Structural model of innovation influences on honey sector business performance

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Abstract

The subject of research in this paper is the analysis of the impact of investments in research and development, the adoption of new technologies and the business environment on the business performance of beekeepers. The research used Partial least square structural equation modeling (PLS-SEM) technique using PLS SMART software. The results of the research confirmed the positive impact of all three groups of variables on the business performance of beekeepers, of which the the most significant factor is the impact of the readiness to adopt new technologies in a positively rated business environment. The adoption of new technologies will enable the expansion of the beekeepers production and product range that can generate higher profits, which depends on the educational level and the family size of the beekeepers. Clear differentiation of real honey in relation to substitutes and counterfeits on the market and honey production, in accordance with growing and clearly defined customer requirements, is a starting point, and overall conditions in the honey sector are safe and attractive for attracting investment and marketing opportunities. There is also a positive impact of investment in research and development on the business performance of

beekeepers, with an emphasis on significant government, professional, scientific and financial assistance.

Keywords: R&D. Adoption of new technologies. Honey sector. Iinvestments.

1. Introduction

Honey production and consumption have been on the rise in recent years, and the changes are caused by incremental innovations and changes in the traditional attitudes of consumers. Although the Republic of Serbia produces satisfactory quantities of honey, and exports significant quantities, beekeepers face problems that go back to the past, to the transition to market economy and restructuring of agriculture and food production chains. The honey sector can be characterized as competitive if it has the ability to grow, innovate and produce, acquire or maintain market share and the like. In the analysis at the sectoral level, the following important indicators have been identified: labor productivity; labor cost per unit of product; attractiveness and investment growth; production dynamics; growth of share on the foreign market, etc. Innovations in agriculture imply the sharing of knowledge between institutions and producers (Tesser and Cavicchioli, 2014), i.e. the dissemination of knowledge and cooperation between science and economics. Investments in R&D, production improvement (Matsop et al., 2011) and efficient resource management contribute to increasing productivity (Francesconi and Ruben, 2012) and maximizing profits, and to improvement the position of agricultural producers, especially in developing countries. Innovations in the supply chain and distribution of agri-food products, especially honey, contribute to the overall competitiveness of the sector. In organizational terms, the most significant innovations within the honey sector in developing countries are cooperative advisory services, which help beekeepers to transfer technology and management skills.

Given the richness of honey plants in Serbia (Grubić, 2008) and the potential for professional and additional employment in the honey sector, innovations in production, improvement of management and marketing skills will contribute to the profitability of the honey sector (Bekić et al., 2013). Earlier research on bee production was focused on the analysis of honey production, or consumption, and quantitative analysis of bee production in Serbia but has neglected the attitudes and the perception of producers – the beekeepers. Having in mind that the attitudes of beekeepers in Serbia in regard to the innovativeness of their production, and other aspects of R&D in beekeeping, have not been researched so far, and in recent years consumers around the world have shown interest in innovative food products, the subject of research is the analysis of the impact

of beekeepers' investment in innovations and their ability to adopt innovations (in the context of the competitive business environment) on their business performance. By the analysis of previous research, the authors have identified a gap and need for further research on the business performance of the beekeepers. The rest of this paper is structured as follows: a section reviewing the literature follows, and then the methods and data used in the research are described, followed by a presentation and discussion of the results. The final section contains concluding remarks.

2. Literature Review

Many studies explore R&D in agri-food production and technology adoption from different aspects. Parrot and Keleher (2017) cite a lack of knowledge to implement complex innovations. However, problems for adopting innovations by small producers are lack of knowledge and information, or proposed technologies and innovations are incompatible with indigenous values, habits and socio-cultural institutions (Curry et al., 2019) and need to adapt to market characteristics (Ghazalian and Fakih, 2017; Fuglie, 2018). Lagos Susaeta et al. (2018) investigate the innovation adoption index and state that practical workshops have contributed to the adoption of innovative production methods. Voloshyn and Kucher (2017) indicate that the rural population of developing countries invests minimal funds in the agro-industry. The use of modern technologies at the sectoral level, regardless of the level of development of the country, requires a high level of research and development (R&D), significant resources and a long period for the introduction of innovation or feedback (Baldos et al., 2019). Andersen (2019) points out that investment data are often not available or are incomplete and poorly measured, which makes it difficult to measure financial benefits. Therefore, that is why is important to perform an investment assessment (Kuntchev et al., 2012), implement risk sharing in R&D financing, state participation (Hall, Lotti, & Mairesse, 2009; Lee and Cin 2010; Cohen and Levinthal, 1989; Singh et al., 2014; Fuglie, 2018). In developing countries, the access to financial resources is limited (González-Pernía, Jung and Pena 2015) and systemic problems and mimicry of innovation are present (Crespi and Zuniga 2012). Accordingly, Kandpal, Bhooshan and Pal (2015) point out that most patents in agriculture and the food industry are owned by foreign companies and there are concerns about the costs of protected technologies.

Finally, reform in this area (in which the state again plays a key role) would allow easier access to technologies (especially in the areas of transgenics, agro-chemicals and animal vaccines), adoption and accumulation of technological capabilities of enterprises

(Rosales and Marín, 2020). Serra and Davidson (2020) point out that small farmers, and especially women, in developing countries face multiple barriers to accessing resources and technology. The authors point out that cooperative membership, especially for women small producers, significantly increases the market price and production volume, as confirmed by Merkel and Mwangi (2010). The effects achieved in this way, in addition to empowering women, are increasing access to quality inputs, technical advice and training (Fischer and Qaim, 2012). Broome, Moore and Alleyne (2018) point out that gender (dominated by women), training of the workforce, the vision of companies or entrepreneurs on social networks, the use of technology and the knowledge base of companies play a key role in deciding to invest in R&D. Fuglie (2018) points out that agricultural research and systems development in developing countries will have to grow sophisticatedly, and that stronger national R&D systems will provide greater technological spillovers..

Many authors, in the honey sector, see the potential for increasing employment, linking it to social entrepreneurship (Pocol et al., 2012) and rural development (Saha, 2003; Pocol and Ilea, 2011; Mickels, 2006; Ahmadu et al., 2017), promotion environment (Dirina and Bugina, 2012; Urbisci, 2011; Prodanović et al., 2016) and horizontal and vertical organization, internationalization and the potential for successful market performance. The issue of innovations in the honey sector of Serbia was researched by Vapa Tankosić et al (2020) and they point out that a higher level of education and professional beekeeping experience presuppose readiness to invest in research and development. Finally, we point out that the conclusions of the research of authors from different areas of agri-food production and especially the honey sector, represent a special contribution due to the sublimation of their recommendations.

3. Data and methods

The research was conducted during 2019 on the territory of Serbia, and pre-tested questionnaire was sent to more than 300 addresses of beekeepers members of SPOS (Association of Beekeeping Organizations of Serbia) and the Association of Beekeepers "Jovan Živanović" from Novi Sad. The questionnaire consisted of the following questions: Economic characteristics of beekeepers production- BP (BP1- We expect that the sales volume of our honey products will decrease - increase in the next three years; BP2- Compared to our main competitors, our profitability is lower; BP3-Compared to our main competitors, our sales volume is smaller - higher; BP4-Our honey production is positively different from

the competition in terms of financial position; BP5- Our honey production positively differs from the competition with a good reputation in the market); Characteristics of the Competitive environment - CE (CE1- The business environment is safe and provides little threat to the survival and well being of our honey production; CE2- The honey sector has the potential to attract investment and marketing opportunities; CE5- The requirements of our customers have a strong impact on our business result; CE6- The number of substitutes for our products is large (honey counterfeits and substitutes); Characteristics of investment in research and development in beekeeping - IRD (IRD1-I invest funds for research and development of my beekeeping production, IRD2-I engage professionals bodies for the research, IRD3- I need the support of the state and scientific and research institutions in further business development, IRD4 - Significant financial resources and further research in business development are needed); NTA – The characteristics of the adoption of new technologies in beekeeping (NTA1-Beekeepers with larger families are more prepared to use new technologies, NTA2-New technology adoption can increase the value-added hive products (such as royal jelly, propolis, bee pollen and beeswax) and NTA3- Level of education (and education) can positively affect the adoption of new technology). In accordance with the research items, the assessment of the subjective judgments of the respondents was assessed using the Likert scale with five levels: 1 - I completely disagree to 5 - I completely agree. The responses that were obtained in full and that could be further elaborated were 250 respondents (response rate 83%).

The following research hypothesizes were specified:

H1: There is a connection between CE and BP of the beekeepers,

H2: There is a connection between IRD and BP of the beekeepers,

H3: There is a link between NTA and BP of the beekeepers.

As the modeling of structural equations by the method of partial least squares (PLS-SEM) is going to utilizied for data analysis, the size of the research sample was estimated. The recommendation (Barclay et al., 1995; Hair et al., 2014; Komšić, 2018; Nunnally & Bernstein, 1994; Onyekachi Akuoma Mabel and Olanrewaju Samuel Olayemi, 2020) is that the sample must be at least ten times the number of formative manifest variables or ten times greater than the number of pathways of the structural model that are directed toward the endogenous latent construct. The size of the investigated sample is 250, so the sample is considered acceptable. The normality of the data distribution was tested using the Kolmogorov - Smirnov test, the Shapiro -Wilk test and the Jarque-Bera test. However, the normality of data distribution is not a mandatory criterion, given that it is a large sample and

that PLS-SEM is robust enough and does not require normality of data distribution (Barclay et al., 1995; Komšić, 2018). In order to analyze and interpret the obtained results, as well as to test the hypotheses, the modeling of structural equations using the method of partial least squares (PLS-SEM) was used, and the analysis was performed using PLS SMART software. PLS-SEM is a linear regression method that can be successfully used in samples with missing data and which do not have a normal distribution (Sarstedt, 2017; Hair et al., 2017, 2019), as well as data loaded with intercorrelation. The PLS-SEM method was applied in impact research latent constructs on the dependent variable of different sectors (Sharabati, et al., 2010; Bontis, 2000, 1998; Hashim et al., 2017; Pulić, 2000, 2004; Engström et al., 2003; Černe and Etinger, 2016; Komšić, 2018; Cepeda - Carrion et al., 2019; Mention and Bontis, 2010; Trevinyo-Rodriguez and Bontis, 2007; Wang and Chang, 2005); marketing and consumer behavior (Yildiz and Kitapci, 2018; Chinomona and Sandada, 2013; Hair et al. 2011 ; Henseler et al., 2009).

4. Results and Discussion

The created PLS-SEM path model consists of a measured model, which consists of reflective and formative manifest variables. The structural, ie internal, model consists of latent variables. The internal model consists of three latent exogenous constructs (CE, IRD and NTA) and one endogenous latent construct (Business Performance). The external model consists of 16 manifest variables, ie 11 reflective variables and 5 formative variables.

Table 1: Display of values of standardized factor loads and results of analysis of the reflective measurement model

	Variable	Path coefficients	Cronbach α	CR - composite reliability	AVE - convergent validity	CE	IRD	NTA	CE	IRD	NTA
						Fornell Larcker			*Cross loadings*		
CE	CE 1	0.721	0.805	0.871	0.630	0.794			**0.721**		
	CE 2	0.708							**0.708**		
	CE 5	0.853							**0.853**		

	CE 6	0.877							0.877		
IRD	IRD 1	0.895	0.88 1	0.918	0.736	0.491	0.858		0.563	0.895	
	IRD 2	0.860							0.285	0.86	
	IRD 3	0.873							0.463	0.873	
	IRD 4	0.802							0.308	0.802	
NTA	NT A1	0.779	0.77 9	0.872	0.696	0.571	0.652	0.834	0.433	0.636	0.779
	NT A2	0.902							0.570	0.506	0.903
	NT A3	0.816							0.415	0.492	0.816

Source: Author's calculation

The results of the research show that in the reflective measurement model, out of a total of 14 variables (they are: CE-6, IRD-5 and NTA-3), 11 variables with a factor load> 0.7 were retained. The variables CE3 and CE4, IRD5 are excluded from the model because their factor load is less than 0.7. The values of the Cronbach's alpha coefficients of the variables of latent constructs: CE has a value of 0.805, IRD has a value of 0.881 and for NTA has a value of 0.779. Finally, the obtained Cronbach's alpha coefficients of latent constructs are in the range of 0.779 - 0.881, which confirms the acceptability and reliability, ie the obtained values indicate a high level of reliability (Hair et al., 2017; Hair et al., 2019; Komšić, 2018; Nunnally & Bernstein, 1994). The obtained CR values are in the range of 0.871 - 0.918, which confirms the composite reliability and means that the variables adequately represent latent constructs. The obtained AVE values are in the range of 0.630 - 0.736, which satisfies the criterion that AVE> 0.5. The research results indicate that convergent validity is satisfied in all latent constructs. The discriminant validity analysis was performed using Fornell Larcker criteria and HTMT values. The standardized factor loads of latent constructs are higher than the cross-standardized factor loads of other constructs, which satisfies the criterion and confirms the discriminant validity of individual latent constructs.

The formative measurement model consists of formative variables that affect the latent construct of Business Performance. The assessment of the formative measurement model was performed using the assessment of collinearity indicators (VIF) and statistical significance and relevance. Table 2 shows the results of the reliability analyzes of the formative latent

construct examined by testing the collinearity between the manifest variables of the latent construct using the variance inflation coefficient (VIF).

Table 2: Values of the collinearity coefficient of inflation variance (VIF)

Variable	*VIF*	*Variable*	*VIF*
BP1	1.371	BP4	1.896
BP2	1.492	BP5	1.366
BP3	1.799		

Source: Author's calculation

The results of the collinearity of formative variables show that the values are in the range of 1,366 - 1,896, which satisfies the criterion that the VIF should be less than 3 (Hair et al., 2017, 2019; Sarstedt et al., 2017; Wong, 2013; Komšić, 2018). The obtained values confirm the fact that the retained formative variables do not have a collinearity problem.

Table 3: Results of statistical analysis of formative variables

	Outer weights	Standard deviation	T-value	*p*-value
BP1 -> BP	0.087	0.0730	1.1900	0.2340
BP2 -> BP	0.577	0.0830	6.9260	0.0000
BP3 -> BP	-0.135	0.1010	1.3410	0.1800
BP4 -> BP	0.417	0.0760	5.4580	0.0000
BP5 -> BP	0.562	0.0540	10.3250	0.0000

Source: Author's calculation

The research of statistical significance of factor weights of external formative variables was conducted using the bootstrapping procedure at the level of significance of 5%. The results shown in Table 3 indicate that BP1 and BP 3 are not statistically significant. The values of the T-test are less than 1.96 for the mentioned variables and the p-values are higher than 0.05, which indicates that the mentioned variables are not significant. All other external weights in the formative measurement model are statistically significant. However, according to Wong (2013), in a situation where a particular variable proves to be insignificant, it is necessary to check the significance of

its factor load (p. 28). In a situation where the values differ, the variable should be retained, ie in the conducted research, all variables can be retained and can be interpreted as important.

As part of the analysis of the structural model, the conceptual model was examined and the connection between latent constructs (CE, IRD and NTA) and the set hypothesis was analyzed. In the process of testing the structural model, the collinearity between CE, IRD and NTA and Business Performance was first examined, and VIF ranges from 1,540-2,033, ie the obtained values are less than 3 (Hair et al., 2017; Hair et al., 2019). The obtained values confirm the fact that there is no collinearity problem in the model.

Table 4: Inner VIF Values, Path Coefficients and f2

	Inner VIF Values	***Path Coefficients***
	Business Performance	Business Performance
CE	1.540	0.336
IRD	1.806	0.139
NTA	2.033	0.432

Source: Author's calculation

The results indicate that the strongest correlation exists between NTA and Business Performance (0.432). The correlation between IRD and BP is the weakest (0.139), while the correlation between CE and Business Performance is 0.336. In the model, the value of the corrected coefficient of determination (eng. R2 adjusted) has the value R2 = 0.604, we can classify it in the category of moderate impact. The coefficient of determination in the value of 0.604 indicates that 60.4% of the formative dependent latent variable is explained by independent - predictor variables. Using the blindfolding procedure, the predictive relevance of the model and cross-validated redundancy were calculated using Stone-Geisser Q2 indicators (Chin, 2010; Henseler et al., 2009; Tenenhaus et al., 2005). The research results show that the obtained value is higher than zero (Q2 = 0.235), which proves a satisfactory level of predictive significance of the model (Chin, 2010).

Finally, testing of the significance of the structural model and confirmation of hypotheses was performed.

Table 5: Results of the hypothesis testing using PLS-SEM technique

	β Original Sample	**Standard Deviation**	**T Statistics**	**P Values**	**Confidence interval 2.5-**	**Hypothesis confirmation**

	(O)	(STDEV)	(|O/STDEV|)		97.5%		
H1: CE -> Business Performance	0.336	0.067	5.047	0	0.214	0.478	+
H2: IRD -> Business Performance	0.139	0.054	2.584	0.01	0.032	0.247	+
H3: NTA -> Business Performance	0.432	0.078	5.542	0	0.274	0.581	+

Source: Author's calculation

The first hypothesis, *There is a statistically significant and positive correlation between CE and Business performance of beekeepers*, has been confirmed due to the empirical relationship (β= 0.336; t= 5.047) which is statistically significant at the level of p <0.05. The population is in the confidence interval from 0.214 to 0.478 with a 97.5% probability.

The second hypothesis, *There is a statistically significant and positive association between IRD and Business Performance*, has been confirmed. The empirical relationship is statistically significant and stable (β= 0.139; t= 2.584). The population with 97.5% is probably in the range of 0.032 to 0.247.

The third hypothesis, *There is a statistically significant and positive correlation between the adoption of new technologies and Business performance*, has been confirmed due to a stable empirical relationship (β= 0.432; t= 5.542) and statistical significance at the level of 97.55% confidence and is in the range of 0.274- 0.581.

The findings of this research show that of the analyzed variables of the business environment of beekeepers (CE), the strongest influence has the existence of similar products and counterfeits on the market (*Path Coefficients* CE6 = 0.877). The answer to such market challenges is certainly education (Pocol et al., 2017), informing consumers on the quality of honey and its clear differentiation from counterfeits on the market (Dugalić-Vrndić et al., 2011), and when it comes to honey with geographical origin, quality is not questioned (Ignjatijević et al., 2015; 2019; Pocol et al., 2017). In order to improve business results, it is necessary to monitor changes in consumption (*Path Coefficients* CE5= 0.853), in fact trends in customer perception (Ignjatijević et al., 2019; Ghazalian and Fakih, 2017; Fuglie, 2018). As the beekeepers point out, the beekeeping production of the Republic of Serbia has potential (Grubić, 2008), the business environment in Serbia for the development of beekeeping is stable (*Path Coefficients* CE1= 0.721) and has the potential to attract

investment and improve business activities through marketing activities (Path Coefficients CE2= 0.708). in accordance with Bekić et al., (2013), Ignjatijević et al., (2015). It is concluded that thanks to a stable environment, the honey sector has the potential for employment (Serra and Davidson, 2020; Pocol et al., 2012), increasing income (Karippai and Puskur, 2011), improving living standards, the environment (Dirina and Bugina, 2012; Urbisci, 2011; Prodanović et al., 2016) and contributes to overall rural development (Saha, 2003; Pocol and Ilea, 2011; Mickels, 2006; Ahmadu et al., 2017). The total impact of the latent factor business environment - CE on the business performance of beekeepers is the second strongest latent factor and as β= 0.336; t= 5.047 and p <0.05 we can conclude that the first hypothesis has been confirmed.

Our findings point out that family size is a significant factor in the adoption of new technologies (*Path Coefficients* NTA1= 0.779), which is consistent with the findings (Broome, Moore, & Alleyne, 2018; Vapa Tankosić et al., 2020). As beekeeping in Serbia (especially for beekeepers with developed production and a larger number of hives) is a family business (Ignjatijević et al., 2015) and brings together several generations, different levels of education and information literacy, the conclusion is that a higher level of education and training (*Path Coefficients* NTA3= 0.816), can positively influence the adoption of new technologies, which is in line with the findings (Abebaw and Haile, 2013; Lagos Susaeta et al. 2018; Fischer and Qaim, 2012; Vapa Tankosić et al., 2020). The research has shown that the adoption of new technologies leads to improved production with added value (*Path Coefficients* NTA2= 0.902), which also affects the increase in income of beekeepers. The total impact of the latent factor, the adoption of new technologies - NTA on the business performance of beekeepers is the first in terms of strength and since β= 0.432; t= 5,542 and p <0.05 we can conclude that the third hypothesis has been confirmed.

Beekeepers from Serbia point out that they need the support of the state (Hall, Lotti and Mairesse, 2009; Lee and Cin, 2010; Cohen and Levinthal, 1989; Singh et al., 2014; Fuglie, 2018) and scientific and research institutions in business development (*Path Coefficients* IRD3= 0.873), as indicated in the studies (Tesser and Cavicchioli, 2014; Ignjatijević et al., 2015, 2018). The respondents pointed out their willingness to invest in R&D (*Path Coefficients* IRD1= 0.895) and hire professionals (*Path Coefficients* IRD2= 0.860), but that significant financial resources are needed, as well as professional investment support (*Path Coefficients* IRD4= 0.802), which is in line with the conclusions of Baldos et al. (2019), Andersen (2019), Kuntchev et al., (2012). The beekeepers also point to limited funds and unfavorable financing conditions (González-Pernía, Jung and Pena 2015). The values

obtained have shown that the association of beekeepers (Merkel and Mwangi, 2010) or advisory work plays a very important role in improving the business performance of beekeepers and the overall competitiveness of the honey sector (Matsop et al., 2011; Francesconi and Ruben, 2012). The total impact of the latent rate of investment in R&D - IRD is a weaker factor in improving the business performance of beekeepers and since $\beta = 0.139$; $t = 2{,}584$ and $p < 0.05$ we can conclude that the second hypothesis has been confirmed.

5. Conclusion

The findings have shown that beekeepers are aware of the importance of improving and modernizing the bee production and of the effects that are achieved. The honey producers are ready to adopt new technological solutions and invest in R&D to increase quantitative and qualitative business results. Previous research has indicated that there has been minimal investment in innovation, technical equipment and marketing activities, and thus it has had a limiting effect on improvement of the business performance. By planning, adopting new technological solutions and investing in R&D and production of honey products, oscillations in supply and demand would be overcome. Given the preferences of consumption of locally produced honey, beekeeping contributes to local employment, the effects of which spill over into the local economy.

The findings show that beekeepers highly value the business environment, ie business conditions in the honey sector. They consider the conditions of the bee production as favorable for investment and further market positioning improvement. On the other hand, education and promotion should differentiate quality honey from counterfeits or substitutes for honey, and it is necessary to follow modern trends in honey consumption. Honey production requires initial small investments, which increase with the volume of production, and provides the possibility of self-employment and employment of all family members and additional engagement of already employed persons. Accordingly, the association, ie horizontal and vertical integration, and education of beekeepers plays a significant role in overcoming the problem of insufficient training and information of beekeepers.

The willingness to adopt new technologies is present especially in younger more educated beekeepers, and as this research shows the beekeepers, whose families have more members, are maximally dedicated to beekeeping, which confirms that family size is a significant factor in the adoption of new technologies. Although traditional production has its advantages and experience and knowledge are passed on to generations, education and

organized advisory work with young beekeepers is very important. Positive experiences are present in countries where beekeeping is in its beginings, but also in our country where there is a long tradition of production. Organized education is an activity of advisory services of state institutions and scientific and educational institutions, and intensification will positively affect the business performance of beekeepers. Our research has shown a significant willingness of beekeepers to invest in R&D, but they lack the financial resources and professional support to invest. In this segment, vertical integration would have a positive impact on improving the business performance of beekeepers and the overall competitiveness of the honey sector.

The results of beekeepers' business performance research show that profitability has the greatest formative influence on the endogenous variable BP, ie respondents said that their profitability is higher compared to competitors and that they differ from them in terms of market reputation. The value of expectations of an increase in sales volume is very low and this is in line with the negative Outer weights for BP3 where they point out that compared to competitors the sales volume is lower. Finally, we can conclude that the research confirmed all three hypotheses, ie that the business performance of beekeepers is most influenced by the NTA and the business environment, while the impact of IRD is positive and statistically significant, but much weaker.

Although the Republic of Serbia has a rural development program and allocated funds to support rural development (measures include beekeeping), financial resources and education are needed to strengthen the honey sector, especially for small producers. As the honey sector develops further, further research is needed to investigate the interplay between the IRD and NTA business environment. The researched "simplistic" model did not analyze the interrelations and further research can be dedicated to the analysis of the diamond model and its further application.

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