their production activity other than an email address and telephone number.

For this reason, although this is the most comprehensive “matching” database in the country, it cannot be used for the studies. It is essential to mention the National Association of Small Scale Producers and Service Providers (Kisléptékű Termékelőállítók és Szolgáltatók Országos Érdekképviselőinek Egyesülete, 2022) (www.kisleptek.hu) who are working to move the national SFSC forward. In addition to promoting SFSC, they help to develop self-employment, showcase good practices, and promote market access for small, medium, and family farms. As of 05.04.2022, the association's website contains the contact details, descriptions, and catchment areas of 19 (some kind of food) communities under the tab "box schemes, shopping and basket communities, and community farms". Unfortunately, in Hungary today, these interfaces to support alternative supply chains are still at a very rudimentary stage. Although it is possible to find family farms' websites and even online stores, but there is no such a comprehensive database that would collect all of them on a single interface. Therefore, there is no opportunity to analyze them.

The analysis of the Austrian farmer shops was based on data from the search engine of MEIN-BAUERNHOF (2021). This is one of the largest online farm store databases in Austria. The website provides the same data for Germany, Switzerland, Luxembourg, Italy, and Netherlands. Producers can register free of charge on the site, where they can indicate the location and opening hours of the shop, as well as a short description. The list of products available and the type of farming (organic or traditional) can also be recorded. In total, more than 2745 Austrian farmer shops are in this database, of which 1589 are conventional. The sample on which the study is based is representative by region and primary activity.

The descriptive statistics of the database are based on data of 1589 traditional farm shops, which meant the population of this research. Since the database is representative, it allows, based on Krejcie and Morgans' sample size determination table – which is discussed in

detail in the statistical methods chapter – to analyze a sample of 310 farm shops but make states regarding the whole population.

The stores were grouped according to the primary activities defined by the search engine. Since the producers regularly offer several different products in parallel (e.g., eggs and meat or fruit and vegetables), the shops were classified according to their introduction, name, and logo and based on data of their available online interfaces. The data was collected between 14.05.2021 and 10.06.2021.

The data of the German farmer shops were collected from the same source and with the same method as in the case of the Austrian shops. The descriptive statistics are based on the data of the 11624 traditional farmer stores. It created the population of this research. Considering the representativeness of the database and the Krejcie and Morgan sample size determination table, the analysis of the sample of 375 farm shops allowed to form states regarding the whole population. Data was collected between 05.11.2020 and 23.11.2020.

3.5. The framework of the research

The framework for the research is based on the publication of VLAHVEI et al., (2013). The authors examined the Greek food SMEs with it. Their research included 25 variables divided into 4 categories. This B2C framework (Table 1.) defined the criteria used in the research to analyze the online interfaces of Austrian and German farm shops.

Table 1: The framework of the research

Website	Corporate identity	Webshop	Community
Direct email address	History	E-commerce availability	Facebook
Mailing address	Certifications	Prices available	Twitter
Phone number	Human resources	Card available	Youtube
Home button	Employment opportunities	Identified method of payment	Instagram
Sitemap		Delivery time	Sign-up
Languages		Delivery cost	Newsletters
FAQ			Feedback
Logo and name			

Source: Based on Vlahvei et al., 2013, own elaboration, 2021

As the analysis of other digital marketing tools (online advertising, SEM, affiliate marketing, direct marketing, social media advertising) would be difficult or inaccurate to

carry out, this research is limited to the above-mentioned areas, and the analysis of online shops. The studied farmer stores evaluation was done by dummy variables.

3.6. Description of used methods

Systematic literature review

From the online databases, 428 publications met the formerly described requirements. To exclude duplicates and irrelevant studies, I used the online interface of Rayyan (RAYYAN, 2022). After deleting duplicates, 302 studies remained, which formed the basis for the systematic literature review. Figure 2 illustrates the steps of the selection process.

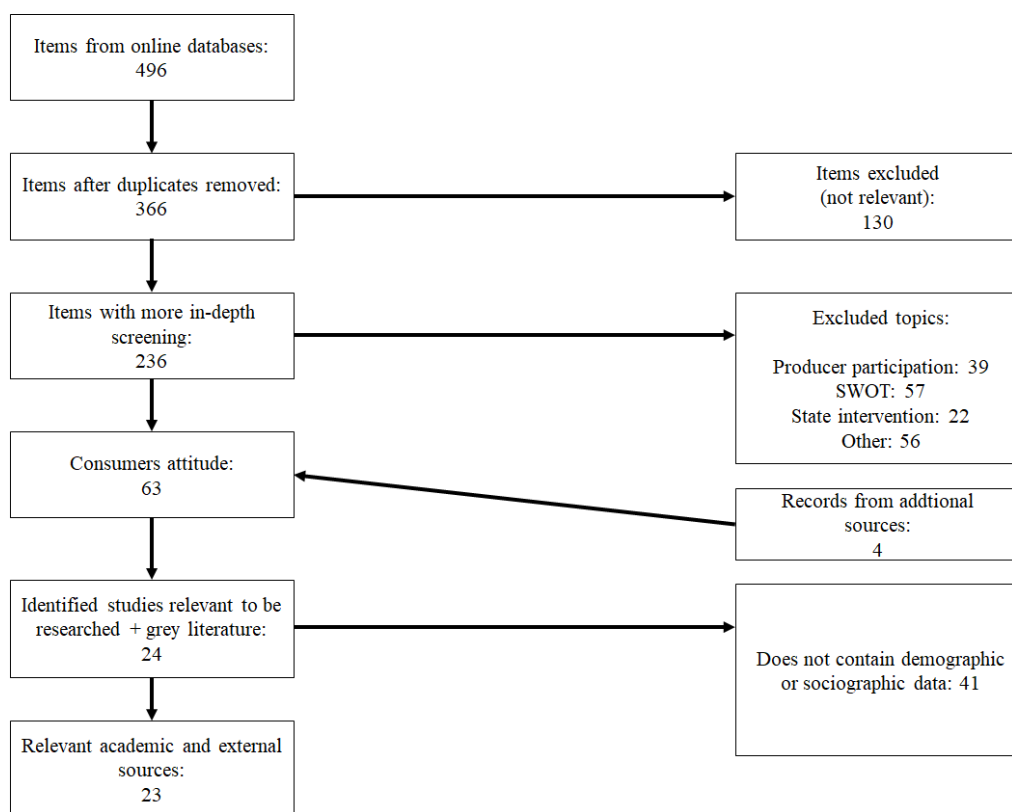


Figure 2: Pathway of the systematic literature review

Note: SWOT: a collection of articles dealing with the strengths or weaknesses or opportunities, or threats of the SFSC

Source: own elaboration, 2021

The first round of screening was based on abstracts, resulting in the exclusion of 115 items. Then I conducted an in-depth study of the remaining 187 articles to identify the different directions within the topic under review. This was necessary because SFSC has become a

buzzword, so it is often associated with topics that are in reality distant from each other. However, using the PRISMA method, they can be detected.

Most of these articles were published in high-ranking journals, confirming the scientific demand for this field. Before I started analyzing the selected primary studies, I looked for demographic and sociographic information in the chosen publications to limit the study to those rare papers that investigate consumer characteristics and attitudes.

Simulation

I used the simulation software AnyLogic, which allows discrete event-driven modeling, agent-based simulation, system dynamics simulation, and a combination of these methods. This makes it the most advanced modeling tool available today. The model was based on 10000 entities, who created the "potential user" of the blockchain-based traceable product. Forasmuch as that information gathering and advertising habits have changed significantly, I included data related to online advertising in the model. The conversion rate optimization company invespro provided this information. The data used and their sources are illustrated in Table 2.

Table 2: Variables of the model

Variable	Value	Source	Meaning
AdEffectiveness	0.1%	(INVESPCRO, 2020)	The percentage of internet user, who see an advertisement and open it.
InterestRate	48%	(INVESPCRO, 2020)	The percentage of interest in the ad about the topic of health.
AdInfluence	33%	(AMANDEEP et al., 2017)	The percentage which shows after the ad from the interesting topic is seen, how many people will buy the product.
ContactRate	13 people	(MOSSONG et al., 2008)	The number of persons with whom a man has contact during a day.
FriendsInfluence	17.9%	(AMANDEEP et al., 2017)	That shows how many percent of satisfied users suggest buying the same product.
DiscardRate	38%	(WU et al., 2015)	The number of unsatisfied users, who do not want to buy the product again.
ReconsiderRate	0.02%	estimated value	This number shows for some reason unsatisfied ex-users decide to use the product again.

Source: own elaboration, 2020

According to them, only one out of a thousand online ads are opened. When the ad gets opened, the potential user becomes an "OpenAd" user in the model. Since any content can be found on the internet, many topics could be interesting to the consumer. In a lucky case, the ad meets the consumer's interest, which, as a result of the click, navigates the "OpenAd" consumer to the advertiser's website. At the end of this process, he becomes an "Orient" in

the model. If the advertiser's content was convincing, the interested party will decide to buy, which makes him a "User". A satisfied "User" can share his opinion about the product with his friends (potential user) in the form of a "recommendation". According to the collected data, one of three recommendations can change the mind. If the buyer is dissatisfied, he will turn to "Disappointed". Either because of subsequent advertising or changes in his environment, he may later become a "User", but the estimated probability of this is very low (0.02%). The results of running the model are illustrated in Table 3.

Table 3: Trends in the number of consumers buying blockchain-based tracking products (headcount)

Run (day)	OpenAd	Orient	User	Disappointed	Potential user
1	7	2	0	0	9991
182	11	24	23	1540	8402
365	16	22	21	2856	7085
547	10	24	16	3948	6002
730	10	16	8	4866	5100
912	8	7	14	5505	4466
1095	6	13	12	6070	3899
1287	7	6	7	6511	3469
1460	7	13	9	6857	3114
1642	8	15	12	7145	2820
1825	7	3	3	7362	2625

Source: own elaboration, 2020

Statistical methods

Descriptive statistics

With regard to the majority of dummy variables in the databases, the arithmetic sum and mean were determined.

Inferential statistics

Taking into account that more databases of the dissertation are representative, which allows reducing the number of analyzed shops, it is essential to define the sample size correctly. The sample size definition table of KREJCIE and MORGAN (1970) can be considered a fundamental work on representativeness. According to Krejcie and Morgan's sample size calculation, the ideal sample element number was determined as follows:

$$s = X^2NP(1 - P)/d^2(N - 1) + X^2P(1 - P) \text{ where,}$$

s = required sample size.

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level.

N = the population size.

P = the population proportion.

d = the degree of accuracy expressed as a proportion.

I then selected the shops using simple random sampling with random number generation. This procedure can be used for a homogeneous finite number of elements. In this case, the elements of the population are selected with equal probability, without the repositioning of the already selected elements (GRAFSTRÖM and SCHELIN, 2014).

I used Pearson's correlation analysis to measure the direction and closeness of the relationship between two variables (ZHOU et al., 2016). To test hypotheses on nominal variables, I used Pearson's Chi-square method. With it, the statistical significance of the relationship between two variables can be determined. Accepting the null hypothesis means no relationship exists between the variables under study. If the significance level for the Chi-square is less than 0.05, the null hypothesis is rejected because there is a significant relationship between the variables under study. Otherwise, the null hypothesis should be retained. The strength of the relationship is measured on a scale of 0 to 1 by the Chi-squared index. It indicates the weakness or absence of a relationship as its value approaches 0 and its strength as it approaches 1 (MCHUGH, 2013).

I also applied a variant of factor analysis called principal component analysis, which allows to transform a set of interrelated variables in a data set. This multivariate statistical procedure reduces the number of dimensions of the data by "compressing" them into fewer variables than the original. In addition, fewer variables contain nearly the same amount of data (JOLLIFE and CADIMA, 2016)(RUTLEDGE, 2018).

Before running the analysis, the following conditions must be checked:

- Correlation matrix: shows the correlation between variables in the database, which is essential for running the analysis. If the correlations are weak, there would be no statistical basis for grouping variables into factors, but too high values are not favorable either. In the latter case, all variables would be grouped into one component, so no meaningful results would be obtained (KLINE, 2014).

- Anti-image matrix: allows variables to be split into explained and non-explained squares (anti-image). The elements outside the diagonal represent the fraction of the variance that does not depend on the other variables. For this reason, they should have low values in this place and as close to 1 as possible in the diagonal. The elements of the main diagonal contain the MSA values related to the different variables. This value ranges from 0 to 1 and indicates how closely related the different variables are. Variables with a high value close to 1 are desirable because they are well estimated by the other variables, while variables with a value below 0.5 are not. Thus they should be excluded from the analysis (YONG and PEARCE, 2013).
- Bartlett's test examines the correlation of the variables in the population, in other words, whether values of the correlation matrix randomly deviate from zero (RODKROH et al., 2016).
- The Kaiser-Meyer-Olkin (KMO) criterion is used to measure the suitability of variables for factor analysis. The KMO value is the average of the MSA values, that were already presented in the Anti-image matrix. In contrast to MSA, which is one, KMO is for all variables. A KMO value above 0.9 is excellent, while below 0.5 is unacceptable (KETHI REDDI and NIKHILA VANGAVETI, 2021).

In the dissertation cluster analysis was also applied, which is a procedure to sort observation units into homogeneous groups. The classification can be hierarchical or non-hierarchical. The main difference is that the former creates the new cluster by considering the previously formed group, while the latter defines the final group number. Within the hierarchical methods, the Ward method is one of the most commonly used. This is based on the smallest internal variance square since it combines the groups where the increase of this value will be the smallest (ESZERGÁR-KISS and CAESAR, 2017). In this dissertation, I also used the K-means method, which is one of the non-hierarchical procedures. This clustering is based on cluster centers, which are based on Euclidean distance (SYAKUR et al., 2018).

The ideal number of the created clusters can be analyzed by the Pseudo F statistic. This is a ratio that illustrates the differences within and between clusters. If its value decreases, the within-group variance remains unchanged/increases, or the between-group variance decreases (CALIŃSKI and HARABASZ, 1974).

The one-point variance analysis was also used in the dissertation. This method and model examine the effect of one or more independent variables on one or more dependent variables. It is usually applied to the analysis of the difference between the means of a population. In this research, I used it to determine which factor has the greatest impact on clustering (KIM, 2017b).

I also used multivariate linear regression to examine the data. This procedure is used to determine the effect of the change a unit in the independent variables on the dependent variable. However, the explanatory model can only be used to detect linear correlations. The test can only be performed if both the dependent and independent variables are linear and there is no multicollinearity between the explanatory variables (KUMARI and YADAV, 2018).

4. MAIN FINDINGS

I started my research by examining registered food safety risks in the European Union, based on the RASFF database. After that, I used a simulation model based on secondary data to investigate the future demand for traceable products. In this way, I analyzed consumer interest in new traceable products. Then, I conducted a systematic literature review covering five international databases to identify the characteristics of consumers in the short food supply chain based on published primary research data. With it identified consumers interested in more product information, i.e., consumers of farmer shops. After the presentation of the food market in Hungary, Germany, and Austria, I examined the available databases of registered farmer stores. Consider that in Hungary, the importance of the "direct from the producer" approach gained more support with the emergence of the coronavirus. However, a similar database to Western Europeans' for collecting farmer shops is not available yet. The study of the Austrian and German farmer shops' online surfaces meant the core question of the dissertation. In addition to the topicality of the issue, the uniqueness of the research lies in the fact that the data collection was partly conducted during the pandemic under the "one-stop shop" restriction. This means only those shops where "everything" was available in one shop were allowed to stay open. That might increased the digital marketing activity of the shops under investigation. The analysis was based on a framework used to study Greek food SMEs. Instead of analyzing online advertising, SEM, affiliate marketing, direct marketing, or social media advertising, which could not be measured at all or maximum inaccurate estimations could be written. So, I analyzed the application of digital marketing tools that can be measured more accurately and do not cost a lot for the producers.

Based on the objectives outlined above, which have been defined taking into account the different aspects of a complex topic, I have formulated the following scientifically based findings.

Objective 1: To investigate what food safety risks may be driving consumers towards alternative food sources.

Due to the limited availability of RASFF, only those food safety risks were studied, which were registered between 11 March 2020 and 11 March 2021 in the EU Member States. The

quality and quantity of data available have greatly influenced the studies that could be performed. In the first year of the pandemic, the number of notifications decreased compared to the pre-pandemic period. However, the increasing number of cases after the announcement of the pandemic is also seen. The most frequent problems by hazard/product category/reporting country highlighted a growing trend of "unauthorized" imports of nuts and seeds. It is essential to underline that "novel food" and GMO products are also included in the RASFF system with this term, but this keyword was previously not included in the list mentioned above. Partly based on these results, it can be assumed that certain food safety risks are specific to certain product categories (which may be linked to a particular region). To test this assumption, I have performed multiple linear regression analyses on the data, which suggests that there is no relationship between food safety risk and the country of products' origin. Given that the points on the residual diagram are not randomly distributed around the horizontal axis, as shown in Figure 3.

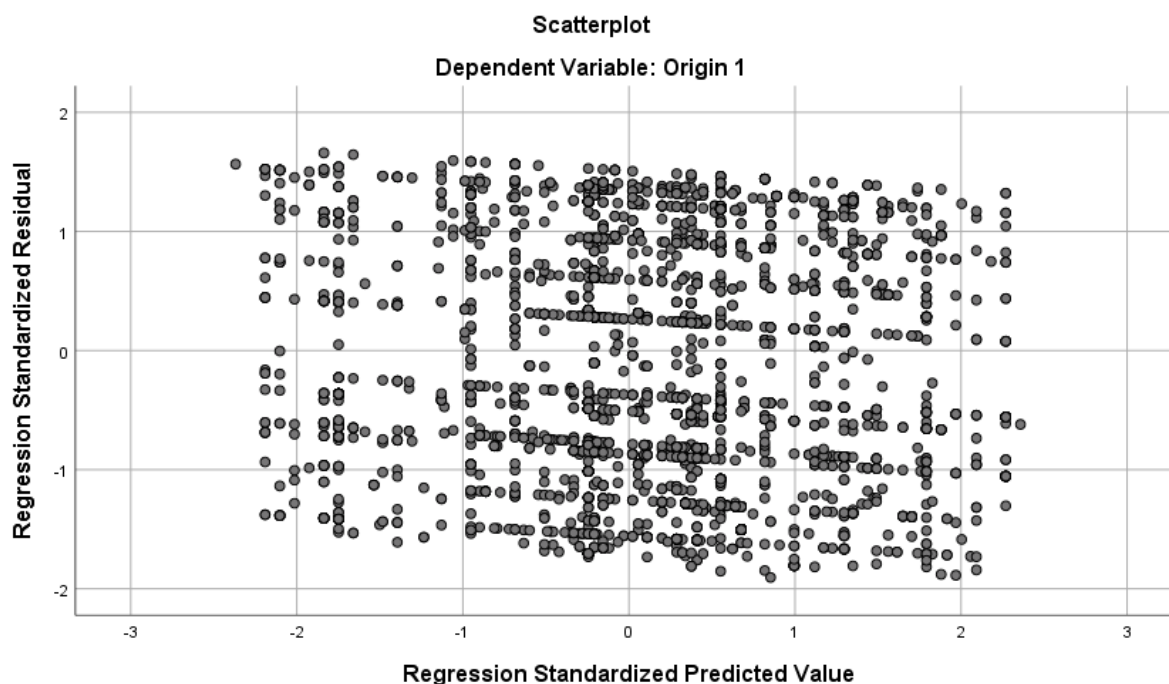


Figure 3: Residual plot of linear regression

Source: own elaboration, 2022

So, a non-linear model would be more appropriate to determine the relationship. However, we have no prior information regarding its nature to determine the estimating function.

The product categories most affected during the period under study were meat and meat products, nuts and seeds, cereals and bakery products, and dairy products. In light of these

results, it can be assumed that the risks associated with cereals and bakery products and the closely related nuts and seeds could lead to an increasing number of consumers switching to local ingredients and locally produced goods. A similar trend could be expected in the case of meat and meat products in addition to dairy products.

Objective 2: To analyze the likely future demand for products offering more accurate traceability.

Based on the review of the literature, blockchain-based product tracking seems to be one possible solution to provide more accurate (detailed) product data. The expected future demand was studied through statistics and marketing-related secondary data from food-related fields. The demand simulation was performed with AnyLogic, a discrete event-driven modeling tool. After analysis of secondary data, no cyclicity was observed in the number of blockchain-based tracking information' users, but the number of consumers showed a downward trend in long term. Assuming that the advertisements were not sufficiently attention-grabbing, I increased the effectiveness of the advertisements within the model. However, this did not positively affect the number of users. Moreover, this intervention increased the average size of the disappointed group by twenty-two percent. Although consumer interest is more of a given, as it can only be shaped with high effort and rather only in the long run, I increased its effectiveness in the following scenario. Then the total number of users increased by eleven percent, but even this meant only eight consumers in a population of ten thousand. Given that the aim of companies is not only to attract customers but also to retain them, I also analyzed the possible effects of a reduction in the disappointment rate. Over five years, this resulted in a marginal 6.5% increase in the number of users and a negligible 0.5% decrease in the number of "disappointed users". Thus, none of the individual changes in the values of the model parameters (Figure 4) had a significant effect on the size of the user group.

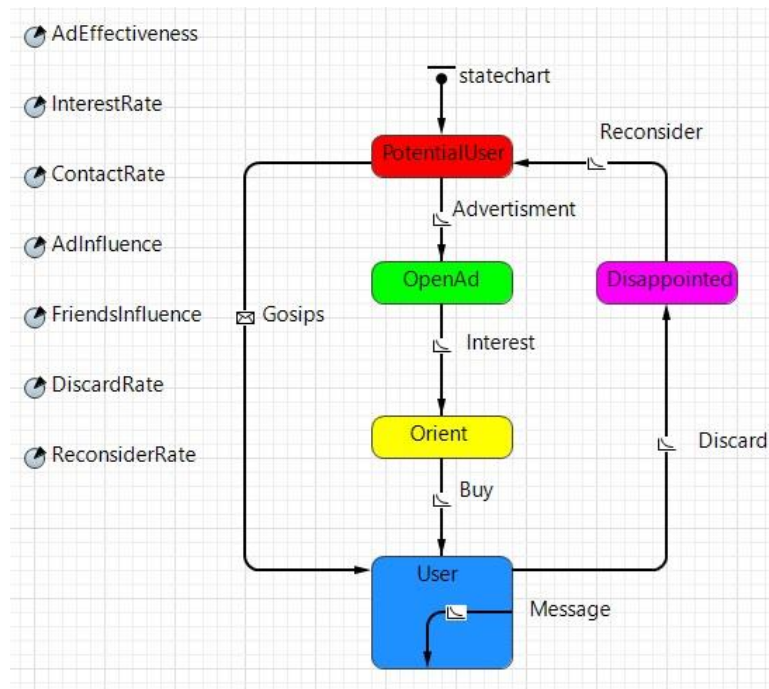


Figure 4: Model analyzing the number of consumers interested in traceable products

Source: own elaboration, 2022

The studies show that lower disappointment rates and higher interest rates increased the number of users, but the increased effectiveness of advertising did not have a positive effect. Increasing the interest rate had a greater effect on the number of users than lowering the disappointment rate, but it also increased the number of disenchanted users more. Given these results, companies should either reduce the cost of extra information or involve the governments in the implementation of a new system. According to the model, these scenarios could increase the number of new products' consumers, as these factors could reduce the disappointment rate. Increasing the interest rate may also be an effective way to increase the size of the user group, but until consumers are aware of the benefits of technological innovation, satisfaction with traceable products' consumers may remain low. Based on these observations, we can assume that the expected future demand for products offering more accurate tracking will not increase significantly.

Objective 3: To study the characteristics of consumers who purchase from alternative food supply chains.

The systematic literature review based on selected English-language publications from five international databases revealed that the results of the research often take different views. Although the number of studies on short food supply chains has increased in recent years,

economic data of SFSC in the EU are not available. Based on the involved scientific works, it is difficult to identify clearly those characteristics and attitudes that undoubtedly influence, that the consumers' purchase from SFSC. Most of the studies identified income and age, but these observations are not generalizable. In many cases, some consumers of different variants of SFSCs are very well characterized, but local specificities may lead to regional differences.

Objective 4: To analyze the network of farmers' shops as a variant of alternative food supply chains based on Hungarian, Austrian and German data.

Even though I wanted to include the data of the Központi Statisztikai Hivatal, Eurostat, OECD, and FADN databases in the analysis of Hungarian farm shops, I could not do so due to the lack of relevant information. For this reason, I decided to use the "local producer search" database. This was created by the Agrárminisztérium and Nemzeti Élelmiszerlánc-Biztonsági Hivatal in 2020, which is the most compatible with the Austrian and German data sources. This online platform allows consumers to find producers. Although it is the most extensive database created for this purpose, it currently contains less than 300 names. Most of those registered are small or small-scale producers, and there are no family businesses in the database. Given the available data, it is impossible to analyze the Hungarian network of farm shops with any scientific basis. The main conclusion that could be drawn from the lack of data is that there is no demand for online access to alternative food sources. Based on Hungarian studies, it can be assumed that traditional farmers' markets play a more important role among alternative channels, which are preferred by older (less digitally literate) consumers.

The Austrian farmer shops were analyzed based on the data of MEIN-BAUERNHOF (2021). At the time of data collection, there were 1589 traditional shops listed on the website, which means that there is one farm shop per 5636 inhabitants in relation to the population. Selling meat is the main activity of most shops, but there are also a significant number of fruit and vegetable-focused shops. The smallest proportion of producers selling non-alcoholic beverages, fish, pasta, and mushrooms. Geographically, the shops are concentrated in the central part of the country, while the capital understandably has the smallest number of shops.

The German data was collected from the same place. At the time of data collection, 11624 farm shops were listed on the website of MEIN-BAUERNHOF (2021), which means that there is one farm shop per 7151 inhabitants in relation to the population. The country's most significant proportion of shops was alcohol-focused, but meat and “other” primary activity shops also had a high share on the website. Shops with a profile selling non-alcoholic beverages, fish, spices, pasta, and mushrooms were the least represented in the database. Looking at the distribution of shops by region, the number of shops increases from north to south. The area/region around Germany's capital had the lowest number of producer shops. Based on the available data, Germany has the highest number of potential consumers per farm shop of all the studied countries. The comparison also shows that meat is sold in many places in both German-speaking countries. The least popular shops in both countries were those selling non-alcoholic drinks, fish, pasta, and mushrooms.

Objective 5: To determine the level of online presence of farm shops, which may have a major impact on their success and sustainability.

Looking at the websites of producers, 54% of Austrian shops did not have a website, while in the case of German producers, the same share was 38%. More than half of the Austrian farms shared information regarding their history on their website. In addition, one in five published some information on certificates. German producers were even more likely than Austrians to present the history of their farms but much less likely to show their products or the certificates. Web stores were rare in both countries. One in six shops in Austria and one in five in Germany offered online shopping. Almost all of them displayed the prices (eight out of ten producers did so). In Austria and Germany, only one in four online shops offered payment by card, just as a similar proportion displayed information on delivery times. German online shops were slightly more secure in terms of payment since almost the half of the shops used identification during the payment. The same value in Austria was lower (only a third of the shops). Based on the data of the studied shops, the application of social media is not widespread. Twitter was the least popular in both countries (2%), but YouTube was also used by less than 5% of shops. The share of Instagram accounts was higher for German farms, but Facebook's leadership was evident in both countries. Three out of ten

farm shops were present on this platform. When comparing the shops by their main activity, it became obvious that the websites of alcoholic shops in both countries contain a lot of (mandatory) information. In Germany, fruit-focused producers also stood out from the other categories. In terms of identity building, shops selling alcohol stand out most in both countries. Compared to the other shops, they were more likely to show up the history of their farm and their employees to potential customers. When analyzing online shops, the above-average activity of alcohol shops should also be highlighted. In Austria, two out of ten and in Germany, six out of ten of the formerly mentioned farm shops offered online shopping. The opportunities provided by social media were most used by alcoholic shops through their Facebook presence and activity. In Austria, almost two-thirds of these shops were active, but more than half of the non-alcoholic shops were also available on this platform. Nearly 40% of German “alcoholic beverages” producers and a third of “dairy product” focused shops were active on Facebook. Before clustering, I defined the main components of the database. For the Austrian shops, I identified the following factors "basic", "extra" and "marketing". Based on the data from the German stores, the "website", "webshop", "information", and "social media" were defined along the lines of the original main components. When grouping the shops along the new components, I distinguished four clusters based on the Austrian data. The “offline”, “beginner”, “developing” and “star” clusters were defined. Seventy-nine percent of the shops belonged to the first two groups. In grouping the German data, I defined five clusters: undeveloped, beginner, progressive, challenger, and leader. In this case, 71% of the sample was placed in the first two groups. This shows that there is a very high proportion of businesses in both countries that could significantly increase their online presence with a small effort.

5. NEW AND NOVEL FINDINGS

The overall aim of the thesis was to show what existing solutions are available to mitigate the growing food safety risk beyond the technological concepts' of blockchain-based food traceability. Logistics has established several alternative food supply chains that oppose the global supply chains in almost every aspect. One possible solution is the concept of farmer shops, which is based on the idea that the consumers buy locally produced and processed food directly from the producer. In my dissertation, I conducted a systematic literature review to identify consumer characteristics because that knowledge can play an important role in the online marketing activities of producers. Based on the available data of the Austrian and German farmer shops, I analyzed their online platforms. On these bases, I conducted the conclusions, which I present as the new and novel findings below.

1. The analysis of the RASFF database shows that the number of "unauthorized" notifications by hazard/product category/reporting country has increased significantly over the studied period, which was not within the most frequent categories in previous years. Since this label is used to record cases related to "new food" and GMO products, I used multiple linear regression to analyze the effect of risk category and product category on the determination of the origin. The regression model revealed a significant relationship between the variables, but this was extremely low. This suggests that a particular type of food safety risk associated with a particular type of product cannot be eliminated by ceasing trade with the importer of the product.
2. The results of the secondary data-based simulation model suggest that no significant increase in the solvent demand for blockchain-based food traceability products could be expected. However, an increase in the interest rate of consumers and a reduction of the extra information premium could significantly increase the number of potential consumers.
3. The cluster analysis based on the principal component analysis shows that more than half of the Austrian shops are considered underdeveloped in terms of digital marketing, as these shops are not available online in any form. However, for those producers that are active in the online space, the usage of certain social media platforms is part of the "core" digital marketing.

4. The K-means clustering method, based on the principal component analysis of the German farm shops, revealed that the "leading" group share is less than 3% of the total sample. In this group, the proportion of alcoholic shops was the largest.
5. Taking into account the clusters defined by the K-means method, which were based on the principal component analysis of the Austrian and German data, it can be concluded that the number of alcoholic shops is prominent among those shops, that provide the highest digital marketing performance.

6. PRACTICAL APPLICABILITY OF THE RESULTS

Based on the results of the dissertation, I formulate the following recommendations, which are primarily suitable for enhancing the online marketing activities and, thus, the business performance of Austrian and German farmer shops. In my opinion, they may also be useful for farmers in other countries (including Hungary):

1. Global food supply chains are more and more often criticized. In addition to the traditional food safety risks, the number of "unauthorized" notifications also increased, which could be mostly linked to novel food. This may also push consumers towards products that offer greater transparency and controllability. For this reason, it may be worthwhile for producers to at least partly offer consumers the possibility to buy direct (B2C).
2. Global supply chains could meet the needs of these customers if they would offer products with more traceability. However, it seems the size of this global consumer group would not provide the solvent demand that is needed to build a new system that would allow more accurate information flows. Consequently, this group of consumers tends to seek and try out visible solutions to meet their needs. This could greatly increase the chances of producers being found by consumers by increasing their online visibility.
3. Because consumers with unmet needs are looking for alternatives (i.e., open to new solutions), it is essential that farms are not only visible but also able to identify and address their potential customers.
4. Consumers are interested in alternative sources. They want to buy not just quality food but also more product information. Therefore farms need to make this information available in the digital space.
5. The first line of the online presence should be the website since any search, or digital advertisement will take the visitor to an electronic interface of the farm. Social media does not allow a clear and transparent way of information sharing at such a high level, nor offer the opportunity to build a unique image and brand.
6. The farmer shops do not sell only food but food with "stories". For this reason, it is essential to provide as much information as possible from as many sources as possible. They should seek to present as comprehensively as possible the certification

of the products, the history of the farm, its employees, their skills, and the way it is run.

7. The availability of online shopping raises several questions for farm shops. The characteristics of the product being sold, the logistical difficulties, and the costs of possible delivery must be considered. Therefore, the development and the return on investment of this project are often questionable. The results of the research suggest that this form of marketing should be considered mainly for farms that primarily sell non-perishable and higher-priced products.
8. If the producer decides to operate a webshop, the order conditions, prices, delivery fee, and expected delivery time should be presented. It is advisable to offer as many payment methods as possible and to create a secure (informatic) environment for consumers to pay.
9. Social media provides plenty of free, easy-to-access platforms for online presence, branding, and networking without any relevant IT skills.

Based on the results of my research, I formulate the following recommendations specifically for Hungarian producers:

1. It would be important to assess the digital skills of producers (self-assessment), as this would help identify the feasible opportunities for them.
2. It could be useful to develop a "digitalization of producers" module for the farmers, which could be a prerequisite for completing the vocational training or carrying out the activity. If this is not possible at state level, it would be worthwhile to acquire, in self-development form, the possibilities offered by the Microsoft Office package and the basics of the Internet. These could greatly support their activities.
3. Selling products with the additional information provided by blockchain-based food traceability will not be profitable for several years. Not only are consumers uninterested in these products, but the costs of the implementation and maintenance of the system are very high (and could be imprecisely estimated), and also difficult to quantify the payback period. They should therefore concentrate on "making visible" the additional information.
4. Social media provides several free and easy-to-use platforms for farms to present their farm, promote themselves and their products. These platforms also offer the possibility

to display paid advertisements to very specific potential customers defined by the operator. Considering that there is also the possibility of "pay-per-click", advertising on these platforms (with low "risk") would be an excellent way to target younger people since, typically the older generation buys from the producer.

5. It is important to stress that this form of the alternative food supply chain is still in its infancy in Hungary. Therefore, those farms that put into practice the Western European models and my suggestions as soon as possible could gain competitive advantage. Taking into account the level of effort and the potential benefits of it, I believe that the above suggestions are not only cost-effective but also effective in increasing the online marketing activity of the farms.

7. LIST OF PUBLICATIONS RELATED TO THE DISSERTATION



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Candidate: Adrián Csordás

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List of publications related to the dissertation

Hungarian scientific articles in Hungarian journals (2)

1. Füzési, I., **Csordás, A.**, Felföldi, J.: A németországi termelői boltok online marketing tevékenysége.
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