

APPLICATION OF INFORMATION TECHNOLOGIES IN FOOD PROCESSING

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Abstract: Information technologies (IT) have become an important part of modern peoples activities. Many activities in food production processes are supported by different types of IT. The aim of this paper is to determine share of companies in Bosnia and Herzegovina (BiH), Serbia (SRB), North Macedonia (MKD) and Montenegro (MNE) that use some form of IT in their operations. Research was conducted in companies from the food sector in four countries in the Balkans. The research included 42 companies from BiH, 30 companies from Serbia, 14 companies from MKD and 6 companies from MNE. A special questionnaire was designed for the purposes of this research. The distribution of the questionnaire was done by e-mail, with a digital link for the users according to the form of the survey questionnaire that they should fill out (Microsoft Forms). The obtained results were statistically processed using IBM SPSS Statistics 26. During the research, authors determined areas in which companies already use IT, their plans related to the development of IT in the coming period and possibly for integration of existing and new IT solutions into a single information system. In their answers, the companies declared about the business areas in which they most often apply IT. Companies have developed and use several e-databases (the share of companies from each country is shown in relation to the number of companies that submitted complete survey questionnaires in the order of BiH, SRB, MKD and MNE): e-database of employees (88.1%; 96.7%; 100% and 100%, respectable), supplier base (73.8%; 100%; 100% and 83.3%, respectable), e-customer base (76.2%; 96.7%; 100% and 100%, respectable), e-base of resources for work (35.7%; 60.0%; 42.9% and 50.0%, respectable), e-base of reports on performed laboratory analyzes (35.7%; 43.3%, 50.0% and 50.0%, respectively) etc. In the development of IT solutions, companies use different programming languages, mostly JAVA (59.3% of all companies surveyed) and C++ (37.4% of the total number of companies surveyed).

The research showed that companies in the food sector in 4 Balkan countries use different forms of IT and that they have clear plans for their development and application in their business. It encourages the view that most companies are working on development of an integrated information system.

Key words: IT, e-baze, Programme languages, Food manufacture.

1. INTRODUCTION

The number of inhabitants in the world is increasing intensively, which is why the demand for food is constantly increasing. Due to the lack of appropriate monitoring systems for food quality and safety, new problems arise related to increased waste and insufficient food quality [1]. The globalization of food production contributed to faster development and gave the opportunity to connect companies

in different countries. However, the strengthening of global supply chains has affected the environmental sustainability of companies [2]. Today, food production systems in developed countries are very efficient in terms of high yields, low production costs, quality and food safety, but it is necessary to reduce the negative impact of the process of food production, processing and storage on the environment. This requires a greater degree of cooperation of all participants in the supply chain and the continuous ex-

change of a large amount of information. The current way of collecting, processing, storing and exchanging information through paper documents does not have the necessary speed and is not efficient enough. Small and medium-sized enterprises (SMEs), especially in developing countries, are additionally burdened in this sense and find it difficult to meet all requirements. The use of information and communication technologies (ICT) serves as a tool with which SMEs can establish traceability, transparency and the necessary efficiency along the supply chain. In addition, the use of ICT provides support in achieving a sustainable competitive advantage [3-6].

Traceability is a system for exchanging food information at all stages of the food supply chain. Traceability systems have become part of food safety management systems and quality management systems [7,8]. The effectiveness of the traceability system is significantly higher if the information from individual sectors in the supply chain is connected through the information system into one whole. The information needed to solve current problems in the company's operations can be easily obtained today thanks to the application of ICT solutions.

In last 20 years, the impact of ICT on industry has been large [9]. In the future, this influence will be even more pronounced and will initiate the change of most production processes. In the food sector, ICT has led to increased efficiency of "integrated food supply chains supported by ICT", better "coordination between different departments" and better "collaboration in the supply chain" [10]. In the food supply chain, ICT applications influence a better exchange of information, more efficient use of existing resources, and a reduction in energy consumption and the amount of generated waste [11,12]. All business partners in the supply chain have increased their interest in topics related to information integration in the industry, including the food production sector. Several papers have been published on the possibilities for improving the food traceability system through the use of an integrated ICT system [13-15].

In addition to hardware and software acquisition, changes in the food sector related to the application of ICT include the integration of numerous information within the supply chain [9]. In more industrially developed countries, ICT applications are part of the overall activities of digitization of production processes [16]. Although for many companies from developing countries capital investments in ICT sys-

tems are large (hardware, software and workforce training), they have a significant impact on reducing the risk of many problems in the supply chain [1].

In recent years, internet and communication technologies, blockchain and other applications of Industry 4.0 are increasingly present in the food supply chain [17]. The application of the Internet of Things (IoT) and ICT (for example, online delivery in the supply chain or e-commerce that uses mobile applications for purchasing purposes) helps small businesses find buyers for their products more easily [18]. Modern technologies, including the cloud, the Internet of Things (IoT), blockchain and big data analytics, represent a potentially powerful tool to make the supply chain transparent and sustainable [19]. Most studies claim that blockchain technology is the most effective tool to support supply chain transparency and sustainability, as it can share accurate data among a large number of participants [20].

Some published studies suggest that better connectivity, digitization, and big data are important ways to improve environmental sustainability and green product innovation practices [21, 22].

The aim of this work is to determine the current state of application of information and communication technologies and the readiness of companies in the food sector in the Balkan countries (Bosnia and Herzegovina, Serbia, Macedonia and Montenegro), as part of the food supply chain, to use the opportunities provided by information and communication technologies for overall business support, and especially support for quality management systems, food safety and environmental protection.

2. MATERIAL AND WORKING METHODS

The results presented in this paper are part of extensive research conducted in four countries in the Balkans (Bosnia and Herzegovina, Serbia, North Macedonia and Montenegro). During the research, a survey was conducted in companies from the food sector in these countries. The questions from the survey questionnaire were answered by owners or representatives of key management personnel.

For the purposes of the research, a survey questionnaire was designed, within which the questions were classified into 4 groups [3]. The first part

of the questionnaire contains questions about general information about the company. The second part of the questionnaire includes questions related to the current implementation and plans of companies to implement ICT in the next five years. In order to eliminate ambiguities, the questionnaire was reviewed and confirmed by three independent experts (two from the university and one manager for food safety and quality employed in a company from the food industry). Based on their opinion, some questions were reformulated. In that way, the clarity of the questionnaire was increased. In addition, several new questions were added to ensure greater coverage of all areas of research interest. Finally, Krombach's alpha coefficient was used to examine reliability and internal agreement for this sample.

During 2021, the questionnaire was distributed to targeted respondents (149 companies from the food industry sector in Bosnia and Herzegovina, Serbia, North Macedonia and Montenegro). The distribution process was via email with a digital link for users to complete the survey questionnaire (Microsoft Forms). Respondents were asked to objectively answer the questions. The completed questionnaires were returned by the companies to the research team. After the quality assessment, the answers of 92 companies were accepted (Bosnia and Herzegovina 42, Serbia 30, North Macedonia 14 and Montenegro 6). This corresponds to a response rate of 61.74% (Table 1).

Table 1. Number of companies that participated in the survey

| The country where the company operates | | | | |
|--|-------------|-------------|-----------|-----|
| BIH | SRB | MKD | MNE | Sum |
| 42 (45,7%)* | 30 (32,6%)* | 14 (15,2%)* | 6 (6,5%)* | 92 |

* number of companies (share in the total number of surveyed companies, %)

After being coded appropriately, the responses were analyzed using the Statistical Package for Social Sciences computer software (IBM SPSS 26.0). The chi-square test of independence at a significance level of 0.05 examined the relationship between the years of operation of the company, the number of employees in the company, the number of IT experts in the company and the business areas in which they use ICTs in relation to the country in which the surveyed companies perform their activities.

3. RESULTS AND DISCUSSION

Out of 149 companies to whose address an invitation to participate in the research was sent, answers that meet the quality assessment were submitted by 92 companies: 42 from Bosnia and Herzegovina (BiH), 30 from Serbia (SRB), 14 from North Macedonia (MKD) and 6 from Montenegro (MNE) (table 1). In the previous paper [3], respondents' answers were analyzed in relation to the total number of companies that submitted quality answers, i.e. in relation to the number of 92 companies).

When looking at the duration of the company's operations, the share of companies from Bosnia and Herzegovina was as follows: 4.8% (1-3 years), 11.9% (4-5 years), 11.9% (6-10 years), 38.1% (11-20 years old) and 33.3% (21 and older). Among companies from Serbia, the duration of business shown in periods of 1-3 years, 4-5 years, 6-10 years, 11-20 years and 21 and more years is: 16.7%; 3.3%, 20.0%; 43.3% and 16.7%, respectable. Half of the surveyed companies in Macedonia (50.0%) have been operating for 11-20 years, 38.6% have been operating for 4-5 years, 21.4% of companies have been operating for 6-10 years, while newly founded companies (under 3 years old) and companies from the 21 and over category did not participate in the survey. On the other hand, companies from Montenegro are relatively younger (33.3% of companies have been operating for less than 3 years and 33.3% of companies have been operating for 4-6 years). The chi-square test of independence showed that the proportions of the number of surveyed companies according to the years of operation differ significantly between countries, there is a statistically significant relationship between the years of operation of the company and the country in which the company operates: $\chi^2(12.92)=23.886$; Sig.=0.021, at the level of significance $p=0.05$ (Table 2). The strength of that relationship, measured by Cramer's alpha indicator, is high (Cramer's $V=0.294$) [23].

According to the number of employees, the classification of companies was done in accordance with the guidelines of the European Commission [24]. Table 2 shows that the majority of surveyed companies belong to the SME group (67 companies), 18 (19.57%) to the micro-enterprise group and 7 (7.61%) to the large company group. In relation to the country in which the companies operate, the situation among the surveyed companies is as follows

Table 2. Structure of a sample of companies from four Balkan countries in relation to the year of operation and the number of employees (N=92)

| Criterion | Answer | The total number | Part of the company in the country in which it operates (%) | | | | χ^2 Sig. Cramer's V |
|---|-------------------|------------------|---|------|------|------|--|
| | | | BIH | SRB | MKD | MNE | |
| Number of years of operation of the company | 1-3 years | 9 (9.8%)* | 4,8 | 16,7 | 0,0 | 33,3 | $\chi^2(92,12)=23,886$ Sig.=0,021 Cramer's V=0,294 |
| | 4-5 years | 12 (13%)* | 11,9 | 3,3 | 28,6 | 33,3 | |
| | 6-10 years | 15 (16,3%)* | 11,9 | 20,0 | 21,4 | 16,7 | |
| | 11-20 years | 37 (40.2%)* | 38,1 | 43,3 | 50,0 | 16,7 | |
| | 21 and more years | 19 (20,7%)* | 33,3 | 16,7 | 0,0 | 0,0 | |
| The number of employees in the company | ≤ 10 | 18 (19,6%)* | 19,0 | 20,0 | 14,3 | 33,3 | $\chi^2(92, 9)=7,482$ Sig.=0,587 Cramer's V=0,342 |
| | od 10 do 49 | 34 (37,0%)* | 42,9 | 23,3 | 42,9 | 50,0 | |
| | od 50 do 249 | 33 (35,9%)* | 31,0 | 43,3 | 42,9 | 16,7 | |
| | ≥ 250 | 7 (7,6%)* | 7,1 | 13,3 | 0,0 | 0,0 | |

N – total number of companies from four Balkan countries that participated in the survey (N=92)

* the number of companies in all countries that answered the question

(proportion of answers in relation to the total number of surveyed companies, %)

$\chi^2(N,df)$ -Chi square test, p=Sig. - significance (p<0.05), Cramer's V – Cramer's correlation strength coefficient

(data shown for micro-enterprises, SMEs and large enterprises): Bosnia and Herzegovina 19.0%; 73.9%; 7.1%, respectable; Serbia: 20.0%; 66.6%, 13.3%, respectable; North Macedonia: 14.3%; 85.8% and 0.0%, respectable and Montenegro: 33.3%; 66.7% and 0.0%, respectable. The chi-square test of independence showed that there is no statistically significant relationship between the number of employees in the surveyed companies and the country in which the company operates $\chi^2(9, 92)=7.482$, Sig.=0.587 at the level of significance p=0.05 (Table 2).

Information and communication technologies have various possibilities for application in the improvement of the control process, in the collection of information and communication. ICT enables food systems to become more efficient, smarter and safer. This can be achieved by the simultaneous application of smart

technologies and devices that collect data throughout the supply chain and turn that information into smart communications [1]. So far, ICT has found application in several areas of the food sector: Food supply chain management, Product traceability and recall, Transparency for consumers, Improved food safety and quality, Easier inventory management, Reduction of food wastage, Product authenticity determination, etc.

Of the 92 companies that returned the completed questionnaire, 32 of them (34.8%) employ IT experts. This represents a great potential for the application of ICT. Chi-square test of independence found that there is no statistically significant relationship between the number of companies employing IT experts and the country in which the company operates: $\chi^2_{IC}(3,92) = 2,112$; Sig. = 0,549 at the level of significance p=0.05 (Table 3).

Table 3. Distribution of companies that employ IT experts in relation to the country in which they perform business activities (N=92)

| Answer | The total number | Part of the company in the country in which it operates (%) | | | | χ^2 Sig. Cramer's V |
|--------|------------------|---|------|------|------|--------------------------------|
| | | BIH | SRB | MKD | MNE | |
| NO | 65,2 | 66,7 | 56,7 | 71,4 | 83,3 | $\chi^2(3,92) = 2,112$ |
| YES | 34,8 | 33,3 | 43,3 | 28,6 | 16,7 | Sig. = 0,549 |

N – total number of companies from four Balkan countries that participated in the survey (N=92)

$\chi^2(N, df)$ Chi square test, p=Sig. - significance (p<0.05), Cramer's V – Cramer's correlation strength coefficient

ICT can be applied in the different business activities of each of the participants in the food supply chain and the chain as a whole: the application of sensors to identify and track food products in the supply chain at each stage to improve traceability and the possibility of withdrawing the product in case of a change in quality or deterioration of the product [1]. Also, the application of ICT provides better visibility of food material and its quality throughout the supply chain. The application of ICT provides various procedures for collecting, processing and displaying information.

During the survey, company representatives listed the areas in which their companies already apply information and communication technologies (ICT). Companies have listed 11 areas in which they most often apply some kind of ICT: Management of procurement and logistics, Management of stocks of raw materials and raw materials, Inventory management system in the warehouse, Human resources management, Management of production operations, Identification and traceability in the production process, Risk assessment for product safety, Occupational risk assessment, Environmental risk assessment, Quality management, Financial management (Table 4). In a previously published paper [3], the authors analyzed the scope of ICT application in relation to the total number of surveyed companies (92 surveyed companies). As determined, the largest number of surveyed companies stated that they use ICT in the areas of "Financial management", "Quality management", Identification and traceability in the production process, "Human resource management" and "Inventory management system in the warehouse". Based on the responses received from companies, 6.5% of companies (in relation to the total number of surveyed companies) do not use ICT in their operations (table 4). When analyzing the situation by country, it can be seen that 14.3% of companies from Bosnia and Herzegovina do not use ICT (14.3%), while all companies in the other three countries stated that they use some form of ICT. The same table shows an overview of the answers given by companies by country. The data from Table 4 refer to the share of companies according to the number of companies from the country (%), which answered YES to the question. Due to the need to shorten the table, the share of companies that responded with NO is not shown here, although these data were used during statistical processing. The column of the

table shows the level of significance of the answers obtained in relation to the country in which the company operates ($\chi^2(N,df)$ -Chi square test, Sig. - significance ($p < 0.05$), Cramer's V - Cramer's correlation coefficient).

Companies from BIH, SRB, MKD and MNE answered that they use information and communication technologies for "Management of procurement and logistics" (54.8%, 36.7%, 42.9% and 16.7%, respectively), "Management of stocks of raw materials and raw materials" (54.8%, 60.0%, 57.1%, 33.3%, respectable), "Inventory management system in the warehouse" (47.6%, 70.0%, 57.1 % and 33.3%, respectable), "Management of human resources" (71.4%, 66.7%, 64.3% and 66.7%, respectable), "Management of production operations" (33.3%, 40.0%, 21.4% and 16.7%, respectively), "Identification and traceability in the production process" (59.5%, 83.3%, 92.9% and 66.7%, respectively), "Product safety risk assessment" (11.9%, 23.3%, 7.1%, 0.0%), "Occupational risk assessment" (2.4%, 16.7%, 14.3% and 0.0%, respectable), "Environmental protection risk assessment" (7.1%, 33.3%, 7.1% and 0.0%, respectable), "Quality management" (66.7%, 83.3%, 78.6% and 83.3%, respectable) and "Financial Management" (78.6%, 96.7%, 100.0%, 100.0%, respectable). Companies operating in Bosnia and Herzegovina most often use ICT in the field of financial management, human resource management and quality management. Companies from Serbia stated that they most often use ICT in financial management, during identification and traceability in the production process, quality management, while companies from North Macedonia use ICT most in the area of financial management, identification and traceability in the production process, and quality management. Although a small number of companies from Montenegro participated in the survey, they showed a similar trend as companies from the other three countries. ICT is mostly used in the areas of financial management, quality management, identification and traceability in production and human resources management. The chi-square test of independence found that there is no statistically significant relationship between the areas of business in which the company uses ICT and the country in which it carries out its business activity

$$\chi^2_{Q1}(3,92) = 4,432; \text{Sig.} = 0,218/$$

$$\chi^2_{Q2}(3,92) = 1,464; \text{Sig.} = 0,691/$$

$$\chi^2_{Q3}(3,92) = 4,818; \text{Sig.} = 0,186/$$

$$\begin{aligned} \chi^2_{Q4} (3,92) &= 0,338; \text{Sig.} = 0,953/ \\ \chi^2_{Q5} (3,92) &= 2,246; \text{Sig.} = 0,523/ \\ \chi^2_{Q7} (3,92) &= 3,816; \text{Sig.} = 0,282/ \\ \chi^2_{Q8} (3,92) &= 5,633; \text{Sig.} = 0,131/ \\ \chi^2_{Q10} (3,92) &= 2,984; \text{Sig.} = 0,394/ \\ \chi^2_{Q12} (3,92) &= 7,641; \text{Sig.} = 0,054 \end{aligned}$$

at the level of significance $p=0.05$ (Table 4). In contrast, the connection between the application of ICT in the following areas of business: identification and traceability in the production process ($\chi^2_{Q6} (3,92) = 8,383; \text{Sig.} = 0,039$), environmental protection risk assessment ($\chi^2_{Q9} (3,92) = 11,538; \text{Sig.} = 0,009$), financial management ($\chi^2_{Q11} (3,92) = 9,031; \text{Sig.} = 0,029$)

Table 4. Business areas in which companies use ICT (N=92)

| Criterion | Part of companies in relation to the total number (%) | Part of the company in the country in which it operates (%) | | | | χ^2 Sig. Cramer's V |
|---|---|---|------|-------|-------|--|
| | | BIH | SRB | MKD | MNE | |
| Procurement and logistics management | 44,6 | 54,8 | 36,7 | 42,9 | 16,7 | $\chi^2(3,92) = 4,432$ Sig. = 0,218 Cramer's V=0,219 |
| Management of stocks of raw materials and raw materials | 55,4 | 54,8 | 60,0 | 57,1 | 33,3 | $\chi^2(3,92) = 1,464$ Sig. = 0,691 Cramer's V=0,126 |
| Inventory management system in the warehouse | 55,4 | 47,6 | 70,0 | 57,1 | 33,3 | $\chi^2(3,92) = 4,818$ Sig. = 0,186 Cramer's V=0,229 |
| Human Resource Management | 68,5 | 71,4 | 66,7 | 64,3 | 66,7 | $\chi^2(3,92) = 0,338$ Sig. = 0,953 Cramer's V=0,061 |
| Management of production operations | 32,6 | 33,3 | 40,0 | 21,4 | 16,7 | $\chi^2(3,92) = 2,246$ Sig. = 0,523 Cramer's V=0,156 |
| Identification and traceability in the production process | 72,8 | 59,5 | 83,3 | 92,9 | 66,7 | $\chi^2(3,92) = 8,383$ Sig. = 0,039 Cramer's V=0,302 |
| Risk assessment for product safety | 14,1 | 11,9 | 23,3 | 7,1 | 0,0 | $\chi^2(3,92) = 3,816$ Sig. = 0,282 Cramer's V=0,204 |
| Risk assessment at work | 8,7 | 2,4 | 16,7 | 14,3 | 0,0 | $\chi^2(3,92) = 5,633$ Sig. = 0,131 Cramer's V=0,247 |
| Environmental risk assessment | 15,2 | 7,1 | 33,3 | 7,1 | 0,0 | $\chi^2(3,92) = 11,538$ Sig. = 0,009 Cramer's V=0,354 |
| Quality management | 75,0 | 66,7 | 83,3 | 78,6 | 83,3 | $\chi^2(3,92) = 2,984$ Sig. = 0,394 Cramer's V=0,180 |
| Financial management | 89,1 | 78,6 | 96,7 | 100,0 | 100,0 | $\chi^2(3,92) = 9,031$ Sig. = 0,029 Cramer's V=0,313 |
| The company does not apply ICT | 6,5 | 14,3 | 0,0 | 0,0 | 0,0 | $\chi^2(3,92) = 7,641$ Sig. = 0,054 Cramer's V=0,288 |

N – total number of companies from four Balkan countries that participated in the survey (N=92)

$\chi^2(N, df)$ – Chi square test, $p=\text{Sig.}$ - significance ($p<0,05$), Cramer's V – Cramer's bond strength coefficient

and the country in which the company operates was statistically significant, with the strength of the relationship, measured by Kramer's coefficient, of medium strength (Cramer's $V_{06} = 0,302$; Cramer's $V_{09} = 0,354$; Cramer's $V_{11} = 0,313$; respectable) (Table 4).

The application of ICT in food production was the subject of study in several papers. The results obtained in our research agree with the works whose conclusions are listed below. Information and communication technologies (ICT) provide support to companies in achieving a sustainable competitive advantage, strengthening logistics [6], better cooperation in the supply chain [10,25] and better use of resources, reducing the amount of waste, increasing efficiency in environmental protection [11, 12]. ICT applications enable easier fulfillment of legal regulations and management system requirements in establishing a more efficient traceability system [7,8]. These are additional reasons for expanding the field of application of ICT in other areas of the company's operations and providing better conditions for the application of MS.

During work in companies, a large amount of information is created [26]. For their collection, processing and storage, companies use paper documents or e-documents. Companies are aware of the advantages provided by electronic documents, and they strive to use ICT more for this purpose [3]. The representatives of the surveyed companies stated that they use several electronic databases in their companies (table 5). This table shows data on the share of companies from different countries that use one of the e-databases. During the filling of the questionnaire, the companies declared separately about each of the e-databases. 11.9% of companies from Bosnia and Herzegovina stated that they do not use e-databases or specific software, which represents 5.4% of the total number of companies that participated in the survey. Based on the responses of company representatives, it can be seen that companies from Bosnia and Herzegovina most often use the e-database of employees (88.1%), the e-database of customers (76.2%) and the e-database of suppliers (73.8%), while they least use the e-database of aspects of environmental protection (16.7%) and the e-database of incidents and injuries at work (19.0%). Companies from Serbia very often use the following three e-databases: supplier database, employee database, and customer database (100.0%; 96.7% and 96.7%, respectively). According to the statements given in the

survey, all companies in North Macedonia have developed and use e-database of employees, e-database of suppliers and e-database of customers, while all companies from Montenegro use e-database of employees and e-database of customers. The above data point to the fact that companies in the four Balkan countries still use e-databases for the needs of administrative, personnel and financial services, while there is significant scope for the application of electronic databases and other documents in the field of quality management, environmental protection, occupational safety and product safety management. That it is necessary to make additional efforts in this segment of the company's operations is confirmed by the data obtained from the companies during the conducted survey on the use of e-bases of reports on laboratory analyses: BiH (35.7%), SRB (43.3%), MKD (50, 0%) and MNE (50.0%). In the survey questionnaire, companies were offered to declare about the application of two specific software: Software for managing individual production operations and Software for product identification and traceability. When looking at the current situation by country (BiH, SRB, MKD, MNE), the following data were obtained for the application of the first software: 22.6%; 33.3%; 42.9% and 50.0%, respectable, and for the application of other software: 28.6%; 56.7%; 28.6% and 16.7%, respectable. Given the company's plan to introduce new technologies and machines with digital guidance, it is clear that companies should work on the development and application of appropriate software and other ITC tools in the production process. Current laws and international management standards require the transparency of the product identification process and the establishment of an effective traceability system. As can be seen from the results of the survey, companies still use paper documents, which complicates the identification process and prolongs the search for products in the traceability system. The use of modern tools for labeling and tracking products, as well as software for storing and analyzing such data, in emergency situations significantly shortens the time required for product recall, reduces company costs and increases consumer safety.

The Chi-square (χ^2) independence test showed that the relationship between the number of companies, which stated that they use certain databases or software in their operations, and the country in which the company operates is statistically significant in the following cases: the company owns an e-base of

suppliers (Sig. = 0.004), the company has an e-database of customers (Sig. = 0.015), the company has an e-database of aspects of environmental protection (Sig. = 0.001) and the company has an e-database of incidents and injuries at work (Sig. = 0.008). In other cases, there is no statistically significant influence of the state at the significance level of $p=0.05$.

Company representatives were asked to state in the survey about the programming languages that were used during the development of existing soft-

ware solutions. As can be seen from Table 6, different programming languages were used for software development. Some companies used only one programming language, some companies used two or more languages. The most frequently used programming languages are JAVA (59.3%) and C++ (37.4%). When looking at the situation by country, JAVA was used the most by companies from Serbia, followed by Montenegro and Bosnia and Herzegovina, and the least by companies from North Macedonia (70.0%;

Table 5. Type of ICT that companies use in their operations (N=92)

| Criterion | Total number of companies (%) | Part of the company in the country in which it operates (%) | | | | χ^2 Sig. Cramer's V |
|--|-------------------------------|---|-------|-------|-------|---|
| | | BIH | SRB | MKD | MNE | |
| E-base of employed workers | 93,5 | 88,1 | 96,7 | 100,0 | 100,0 | $\chi^2(3,92) = 3,892$ Sig. = 0,273 Cramer's V=0,206 |
| E-base of resources for work | 45,7 | 35,7 | 60,0 | 42,9 | 50,0 | $\chi^2(3,92) = 4,251$ Sig. = 0,236 Cramer's V=0,215 |
| E-base of suppliers | 87,0 | 73,8 | 100,0 | 100,0 | 83,3 | $\chi^2(3,92) = 13,070$ Sig. = 0,004 Cramer's V=0,377 |
| Customer e-base | 88,0 | 76,2 | 96,7 | 100,0 | 100,0 | $\chi^2(3,92) = 10,441$ Sig. = 0,015 Cramer's V=0,337 |
| E-base of contracts | 34,8 | 33,3 | 33,3 | 42,9 | 33,3 | $\chi^2(3,92) = 0,475$ Sig. = 0,924 Cramer's V=0,072 |
| E-base of aspects of environmental protection | 33,3 | 16,7 | 53,3 | 57,1 | 0,0 | $\chi^2(3,92) = 17,124$ Sig. = 0,001 Cramer's V=0,431 |
| E-base of incidents and injuries at work | 33,3 | 19,0 | 43,3 | 64,3 | 16,7 | $\chi^2(3,92) = 11,923$ Sig. = 0,008 Cramer's V=0,360 |
| E-base of reports on conducted laboratory analyses | 41,3 | 35,7 | 43,3 | 50,0 | 50,0 | $\chi^2(3,92) = 1,216$ Sig. = 0,749 Cramer's V=0,115 |
| Software for managing individual production operations | 32,6 | 26,2 | 33,3 | 42,9 | 50,0 | $\chi^2(3,92) = 2,289$ Sig. = 0,515 Cramer's V=0,158 |
| Product identification and traceability software | 37 | 28,6 | 56,7 | 28,6 | 16,7 | $\chi^2(3,92) = 7,752$ Sig. = 0,051 Cramer's V=0,290 |
| The company does not use electronic databases | 5,4 | 11,9 | 0,0 | 0,0 | 0,0 | $\chi^2(3,92) = 6,294$ Sig. = 0,098 Cramer's V=0,262 |

N – the total number of companies from four Balkan countries that participated in the survey (N=92)

$\chi^2(N, df)$ – Chi square test, $p=Sig.$ - significance ($p<0,05$), Cramer's V – Cramer's bond strength coefficient

Table 6. Analysis of the application of programming languages in integrated software systems (N=92)

| Criterion | Total number of companies (%) | Part of the company in the country in which it operates (%) | | | | χ^2 Sig. Cramer's V |
|--|-------------------------------|---|------|------|------|---|
| | | BIH | SRB | MKD | MNE | |
| In the programming language PHP | 7,7 | 7,1 | 3,3 | 14,3 | 20,0 | $\chi^2(3,92)=2,744$ Sig.=0,433 Cramer's V=0,174 |
| In the programming language JAVA | 59,3 | 57,1 | 70,0 | 42,9 | 60,0 | $\chi^2(3,92)=3,074$ Sig.=0,380 Cramer's V=0,184 |
| In the Python programming language | 4,4 | 0,0 | 0,0 | 21,4 | 20,0 | $\chi^2(3,92)=15,873$ Sig.=0,001 Cramer's V=0,418 |
| In the Visual Basic programming language | 4,4 | 0,0 | 3,3 | 0,0 | 60,0 | $\chi^2(3,92)=39,442$ Sig.=0,000 Cramer's V=0,658 |
| In the C++ programming language | 37,4 | 19,0 | 56,7 | 50,0 | 40,0 | $\chi^2(3,92)=11,767$ Sig.=0,008 Cramer's V=0,360 |
| In the C# programming language | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | - |
| Other | 1,1 | 2,4 | 0,0 | 0,0 | 0,0 | $\chi^2(3,92)=12,04$ Sig.=0,752 Cramer's V=0,114 |

N – the total number of companies from four Balkan countries that participated in the survey (N=92)

$\chi^2(N, df)$ – Chi square test, p=Sig. - significance ($p < 0,05$), Cramer's V – Cramer's bond strength coefficient

60.0%; 57.1%; 42.9%, respectable). The programming language C++ for creating their IT solutions was most often used by companies from Serbia and North Macedonia, less companies from Montenegro and the least companies from Bosnia and Herzegovina (56.5%; 50.0%; 40.0% and 19.0%, respectable). According to the company's statement, certain IT solutions used were PHP (7.7% compared to all companies that submitted their questionnaire), Python (4.4%) and Visual Basic (4.4%). The same table (table 6) shows the results obtained by the Chi-square test of independence (χ^2) between the responses of companies that use or do not use a certain programming language.

Companies, which currently do not use e-databases, claim that they will establish them in the coming years (in 5 years at most) and that they will use

ICT in the systems for assessing product safety risks and environmental protection assessment systems [3]. The company's plan for the development and use of ICT is shown by country (table 7). The results of the survey are expressed as a share of companies in the total number of surveyed companies for each country individually. As can be seen, all companies planned to develop and use certain e-databases, and to apply ITC in the product safety risk assessment system and the environmental protection risk assessment system. In addition, they plan to develop and apply an Integrated Information System in their business, which will cover all areas of business (table 7).

Information and communication technologies (ICT) include a number of technologies for collecting, finding, exchanging, analyzing, processing and transmitting data in digital form [1]. The universal ac-

Table 7. Plan of companies to apply certain ITC applications in their work in the next 5 years (N=92)

| Question | Total number of companies (%) | Part of the company in the country in which it operates (%) | | | |
|---|-------------------------------|---|------|-------|-------|
| | | BIH | SRB | MKD | MNE |
| electronic database of raw materials | 31,5 | 33,3 | 26,6 | 35,7 | 33,3 |
| warehouse inventory management system | 33,7 | 35,7 | 19,9 | 50,0 | 50,0 |
| electronic database of human resources | 8,7 | 16,7 | 3,3 | 0,0 | 0,0 |
| electronic database of resources for work | 54,4 | 61,9 | 53,3 | 42,9 | 33,3 |
| electronic customer database | 13,1 | 23,8 | 3,3 | 7,1 | 0,0 |
| product safety risk assessment system | 88,1 | 85,8 | 86,6 | 85,7 | 100,0 |
| system for environmental protection risk assessment | 62,0 | 90,5 | 93,4 | 85,7 | 100,0 |
| integrated information system | 94,5 | 90,5 | 96,7 | 100,0 | 100,0 |

ceptance of internet platforms for communication and business exchange of knowledge also influences the fact that ICTs become a powerful tool for social and economic development in the world. ICT can contribute to increasing the efficiency of food supply chains, because it can have a positive effect on increasing productivity, reducing business costs, facilitating access to new markets and finally, ICT can contribute to overall sustainable development. Gómez-Barroso and Marbán-Flores [27] state that the rapid development and application of ICT influence the increase of growth, productivity and employment opportunities in developing countries. Apiah-Otoo and Song [28] state that the benefits due to the application of ICT are greater in poor than in rich countries. The use of ICT contributes to achieving the goals of sustainable development [29]. ICT helps improve the organization and color linking of activities in the food processing process and influence the reduction of food wastage [30]. Finally, the application of ICT-based systems help food processing organizations to determine factors that affect food quality and food waste, and better use resources and reduce environmental impact [11]. Integrating ICT into the food supply chain management system has a positive impact on all organizations involved in the supply chain [31], helps the sustainable growth of small and medium enterprises in developing countries [10] and directs the national economy towards sustainable development. The results obtained during the research showed that companies from the food sector in the Balkan countries follow the

trend of applying ICT in their business, that through the translation of documents in hard copy into e-documents, the development and application of e-bases with different data and different software enable easier collection and processing of data, easier application of regulations and management standards and create prerequisites for establishing more efficient communication between supply chain participants. These activities affect the strengthening of the capacity of the food sector to increase production, reduce business costs and access new markets.

4. CONCLUSION

Based on a survey conducted in companies from the food production sector in four Balkan countries (Bosnia and Herzegovina, Serbia, North Macedonia and Montenegro), it can be concluded that companies in this sector apply various forms of information and communication technologies during their operations, and that they have developed a five-year business improvement plan in several sectors that will be supported by IT solutions and modern communication technologies. According to the statement of the company representative, all surveyed companies plan to apply an integrated information system.

In the continuation of the research, it is necessary to determine the economic, ecological and social degree of sustainability of new ICT-based technologies in the food production sector and the food supply chain as a whole.

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PRIMJENA INFORMACIONIH TEHNOLOGIJA U PRERADI HRANE

Sažetak: Informacione tehnologije (IT) postale su važan dio aktivnosti savremenog čovjeka. Mnoge aktivnosti u procesima proizvodnje hrane podržane su različitim vrstama IT. Cilj ovog rada je da se utvrdi udio preduzeća u Bosni i Hercegovini (BiH), Srbiji (SRB), Sjevernoj Makedoniji (MKD) i Crnoj Gori (MNE), koja u svom poslovanju koriste neki oblik IT. Provedeno je istraživanje u preduzećima iz prehrambenog sektora u četiri države na Balkanu. Istraživanje je obuhvatilo 42 preduzeća iz BiH, 30 preduzeća iz SRB, 14 preduzeća iz MKD i 6 preduzeća iz MNE. Za potrebe ovog istraživanja dizajniran je poseban upitnik. Distribucija upitnika je obavljena putem e-pošte, s digitalnom vezom za korisnike prema obrascu anketnog upitnika koje oni treba da ispune (Microsoft Forms). Dobijeni rezultati su statistički obrađeni korištenjem IBM SPSS Statistics 26.

Tokom istraživanja autori su utvrdili područja u kojima preduzeća već primjenjuju IT, njihove planove vezane za razvoj IT u narednom periodu i eventualno integraciju postojećih i novih IT rješenja u jedinstven informacioni sistem. U svojim odgovorima, preduzeća su se izjasnila o oblastima poslovanja u kojima najčešće primjenjuju IT. Preduzeća su razvila i koriste više e-baza (prikazan je udio preduzeća iz svake države u odnosu na broj preduzeća koja su dostavila popunjene anketne upitnike i to redom BiH, SRB, MKD i MNE): e-baza zaposlenih (88,1%; 96,7%; 100% i 100%, respektabilno), baza do-

bavljača (73,8%; 100%; 100% i 83,3%, respektabilno), e-baza kupaca (76,2%; 96,7%; 100% i 100%, respektabilno), e-baza resursa za rad (35,7%; 60,0%; 42,9% i 50,0%, respektabilno), e-baza izvještaja o provedenim laboratorijskim analizama (35,7%; 43,3%, 50,0% i 50,0%, respektabilno) itd. U razvoju IT rješenja, preduzeća koriste različite programske jezike, a najviše JAVA (59,3% od svih anketiranih preduzeća) i C++ (37,4% u odnosu na ukupni broj anketiranih preduzeća).

Istraživanje je pokazalo da preduzeća u prehrambenom sektoru u 4 države Balkana koriste različite oblike IT i da imaju jasne planove za njihov razvoj i primjenu u svom poslovanju. Ohrabruje stav da većina preduzeća radi na razvoju integrisanog informacionog sistema.

Ključne riječi: IT, e-baze, Programski jezici, Proizvodnja hrane.

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