

## Digitalized business processes – assessment and opportunities of Hungarian agri-food companies

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### ABSTRACT

Digitalization in agri-food supply chain has become increasingly important since safe and secure food supply is a priority for stakeholders. ICT-based (Information and Communication Technologies) business solutions have an impact on the whole food supply chain and separately the participants (producers, processors, distributors, retailers and consumers). Advanced technologies support many business activities as proving traceability and transparency, improving internal business processes, simplifying cooperation with partners and establishing the capability to develop supplementary value-added services. The main objective of the current paper is to determine the development potentials of digitalized business processes related to the operation of companies related to the production and processing of agricultural products and food. For this aim, we analysed the differences between food producers and food processors regarding their evaluation of ICT solutions in their partnerships and for certain business activities. Institute of Applied Informatics and Logistics at University of Debrecen has prepared a questionnaire for a survey on the assessment of ICT by food producer and food processor enterprises (n=500). We go into a little bit more depth about the role of information share with the final consumers as they are more and more conscious about their food and may have special information requirements for food products. Thus, we supplemented our research with another questionnaire that was aimed at young food consumers (n=376) to survey their attitude to the main food information and the opportunities to support their choice. For the analyses, we used descriptive statistical methods and Mann-Whitney test. Our results show that both enterprise categories assessed the variables tested as being rather medium importance. Statistically, processors evaluated two variables significantly higher compared to producers these were the 'Fast evaluation of business performance' (Sig(2-tailed)=0,010) and 'Operating high-quality website' (Sig(2-tailed)=0.012). For the respondent consumers, food component list is one of the most important product information. The importance of this variable was the third during the purchase (after price and quality) and second in product comparison (after price). The majority (64%) often or always read this information on the package. Most respondents indicated a willingness to use such mobile applications that may support easy information access.

## 1. Introduction

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From our point of view, the most relevant keywords in one cluster support the concept of the current paper. Analyzing the role of ICTs and information flow in agriculture and food sector may lead us to determine barriers to and opportunities for ICT usage. Thus, on the one hand, this paper presents an analysis of how important agri-food companies consider ICT solutions in their business processes. On the other hand, we highlight a typical information interface between business to consumer, complemented with a consumer analysis based on another survey.

## Literature review

Information and communication technologies (ICTs) play an increasingly important role in business, there are hardly any areas that are not been affected by them. However, the simple use of these technologies is no longer enough. Digitalization from production to consumption may have an impact on the performance both in the case of smaller and larger companies. Mobile applications can be used in any part of the food supply chain (e.g. production, logistics, performance evaluation, food tracing, quality monitoring) including the final consumers (e.g. applications for food information). In this section, we review the importance of smooth information flow in FSC (food supply chain) and the trends of applying ICTs in general business processes and at companies operating in the food value chain, from agriculture to food processing.

Analysis of information flow and the impact of digitalization on it has received much attention over the last two decades. Several review papers, empirical articles and case studies have been published on the key role of information sharing and the advantages of using ICTs in business processes (Chen, 2003; Consoli, 2012; Viet, Behdani & Bloemhof, 2018; Costantino et al., 2015; Wu & Jia, 2018). It is important to share information for supply chain stability (Singh et al., 2019) that is more and more affected by network and dynamic business environment and by ICTs (Fiala, 2005). Marketing, communication, networking and resource planning are the areas that ICT impacts the most (Taruté & Gatautis, 2014). Regarding corporate performance, Millán et al. (2019) claim there are grounds to expect that differences in the usage of ICT among firms may affect firm performance. Digital transformation is taking place along the entire value chain (Bogner et al., 2016; Kilimis et al., 2019). Researchers have recently started investigating different aspects of digital agriculture in relation to farm production systems, value chains and food systems (Klerkx, Jakku & Labarthe, 2019).

Annosi et al. (2019) highlighted a few Technology 4.0 opportunities (e.g. Cloud services, Internet of Things, Big Data Analytics) that can be important in the agriculture and food industry equally. In the article of Látečková, Bolek & Szabo (2018) cloud computing was underlined as a solution that can help in virtualisation of processes and it establishes a single modern and complex system of agricultural smart enterprises supported by ICTs. Internet of Things would have a contribution to the change of agri-food processes and towards data-driven farming supported by decision-making tools (Verdouw, Wolfert & Tekinerdogan, 2016). Panetto et al. (2020) highlight the key role of technology in the operations and decision-making of the agri-food sector. The use of digital information sources may play a potential role during organizational partner selection (Tóth, Nieroda & Koles, 2020). In agriculture, improved availability of information and knowledge will lead to increased production for the farmers through better decision-making (Ali & Kumar, 2011). Analyzing the concept of Agriculture 4.0, Lezoche et al. (2020) found that Big Data may be a tool to a better understanding of consumer needs and target higher value markets. In the food sector, besides efficiency and process control, consumer communications are also closely related to the use of ICTs (Lehmann, Reiche & Schiefer, 2012). In this regard, the level of ICT usage determines the success of customer services and customer satisfaction that according to Kilimis et al., (2019) could also be important indicators in the performance of the companies.

Understanding the importance of online information-sharing with the consumers is important, as mentioned by Van Der Vorst (2006), there is a requirement from consumer side for information not only about food but farming or distribution practices as well. With new food choice features of consumers (healthy food ingredients and nutritional value, fair-trade resources, strengthening domestic loyalty and local consumption etc.), the role of ICTs in the information flow will have a key role. Since much information is available at the information systems of companies, this information is not

easily accessible for consumers. On websites, they can find only some subsets of relevant information (Kaloxylos et al. (2013). Räsänen & Tuovinen (2020) researched on rural micro-enterprises regarding online appearance and based on their results, respondents were interested in website development and social media usage among other survey questions aimed at improving online information flow. For instance, Kubicová, Predanocyová & Kádeková (2019) analysed the dairy sector and they found information that could be appeared digitalized (e.g. country of origin, nutrition data or composition). In the food sector, there is a wealth of research opportunity in B2B2C (business to business to consumer) business models regarding the benefit of customer social media interactions (Iankova et al., 2019) as these companies are a prime example of the B2B2C type of marketing (Pillai, 2020). Making easier access to information by all food chain actors (including consumers) is a need to maximize the benefits of ICTs in food chains and it is necessary to develop applications and services that are user-friendly, relevant, localized and affordable (El Bilali & Allahyary, 2018). There is a potential of digitalization to find new customers and design new services (Räsänen & Tuovinen, 2020), such as applications or using Augmented Reality supporting food choice.

ICT applications may also help in improving collaboration between different stakeholders and results in enhanced food supply performance (Singh et al., 2019). However, strategic decisions on digital transformation do not automatically improve performance, because it requires enterprises to rethink and change their business model (Bouwman, Nikou & de Reuver, 2019). More intensive deployment of ICT is needed inter alia for the optimization of the company's internal processes (Ahmedova, 2015). Strong and dynamic corporate entrepreneurship is needed to seize the benefits of ICT by integrating them into organizational strategies and creating the right corporate culture for ICT adoption, use, and innovation diffusion (Yunis, Abbas & Kassar, 2017).

## 2. Materials and methods

Our study used a primary source of data collected with the help of a structured survey. The target population was the food producing and food processing companies operating in Hungary. The survey was conducted in the fourth quarter of 2017, and a market research company was involved to make the interviews and data recording. Respondents were the leaders or a member of the management of the companies. Sampling based on some economic features of the companies, these were the size (number of employees), region (NUTS-2 level) and activity (Nace Rev.2.). The data source for sampling was the Hungarian Central Statistical Office (hereinafter HCSO). The database contains data on ICT usage characteristics about 500 enterprises operating in the agriculture and food industry as a producer or processor. The exact sector of respondent enterprises can be seen in Table 1.

**Table 1.** NACE Rev.2 Codes of Respondent Enterprises

<b>A (Agriculture, forestry and fishing)</b>
<b>01 (Crop and animal production, hunting and related service activities)</b>
<i>01.11 – Growing of cereals (except rice), leguminous crops and oil seeds</i>
<i>01.13 – Growing of vegetables and melons, roots and tubers</i>
<i>01.21 – Growing of grapes</i>
<i>01.24 – Growing of pome fruits and stone fruits</i>
<i>01.41 – Raising of dairy cattle</i>
<i>01.46 – Raising of swine/pigs</i>
<i>01.47 – Raising of poultry</i>
<b>C (Manufacturing)</b>
<b>10 (Manufacture of food products)</b>
<i>10.1 – Processing and preserving of meat and production of meat products</i>
<i>10.3 – Processing and preserving of fruit and vegetables</i>
<i>10.5 – Manufacture of dairy products</i>
<i>10.7 – Manufacture of bakery and farinaceous products</i>

Source: HCSO

The number of enterprises in the database of HCSO and the sample database; and the percentage of the represented population by sector can be seen in Table 2.

**Table 2.** Share of respondent enterprises by sector

Sector	Population (N=19 385)	Sample (n=500)	n/N %
<b>Food producers</b>	<b>16 133</b>	<b>355</b>	<b>2.20%</b>
01.11	7 860	234	2.98%
01.13	2 627	16	0.61%
01.21	890	6	0.67%
01.24	1 763	5	0.28%
01.41	778	28	3.60%
01.46	842	19	2.26%
01.47	1 373	47	3.42%
<b>Food processors</b>	<b>3 252</b>	<b>145</b>	<b>4.46%</b>
10.1	581	37	6.37%
10.3	556	37	6.65%
10.5	119	10	8.40%
10.7	1 996	61	3.06%

Source: own editing according to the authors' survey, 2017 and HCSO database, 2017

The resulting database allowed us to analyze how agri-food companies evaluate the role and importance of ICT solutions in their business processes. Variables were assessed on a 5-Likert scale. Our hypothesis is that food processors evaluate ICTs in business processes higher than food producers and the difference is significant. To prove our hypothesis, in this paper we used the question of "Evaluate the following ICT-based solutions in the business processes of your company" and the variables were:

- v1: Fast evaluation of business performance
- v2: Use of low-cost solutions
- v3: Safe data storage at service providers
- v4: Operating high-quality website
- v5: Level of IT infrastructure of suppliers
- v6: Level of IT infrastructure of purchasers

For survey questions formation we used some Eurostat indicators as a basis, the ones that can be considered relevant for agri-food companies and these are the followings:

- v1: Integration of internal processes
- v2: Cloud computing services
- v3: ICT security
- v4: Websites and functionalities
- v5 and v6: Integration with customers/suppliers, supply chain management

The statistical program SPSS 23 was used for our calculations. As our data measured on an ordinal scale, in the first step, the non-parametric Mann-Whitney U test was conducted to determine differences between groups of food producers (group A) and food processors (group B). The difference was considered significant on the level of 0.05. As there are diverging views on the normality of data measured on Likert-scale data and according to Norman (2010), independent t-test also means an option for determining differences in ordinal data. Thus, we checked our dataset for normality and independent t-test with equal and unequal variances was applied (F-test was applied for calculating variances). The normality test showed a roughly normal distribution and the result of t-test was the same. In this article, we present the statistical output tables of the Mann-Whitney U test.

We made another questionnaire in 2019 to complement our research with consumer attitudes that may take into consideration for developing business processes and the usage level of ICTs in a business to consumer relationship. The survey aimed at young people aged between 18 and 25 and data recording was performed at the University of Debrecen. The participation was voluntary and anonymous and in total 376 replies were received.

### 3. Results and discussion

Given that the focus of this article was on the analysis of enterprises, the main part of this section contains our results calculated for the sampled companies. The variables chosen are considered important to analyze as for agri-food companies these may be relevant services in their business activity, and the level of using them has an impact on the cooperation among supply chain stakeholders. An increasing number of studies have published on the relation between performance growth through indirect factors (e.g. customer satisfaction, better partner cooperation) and cost savings reachable by use of ICT in different business processes. Information management, however, plays an indirect role in the operation of a business, its level affects the transparency and continuity of the information flow in every type of supply chain. The lack of information value could place the enterprises operating in a chain at a competitive disadvantage as members could not form the integration of internal processes and create cooperation with suppliers or customers. Effective operation and business development are also crucial for agri-food companies and the whole supply chain. There are many actors (suppliers and producers of raw materials, food and feed processors, distributors, retailers and final consumers) to interact with, so the usage level of the partners has a great impact on the success of the information flow. Our analysis aims to reveal some ICT usage characteristics of businesses from the agri-food sector and to determine differences between two groups operating two different parts of the supply chain. In the end, a few data from our consumer survey were displayed to complement our research of information flow in the supply chain towards the consumer side to initiate potential new supply chain research.

First, we determined the main indicators of the sample using descriptive statistics, subsequently, we analyzed the variables applying the Mann-Whitney test since all the data were measured on ordinal data (5-Likert scale). The result of the descriptive statistics of enterprise data is summarized in Table 3.

**Table 3.** Group statistics of the scores given by the sample enterprises

	Food producers (n=355)			Food processors (n=145)		
	Mean	Std. Deviation	Std. Error Mean	Mean	Std. Deviation	Std. Error Mean
<b>v1</b>	<b>3.3746</b>	1.2923	0.0686	<b>3.6897</b>	1.2106	0.1005
<b>v2</b>	3.6901	1.1692	0.0621	3.7517	1.2612	0.1047
<b>v3</b>	<b>3.9493</b>	1.3074	0.0694	<b>3.7241</b>	1.4836	0.1232
<b>v4</b>	<b>3.0028</b>	1.5793	0.0838	<b>3.3862</b>	1.5509	0.1288
<b>v5</b>	3.4986	1.2059	0.0640	3.4690	1.2805	0.1063
<b>v6</b>	3.4141	1.1743	0.0623	3.3379	1.2868	0.1069

Source: own calculation based on own survey data

Our result shows that the average values of the two enterprise categories are rather medium (all the variables are under 4) and the mean values belonging to processors, however, are only higher in the case of v1, v2 and v4. Food processors appreciate a fast evaluation of business performance, use of low-cost solutions (e.g. cloud computing services) and operating high-quality website (including the display of detailed company and product information and frequently refreshed content). This latter seems to be reasonable as food processors have significant trading activities and this is in connection

with both retail partners and final consumers. Safe data storage (v3) is more important for the food producer group with a greater difference from processors. The trend towards a comprehensive data collection and processing in the framework of precision agriculture in agricultural farms and enterprises can be a possible explanation for the higher evaluation. In the case of the importance of the level of IT infrastructure of suppliers and purchasers (v5 and v6) the mean values are higher for the producer group; however, this difference is slight.

It can thus conceivably hypothesized that food processors do not consider ICT-based business processes more important than enterprises operating in agriculture. Mean values indicate that there is a potential to improve the ICT readiness of enterprises through a better understanding and increased use in order to a more smooth and effective information flow throughout the whole food supply chain. Regarding mean values, it can be seen a greater difference between the two groups in case of v1, v3 and v4. To determine that these differences can be considered statistically significant or not, the Mann-Whitney test was applied to the scores given by the two enterprise groups. Table 4. shows the output table of ranks and Table 5. contains the result of the Mann-Whitney test.

**Table 4.** Output table of Ranks

Variable	Group	Mean Rank	Sum of Ranks
v1	A	240.22	85,279.00
	B	<b>275.66</b>	39,971.00
v2	A	246.99	87,683.00
	B	<b>259.08</b>	37,567.00
v3	A	<b>255.04</b>	90,538.00
	B	239.39	34,712.00
v4	A	240.40	85,341.50
	B	<b>275.23</b>	39,908.50
v5	A	250.94	89,083.50
	B	249.42	36,166.50
v6	A	252.33	89,575.50
	B	246.03	35,674.00

Source: own calculation based on own survey data

Regarding mean ranks, besides v1, v2 and v4 variables, a higher rank is observed in the case of food producers for v3. In the next step, we tested these differences using the Mann-Whitney test to verify our hypothesis that is food processors perceive ICTs in business processes higher than food producers at a significant level. Our assumption based on the idea that processors may have a closer connection with final consumers and trading partners in rather digitalized ways. On the one hand, we assumed food processing companies require complex information systems both for internal and external integration. On the other hand, communication was supposed relevant to consumers in several aspects (e.g. market research activity for launching a new product, introducing value-added services for consumers, or developing an existing product). The output table of Mann-Whitney test can be seen in Table 5. We used Asymptotic Significance (2-tailed) p-value to determine the significance of the difference as it is suitable for larger sample sizes, and the normality test showed that the dataset is roughly normally distributed.

**Table 5.** Output table of Mann-Whitney Test Statistics

	v1	v2	v3	v4	v5	v6
<b>Mann-Whitney U</b>	22,089.000	24,493.000	24,127.000	22,151.500	25,151.500	25,089.500
<b>Wilcoxon W</b>	85,279.000	87,683.000	34,712.000	85,341.500	36,166.500	35,674.500
<b>Z</b>	-2.564	-.884	-1.175	-2.518	-.110	-.457
<b>Asymp. Sig (2-tailed)</b>	<b>.010</b>	.377	.240	<b>.012</b>	.912	.647

Source: own calculation based on own survey data

Our test result shows a significant difference in two cases, for v1 and v4 between food producers and food processors in the values given for the importance of the two business processes supportable with ICTs. In both cases, the evaluation of food processors was higher. The value of Asymp. Sig(2-tailed) for the importance of “Fast evaluation of business performance” and “Operating high-quality website” were 0.010 and 0.012, respectively. Our main hypothesis that food processors evaluate higher ICT-based business solutions for corporate activities has been partly proved based on our research findings. Agri-food companies assessed v2, v3, v5 and v6 at roughly the same level, furthermore, the overall average runs at around 3.5 which is below the level authors expected. However, our study provides considerable insight into the analysis of information flow at agri-food companies.

In order to link our enterprise research with the consumer side, we made a questionnaire to analyze their requirements for food information. The following 3 variables were thought suitable connection points with the variables used for measuring some indicators that can have a greater role in the information flow. Our assumption was that to have easy access to information provided by the company side may be important for consumers. Table 6. shows some information on the attitude of consumers regarding the food ingredients as this variable has been considered one of the three most important factors during purchasing with the price and quality/brand.

**Table 6.** Summarizing table of the main information of the consumer survey

<b>Variables</b>	<b>Ratio</b>
<b>Respondents who consider food ingredient list</b>	
as one of 3 most important factors during purchasing	51%
a basis for comparing product alternatives	65%
<b>Respondents who check the food ingredient list:</b>	
never	5%
rarely	31%
often	43%
always	21%
<b>Respondents who are interested in such an application that helps in:</b>	
displaying food allergens	15%
comparing similar product alternatives	28%
displaying certain product ingredients	31%
displaying the place of origin	33%
a complex version of these four functions	35%

Source: own calculation based on own survey data

Survey results show that the majority of respondents consider the food component list as one of the most important product information. The importance of this variable was the third during the purchase (after price and quality) and second in product comparison (after price). The majority (64%) often or



always read this information on the package. Most respondents indicated a willingness to use such mobile applications that may support easy information access to certain information or a complex application that can help them during purchasing and to compare product alternatives. It could be useful in the development or introduction of related services for consumers as 60% of the age group surveyed buy food mostly or almost always themselves. Thus, their information requirement may be relevant in developing new services, such as mobile applications helping in food purchasing.

#### 4. Conclusion

Our overall conclusion is at the beginning of the food supply chain there is a potential regarding the development of ICT level and attitude towards the importance of ICT-based business processes. As our result showed, the means calculated for the importance of the variables were around 3.5 which means a rather medium evaluation from respondent enterprises, both from food producers and processors. Our assumption that processors assess higher ICT solutions with the aim to increase time and cost-effectiveness of the companies has been partly proved based on the results of our calculations. Statistically, processors evaluated only two variables significantly higher compared to producers. These were the “Fast evaluation of business performance” (Sig(2-tailed)=0,010) and “Operating high-quality website” (Sig(2-tailed)=0.012). Agri-food companies assessed the remained four variables at roughly the same level. However, our research may be contributed to those studies that deal with the information flow within the agri-food supply chain. In our opinion, there is a great opportunity for enterprises to reduce the information gap by promoting new, ICT-enhanced business solutions and changing the approach to use ICT to develop entrepreneurial business activities. A better understanding of the importance of projects aiming the development of intra-corporate ICT-level and use these solutions in B2B2C communication and marketing is also crucial. Our complement research also supports our suggestion as results showed there is a requirement from the consumer side to food information and in a simple way. The majority of respondent students (64%) often or always read food information they also indicated a willingness to use such mobile applications that may support easy information access to certain information or a complex application that can help them during purchasing and to compare product alternatives. Application development as ancillary services, using new technologies such as Augmented Reality or Virtual Reality means the real potential to increase the efficiency of information flow throughout the food supply chain. Our work has some limitations, nevertheless, we believe our work could provide ideas for future research direction to study the ICT attitude of participants in the chain and to highlight the importance of ICT solutions and smooth and continuous information flow in their business relations and overall in the food supply chain.

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