ASSESSMENT MODEL FOR SUSTAINABLE RURAL DEVELOPMENT AT NUTS 3 LEVEL: A MULTI-CRITERIA APPROACH

Mateja Jež Rogelj[1], Ornella Mikuš[2], Lari Hadelan[3]

**Corresponding author E-mail: mrogelj@agr.hr*

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ABSTRACT

Sustainable rural development, encompassing economic growth, social equity, and environmental protection, is a multifaceted concept with inherent complexities. Achieving it often involves navigating trade-offs between these three pillars. To effectively allocate resources and achieve convergent development in the EU, measuring rural sustainability at the regional level is crucial. The multi-criteria approach addresses this challenge by considering the diverse perspectives of stakeholders involved in rural development. This paper presents a model for measuring sustainable rural development at the NUTS 3 level in Croatia, utilizing the Analytic Hierarchy Process (AHP) within a multi-criteria analysis framework. Based on a survey of rural development stakeholders, 15 indicators were selected, weighted, and incorporated into the model. The survey revealed that economic indicators received the highest weight (0.415), followed by social (0.309) and environmental (0.275) considerations. This model offers a valuable foundation for local and regional decision-makers to develop strategies and implement actions that promote sustainable development in rural areas.

1 Mateja Jež Rogelj, Ph.D., Assistant Professor, University of Zagreb, Faculty of Agriculture, Department of Agricultural Economics and Rural Development, Svetošimunska cesta 25, 10 000 Zagreb, Croatia, Phone: +385 1 239 3743, E-mail: mrogelj@agr.hr, ORCID ID (https://orcid.org/0000-0002-7259-8019)

2 Ornella Mikuš, Ph.D., Associate Professor, University of Zagreb, Faculty of Agriculture, Department of Agricultural Economics and Rural Development, Svetošimunska cesta 25, 10 000 Zagreb, Croatia, Phone: +385 1 239 3964, E-mail: omikus@agr.hr, ORCID ID (https://orcid.org/0000-0001-8116-3159)

3 Lari Hadelan, Ph.D., Associate Professor, University of Zagreb, Faculty of Agriculture, Department of Agricultural Economics and Rural Development, Svetošimunska cesta 25, 10 000 Zagreb, Croatia, Phone: +385 1 239 4037, E-mail: lhadelan@agr.hr, ORCID ID (https://orcid.org/0000-0002-8499-0771)

Introduction

Sustainable development reconciles environmental, social and economic needs despite their complexity and resource constraints (Chatzinikolaou & Manos, 2012). Ideally, these components progress together, but in practice, trade-offs exist. The Environmental Kuznets Curve (EKC) indicates an initial deterioration of the environmental situation with economic growth, followed by an improvement at higher income levels (Kordej-De Villa et al., 2009). Šimleša (2003) argues that economic progress since the industrial revolution has often been detrimental to the environment. At its core, sustainability aims to conserve resources (natural, human and created) while promoting efficiency and fairness (EC-ADG, 2001).

The European Union (EU) has been encouraging sustainable development to be the primary priority in all future endeavours across countries, sectors and industries (Bilas et al., 2021).

Sustainable development encompasses many areas, the most interesting of which for the agricultural profession is sustainable rural development. It is generally recognized as the result of human activities that use rural resources to enhance the well-being of its inhabitants (Permanent secretariat of the Alpine Convention, 2011).

Sustainable rural development can be observed at various levels, from the international to the national or local level. One of the reasons why sustainable rural development needs to be researched at the level of local government units is because rural areas within the EU are incredibly diverse, even within the same country. By understanding the specific context of each rural county, researchers and policymakers can design solutions that are tailored to address the local needs and opportunities. A "one-size-fits-all" approach wouldn't be effective in addressing the diverse challenges faced by different rural areas.

Despite the need for measurement tools to assess rural sustainability progress, there's no international consensus on the number and type of indicators, frameworks, or conceptual models for national use. This lack of agreement is even more pronounced at regional and local levels (Ramos, 2009).

Given the multiple dimensions of rural development (economic, social, environmental), policymakers are highly interested in better understanding the extent and patterns of overall well-being in rural regions. Convergence aims to strengthen sustainability in less developed European Union countries, which will also be achieved through the reallocation of financial resources to achieve this goal.

This paper focuses on sustainable rural development at the county (NUTS 3) level. While data availability is a key factor, this focus also aligns with the principle of achieving national development through the balanced progress of all regions. National-level indicators, like GDP per capita growth, can mask disparities between counties. Similar inconsistencies likely exist in other aspects of sustainable development. Therefore, comparing regions is crucial to identify those lagging behind and support them in overcoming their specific challenges.

Most of the indicators proposed to date are based on a top-down definition of sustainability and use data available at the national level, which can lead to ignoring critical sustainability issues at the local level and failing to measure what is important to people at the local level (Reed et al., 2006).

Indicators, as emphasized by the EU Commission (2001), should be tailored to policy and decision-making. They should reveal policy gaps and track impact, while also informing resource allocation based on development levels and their causes (Boggia et al., 2014).

Kahila et al. (2023) summarized the conclusions of the European Commission's Eighth Report on Economic, Social and Territorial Cohesion (2021) into eight groups of sustainability indicators. These groups include three traditional indicators supplemented with indicators for digitalization, demographics, efficient transportation, quality of life/well-being, and governance.
The drawback of new indicators is that they are not yet integrated into official statistical overviews, especially at regional levels, which makes their use in comparisons at the county level difficult.

Due to the heterogeneity of rural development stakeholders in terms of professional, political, and interest orientations, and the need to balance the various components of sustainable development, the application of the multi-criteria approach is common in scientific and professional practice for appraising rural sustainability (Boggia et al., 2014; Hedayati-Moghadam, 2014; Chantzinikolaou, 2013; Boggia and Cortina, 2010; Poursaeed et al., 2010; Ferrarini et al., 2001).

Therefore, the objectives of this paper are:

(1) to identify the most appropriate indicators to measure sustainable rural development at the NUTS 3 level,

(2) to create a model to measure sustainable rural development at the NUTS 3 level using the method of multi-criteria analysis.

Measuring sustainable rural development globally is challenging due to diverse local contexts, including environmental and socio-economic factors. In poorer regions, the fight against hunger takes precedence, while in developed ones, concerns shift towards cultural access and CO2 reduction (Swain & Yang-Wallentin, 2020). Croatia, while not facing hunger issues, still lags behind the EU average in GDP per capita, suggesting the economic dimension of sustainability remains crucial for the nation.

On this basis, the following research hypothesis can be made:

Economic indicators will determine sustainable rural development in Croatia to the greatest extent, i.e. they have an advantage over environmental and social indicators.

Materials and methods

The first step of the research was to make an overview of the indicators used so far or proposed only in the literature to measure sustainable rural development (14 environmental, 15 economic and 18 social). The indicators proposed in the literature are indicators proposed by certain institutions in their templates for assessing the sustainability of rural areas, but for which no examples of their application in actual research were found. The indicators are divided into three groups: environmental, economic and social. Respondents were required to rate, on a scale of one to five, how important they thought each proposed indicator should be in the model for measuring sustainable rural development. Respondents also had the opportunity to suggest indicators they thought were important that were not included in the survey. The survey was conducted in person and via e-mail, and 47 respondents participated. The respondents consisted of representatives of scientific and teaching institutions dealing with rural development, sociology and economics, representatives of counties dealing with rural development and agriculture, representatives of various relevant agencies and associations, and leaders of local action groups (LAGs) operating in Croatia. 20 representatives of scientific and teaching institutions, 20 representatives of LAGs and associations, and seven representatives of state institutions (counties, ministries, agencies) participated in the survey.

Data were processed using the SPSS Statistics 17.0 program, with average scores calculated for each indicator. Five indicators from each of the three groups that achieved the highest average scores were included in the model for measuring sustainable rural development.

A multi-criteria analysis, the Analytical Hierarchy Process, was used to create a model for measuring sustainable rural development at the NUTS 3 level. Key indicators selected by respondents were entered into the Expert Choice 2000 program and then comparatively scored. This program was also used in some other sustainable development researches that were using AHP method. For example, Huehner et al. (2016) used AHP to evaluate Agro-Environmental measures of the rural development program in Slovenia. Evaluation of China's rural development strategy based on SWOT-AHP was used by Guo et al. (2019).

Kusakci et al. (2022) used a hybridized version of the AHP to assess the sustainability of urbanization policies in Turkey. Ameen and Mourshed (2018) also used AHP to rank and weight sustainability indicators for the purpose of assessing urban sustainability in Iraq.

Using the Saaty scale, respondents made an expert assessment of the relative importance of the selected indicators in relation to the specified goal - achieving sustainable rural development. Part of the respondents' judgments were obtained through personal contact, while the other part of the participants received paired indicators sent to e-mail addresses. The expert judgments were obtained from the same respondents as in the first part of the research. The participation was lower, the judgment was given by 32 respondents, of which 18 were representatives of scientific and teaching institutions, nine were from LAGs and associations, and five were respondents from county offices

for economy and rural development.

The AHP model can be divided into the following stages: (1) formation of the hierarchical structure which is the most significant action in the AHP model (Çimren et al., 2007). (2) After completing the questionnaires by 32 relevant experts and specialists of the field, the relative importance of the subcriteria to each other was calculated through forming a pairwise comparison matrix via assigning scores 1 to 9. (3) Evaluation of system consistency and inconsistency is the last step in the AHP model, and the value was estimated using Expert Choice software in the present study. In a pairwise comparison matrix, if the inconsistency rate (IR) is less than 0.1, the comparisons will be acceptable and represent consistency (Tzeng et al., 2002). Of the 32 expert judgments, 25 were included in the model, while the remaining seven were rejected due to too high inconsistency. After prioritization, the data are entered into the model and the aggregate priorities of the alternatives are calculated by summing their weighted local priorities, starting from the lowest level of the hierarchical model. The sum of priorities of all criteria is one, as well as the sum of sub-criteria of a criterion and all alternatives in the model.

In this model, criteria are groups of indicators – environmental, economic, and social and sub-criteria are individual indicators in each of the above mentioned groups. Alternatives are NUTS 3 areas compared with this model (that is not subject in this paper).

Results

Proposed indicators for measuring sustainable rural development with indication of the authors who proposed and/or used them

Through the analysis of previous research on sustainable rural development, the indicators listed in Table 1 were summarized. The given indicators are divided into three groups: ecological, economic and social. In the ecological group 14, in the economic 15 and in the social 18 indicators were proposed.

Table 1. List of proposed indicators for measuring sustainable rural development with indication of the authors who proposed and/or used them

Economic	Ecological	Social
Budget revenues of local or regional self-government units per capita *(Khalifa and Connelly, 2009)*	Share of organic agriculture in the whole agriculture *(EC-ADG, 2001; Boggia et al., 2014; EEA, 2005; Golusin and Munitlak Ivanović, 2009; Dantsis et al., 2010; EC-DGAGRI, 2013; OECD, 2001; Priorr, 2013; OG 30/2009)*	Number of women in local self-government councils in relation to the total number of councilors *(Golusin and Munitlak Ivanović, 2009; Niggemann, 2009; FAO, 2013)*
Number of beds in rural tourism in relation to the total population *(EC-ADG, 2001; Boggia et al., 2014; EC, 2013)*	Number of livestock units/ha *(Boggia et al., 2014; Ferrarini et al., 2001)*	Number of agricultural holdings in which women are stakeholders *(Niggemann, 2009; FAO, 2013)*

Diversification of sources of income on the farm (additional activities on the farms) *(EC-ADG, 2001; Dantsis et al., 2010; EC, 2013)*	Area under special protection *(EEA, 2005; OG 30/2009; Niggemann, 2009; EC, 2013a)*	Age structure *(EC-ADG, 2001; EC-DGAGRI, 2013)*
Diversification of economic activities in the rural area (GVA of individual activities, number of employees in individual sectors) *(EC-ADG, 2001; EC-DGAGRI, 2013; Niggemann, 2009)*	Biodiversity of plant and animal species *(Ramos, 2009; OECD, 2001; FAO, 2013; EC, 2013; Hilden et al., 2012; Van der Werf and Petit, 2002)*	Number of single person households in rural areas
Number of EU-level protected products in each county in relation to the total number of such products in the country *(EC-ADG, 2001; Boggia et al., 2014)*	Availability of drinking water per inhabitant *(Khalifa and Connelly, 2009; UN, 2007)*	Availability of health institutions -– number of general practice clinics per km^2 *(Ramos, 2009; Khalifa and Connelly, 2009; OG 30/2009; UN, 2007; Dolata, 2013)*
Unemployment rate *(EC-ADG, 2001; Ramos, 2009; Boggia and Cortina, 2010; Ferrarini et al., 2001; Khalifa and Connelly, 2009; Golusin and Munitlak Ivanović, 2009; EC-DGAGRI, 2013; Niggemann, 2009)*	Consumption of drinking water per inhabitant *(Ramos, 2009; Boggia and Cortina, 2010; Ferrarini et al., 2001; Niggemann, 2009)*	Availability of postal services -– number of post offices per km^2
GDP per capita *(EC-ADG, 2001, Ramos, 2009; Khalifa and Connelly, 2009, Golusin and Munitlak Ivanović, 2009; EC-DGAGRI, 2013; UN, 2007)*	Amount of municipal waste per household *(Ferrarini et al., 2001; OG 30/2009; Niggemann, 2009; UN, 2007)*	Availability of basic groceries – number of grocery stores per km^2 *(Niggemann, 2009)*
Productivity of agricultural production (GVA / agricultural land area) *(EC-ADG, 2001; EC-DGAGRI, 2013)*	Existence of infrastructure for recycling and composting *(Ramos, 2009; Ferrarini et al, 2001; OG 30/2009; Dolata, 2013)*	Availability of educational institutions – number of primary and secondary schools per km^2 *(OG 30/2009; Global Ecovillage Network, n.a.)*
Number of entrepreneurs in agricultural and nonagricultural activities in rural areas *(EC-DGAGRI, 2013)*	Investment in renewable energy sources and energy efficiency *(Global Ecovillage Network, n.a.)*	Quality and frequency of public transport lines *(Ferrarini et al., 2001; OG 30/2009; Niggemann, 2009)*
Education as a prerequisite for using innovation *(Dantsis et al., 2010; Niggemann, 2009)*	Use of mineral and organic fertilizers per ha *(EEA, 2005; Golusin and Munitlak Ivanović, 2009; Dantsis et al., 2010; OECD, 2001; Priorr, 2013; OG 30/2009; Van der Werf and Petit, 2002, Bosshaq et al., 2012)*	Tradition and cultural facilities *(Global Ecovillage Network, n.a.)*
Number of cars per household *(Niggemann, 2009)*	Use of pesticides per ha *(EEA, 2005; Golusin and Munitlak Ivanović, 2009; Dantsis et al., 2010; OECD, 2001; Priorr, 2013; OG 30/2009; Hilden et al., 2012; Bosshaq et al., 2012)*	Voter turnout in the last local and parliamentary elections *(Ramos, 2009; Niggemann, 2009)*

Internet access – number of connections / number of inhabitants or households *(EC-ADG, 2001; Golusin and Munitlak Ivanović, 2009; OG 30/2009; EC, 2013; UN, 2007)*	Number of cars and tractors per inhabitant *(Ferrarini et al., 2001)*	Crime rate *(Ramos, 2009; OG 30/2009; Niggemann, 2009; UN, 2007; Global Ecovillage Network, n.a.)*
Availability of infrastructure facilities connected to agriculture *(Bosshaq, 2012)*	Number of farms included in the quality assurance system for farms producing beef, lamb and goat meat, or in other authors research animal welfare *(EC-ADG, 2001, Van der Werf and Petit, 2002)*	Number of active theaters, cinemas and cultural and artistic societies in the county in relation to the number of inhabitants *(Niggemann, 2009)*
Economic vitality – the number of blocked vs. the number of newly established companies *(Niggemann, 2009)*	Areas under forests *(Golusin and Munitlak Ivanović, 2009; EC-DGAGRI, 2013; UN, 2007)*	County expenditure (NUTS 3 region) for culture *(Niggemann, 2009)*
Land fragmentation — average farmland size in ARKOD		Population growth between two censuses *(Ramos, 2009; Khalifa and Connelly, 2009; OG 30/2009; UN, 2007)*
		Age and gender structure *(EC-ADG, 2001; Niggemann, 2009)*
		Institutional efficiency (legislative framework, informal links, governance mechanism) *(EC-ADG, 2001)*
		Educational structure *(EC-ADG, 2001; Ramos, 2009; EC, 2013)*

Source: Authors's' synthesis based on literature.

Among the indicators listed in Table 1, the expert group selected five indicators from each group (Table 2) that will be included in the model for measuring sustainable rural development.

Table 2. List of indicators included in the model with the average ratings of the experts

Economic	Ecological	Social
Unemployment rate (4.49)	Availability of drinking water per inhabitant (4.60)	Age structure (4.70)
Availability of infrastructure facilities connected to agriculture (4.47)	Investment in renewable energy sources and energy efficiency (4.38)	Availability of educational institutions (4.45)
GDP per capita (4.45)	Share of organic agriculture in the whole agriculture (4.15)	Educational structure (4.34)
Productivity of agricultural production (GVA / agricultural land area) (4.21)	Existence of infrastructure for recycling and composting (4.13)	Availability of health institutions (4.32)
Diversification of economic activities in the rural area (4.13)	Biodiversity of plant and animal species (4.09)	Population growth between two censuses (4.32)

Source: Author

The five best-ranked indicators within each group depended on the expert's workplace. A statistically significant difference in the selection of indicators related to the expert's workplace exists for the indicators: Share of organic agriculture in the whole agriculture, availability of drinking water per inhabitant, amount of municipal waste per household, existence of infrastructure for recycling and composting, use of pesticides per ha, GDP per inhabitant, and age structure of rural residents ($p< 0.05$; N=47).

Development of a model for assessing sustainable rural development

After selecting the five highest ranked indicators from each group, their pairing and comparative evaluation was done to obtain weights (importance factors) for the model.

Figure 1 shows the local priorities of all criteria and sub-criteria based on the opinions of all respondents who met the criteria (inconsistency factor less than or equal to 0.10). The sum of the local priorities of all three criteria is 1, as well as the sum of all five sub-criteria within each of the three criteria.

Economic indicators (L: .415) have the highest local priority in this model, followed by social (L: .309) and environmental (L: .275). Looking at the sub-criteria of all three criteria, it can be seen that the indicator of availability of drinking water (L: .286) has the highest local priority, followed by educational structure (L: .267) and investment in renewable energy sources (L: .254). The indicator share of organic agriculture in total agriculture has the lowest local priority (L: .127).

Figure 1. Local priorities of criteria and sub-criteria - excerpt from the Expert Choice Program

Source: Author

Discussions

The advantages of the AHP over other multi-criteria methods, as often cited by its proponents, are its flexibility, intuitive appeal to the decision- makers (experts and stakeholders here), and its ability to check the inconsistencies in judgments (Saaty, 2000 according to Ramanathan, 2001).

The recent disputes on environmentally sensitive projects have led to the necessity to con-sider all the stakeholders (i.e. key actors) of a project (such as the authorities, local and affected people, engineers, and others). Several studies on environmentally and socio-economically sensitive projects consider such a stakeholder analysis (Grimble and Chan, 1995; Grimble and Wellard, 1997; Adger et al., 1998 according to Ramanathan, 2001).

Among its many advantages, the AHP method used in the paper also has a major disadvantage, namely the impossibility of complete elimination of subjectivity (Trstenjak and Ćosić, 2015), which implies that the results of the paper are significantly determined by the preferences of the model maker and his selection of criteria and sub-criteria. Tesfamariam and Sadiq (2006) state that AHP involves human subjectivity, which leads to ambiguity and uncertainty in decision making. Dalalah et al. (2010), on the other hand, state that AHP incorporates subjective and objective evaluations, making it a useful tool for assessing the consistency of evaluations, thereby reducing variation in the decision-making process. In order to minimize the influence of the author's subjectivity on the selection of sustainable development criteria, different groups of rural development stakeholders were involved and their over-all average rating determined which of the proposed indicators were included in the sustainable rural development measurement model. On the other hand, complete elimination of subjectivity is not possible in any model, including the one created using the AHP method, but Tahriri et al. (2007) state that AHP is a way of channeling the subjective judgments of experts, their experiences, and intuition into a rational evaluation model. Participants in the research conducted by Maruthur et al. (2015) indicated that the AHP method improved transparency, coherence, and understanding of others' perspectives.

From the obtained results it is evident that there are differences in the selection of indicators depending on which group the respondents belong to (scientific and teaching institutions, LAGs, governmental institutions), suggesting that different life experiences shape different judgments about the importance of individual indicators. The differences become visible when considering the place of work of the respondents; respondents from LAGs are predominantly residents of rural areas, while representatives from science and teaching institutions are predominantly from larger cities. Keseru et al. (2015) also concluded in their study, which involved multiple stakeholder groups, that there is a great deal of het-erogeneity in the responses.

The paper used the overall average score of all respondents, but it is interesting to see the thoughts of each group, each of which is involved in rural development in its own way.

In the group of ecological indicators, the only indicator chosen by all three groups of respondents is the availability of drinking water. The choice of this indicator and its very high average value are surprising, considering that Croatia does not belong to the group of underdeveloped countries where the availability of drinking water is questionable. Gleick (1998) states that access to drinking water is a universal human right and that there should be no differences between rich and poor parts of the world. He also states that people in developed countries take access to drinking water for granted, which was not the case in this study. The fact that water is available to almost everyone in Croatia is also shown by the fact that the possibility of connecting to the public water supply network is 92% at the Croatian level. It should also be taken into account that the public water supply networks are not the only source of drinking water, but there are also local water supply networks and private wells, so it can be said that water is available to almost everyone in Croatia. Therefore, the question remains unanswered why this indicator is considered the most important by the respondents, when it should be clear that nowadays in Croatia water is available for everyone.

In the group of economic indicators, the selection coincides on two indicators - unemployment rate and availability of infrastructure facilities connected to agriculture. The greatest agreement in the selection of indicators was found in the group of social indicators, where the selection agrees on three indicators - age structure, availability of educational institutions and educational structure.

Although the unemployment rate indicator has the lowest value of local priorities of all economic indicators in this research, it is very important for the sustainable development of rural areas. Its importance, as well as the importance of the employment rate as an indicator of economic development, is emphasized by Živić and Pokos (2005). The importance of this indicator is reflected in the fact that employed residents are more likely to decide to stay in rural areas, perhaps sacrificing some other things. When unemployment rate is high, dissatisfaction is high and people leave rural areas in search of work, which affects the sustainability of these areas. The importance of this indicator is highlighted in the measurement of the county development index, where the unemployment rate participates in the final assessment with 30% (OG 63/2010). Looking at all Croatian counties, it can be seen that in all counties where population growth was recorded, with the exception of Zagreb, the unemployment rate is lower than the Croatian average. In Zagreb County, the unemployment rate is only one percentage point higher than the Croatian average.

It is interesting to note the indicator “quality and frequency of public transport lines”, which would be included in the model according to the average evaluation of respondents from LAGs and state institutions, but not according to the choice of representatives of scientific and teaching institutions. The reason for this is most likely the fact that the majority of respondents representing scientific and teaching institutions live in Zagreb and Osijek, cities where the public transport network is well developed, and they do not consider public transport important. Leaders of the LAGs and the representatives of the institutions live in smaller municipalities and understand the importance of having a good public transport network, that is, they feel the shortcomings first hand.

With this overview of the indicators chosen by different groups of respondents, we wanted to point out the importance of involving the different stakeholders of sustainable rural development in the whole process, because everyone has their own opinion and perception of the meaning of the term "sustainable rural development" and how it should be achieved. In addition to involving different stakeholders, a heterogeneous group of respondents was selected to reduce the subjectivity of judgments as much as possible, since each of the groups has its own priorities. The importance of heterogeneity of groups in re-search with sensitive topics (environment, sustainable development, and socially responsible enterprises) is also emphasized by Mardle et al. (2004) and Von Solms (2009). The short-coming of the conducted research is that respondents from all groups did not respond equally to the research and the opinion of representatives of scientific and teaching institutions, mostly from big cities, predominates, as mentioned above.

Table 3 shows that the values of local priorities of the three groups of indicators are different in relation to the respondents' workplace. For example, for respondents representing science and teaching institutions, social indicators are the most important, followed by economic and environmental indicators. For respondents representing LAGs and associations and state and county institutions, economic indicators are most important. For the respondents, the representatives of LAGs, the social indicators are in the second place and the environmental indicators are in the last place, while for the representatives of state and municipal institutions the situation is reversed: for them the environmental indicators are in the second place and the social ones in the third place. The same order of groups of indicators as in the LAGs is given in the IUCN program according to Frajman Ivković (2012) as the current status of the three pillars of sustainability. They believe that the three pillars of sustainability are equally important only in theory, and as necessary changes they indicate a small increase in the social component and a significant increase in the ecological component, which lags far behind the economic and social components.

Table 3. Weights of the indicators according to the opinion of the respondents with regard to the place of employment

	Economic	Ecological	Social
Total	**0.415**	0.275	0.309
Science and teaching institutions	0.331	0.306	**0.363**
LAGs and associations	**0.587**	0.178	0.235
State and county institutions	**0.421**	0.314	0.239

Source: Author

As expected, economic indicators reached the highest values of local priorities in the created model. The findings are consistent with the conclusions of Bali Swain and Yang-Wallentin (2020), who used 117 countries around the world as examples to examine which of the three underlying pillars of the Sustainable Development Goals are most effective in creating sustainable development. Although all three factors are critical to

sustainable development, less developed countries focus more on economic and social goals. The same conclusion was reached by Hedayaty-Moghadam et al. (2014) in measuring the sustainability of rural areas in Iran, Isfahan province. Economic indicators had the highest weighting value (0.281), followed by indicators of the availability of various institutions (0.257), social indicators (0.191), environmental indicators (0.142), and in last place were indicators of the condition of fixed assets (0.128). Dantsis et al. (2010) also emphasize that the final outcome depends on economic and social criteria, while the importance of environmental criteria is marginal, which is also true in this model. In contrast, Van der Werf and Petit (2002) claim that the environmental dimension is crucial for achieving overall sustainability and that it is a prerequisite for the economic and social dimensions. Turtoi et al. (2010) state that they place the economic dimension at the center of the agricultural sustainability plan because it is a prerequisite for its implementation. Taking into account the Kuznets curve and the hypothesis confirmed here, it can be concluded that Croatia has not yet reached the level of economic development after which environmental awareness increases, since the respondents consider environmental indicators to be the least important for achieving sustainable rural development and assign them the lowest weight.

Reviewing the relevant scientific and professional works and publications in Croatia and in the world, it was not found that there is a standardized, comprehensive and universally accepted method for measuring sustainable rural development. Besides the enumeration and sporadic quantification of sub-indicators, there is no holistic tool that clearly quantifies the sustainability of rural development of an area. In this paper, a model was developed that attempts to take into account the specifics of Croatian rural areas and the opinions of a professionally heterogeneous group of experts in order to provide an answer to the questions of which rural parts of Croatia are more developed than others, what are the limiting factors of rural development, and which development factors should be given more attention. The developed model is aimed at measuring sustainable rural development. The advantage of the developed model for measuring sustainable rural development is that it includes all three pillars of sustainable development, which is not the case with the Development Index, which lacks an environmental component and which, as mentioned above, is a basic instrument of regional policy in Croatia. Besides the Development Index, there are other indices (Human Development Index, Ecological Footprint) that measure only some components of sustainable development, which puts them at a disadvantage compared to this model. A comprehensive model like this one, created through a multi-criteria analysis, gives a better insight into the overall state of space and population, and based on the comparisons obtained, a comprehensive development strategy can be created based on the characteristics, potential, specificities and recognition of a given area.

One of the EU policies aimed at reducing development disparities among EU regions is regional policy. The model created here includes some indicators (investments in renewable energy sources, unemployment rate, GDP per capita, diversification of economic activities in rural areas, educational structure, availability of educational and

health facilities) that can be used to identify the areas that need these funds more. To make the model as useful as possible, it can be supplemented with the necessary indicators to provide a more complete picture of a region's condition and identify investment priorities to achieve further development. The model can be applied in any country at the NUTS 3 level. The data for the indicators "investments in renewable energy sources" and "availability of agricultural infrastructure facilities" could be a problem for international comparisons, as the methodology for collecting these data is not defined at the EU level, but also in the individual member states.

The advantage of the method is that different stakeholders can be involved in the selection of indicators and in the evaluation of their importance in achieving sustainable rural development, which has been done in the construction of this model, while the disadvantage in this research is the unequal representation of certain groups of stakeholders, which has certainly influenced the selection of indicators as well as the assignment of weights. This advantage can certainly be used if the model created is modified for the purpose of ranking the submitted projects using bottom-up and top-down approaches, so that the evaluation better suits the needs of a particular area. The problem with any model, including this one, is a certain degree of subjectivity. In this model, subjectivity is evident in the proposal of indicators for inclusion in the model and in the selection of indicators and their weighting by respondents. While this subjectivity could not be avoided entirely, it was neutralized to some extent by the heterogeneity of respondents in terms of career orientation.

Including a larger number of respondents in the model and representing them more evenly according to different professional orientations would reduce the subjectivity of judgments, and it would be very interesting to observe whether this would affect the selection of indicators for the model as well as their weighting in the model. The model also leaves open the possibility of introducing additional indicators to determine whether a change in the observed indicators would affect the assessment of the sustainable rural development of the counties or whether the counties that have now stood out as leaders would maintain that position regardless of what is observed, simply because they are more developed than others in all segments.

This type of comprehensive model with quantification of rural sustainability components is applied for the first time in Croatia. The model and the first results of the County Rural Ranking can be used by regional and local decision makers to identify strengths and weaknesses in specific areas of economic, environmental and social development, which will provide a scientifically and professionally sound basis for the preparation of rural development strategies and for differentiation in the development policy of individual parts of Croatia. Since different problems exist in different parts of rural Croatia, the model provides a trade-off assessment combining top-down and bottom-up analysis. In addition, the model can be used for more efficient ranking of registered projects for various measures under the Rural Development Program, especially those whose beneficiaries are local government units.

Conclusions

1. The paper identified the most appropriate set of indicators for measuring sustainable rural development at the NUTS 3 level. 15 indicators were selected, which are divided into three groups: environmental (availability of drinking water, investment in renewable energy sources and energy efficiency, share of organic agriculture in the whole agriculture, existence of infrastructure for recycling and composting, and biodiversity of plant and animal species), Economic (unemployment rate, availability of infrastructure facilities related to agriculture, gross domestic product per capita, productivity of agricultural production, and diversification of economic activities in the rural area), and Social (age structure, availability of educational institutions, educational structure, population growth between the two censuses, and availability of health institutions).

2. A model for measuring sustainable rural development at the NUTS 3 level using the multicriteria AHP method was developed in the Expert Choice 2000 program and can be used throughout the European Union with certain adaptations.

3. The multicriteria AHP method proved to be appropriate for building a model for assessing sustainable rural development because it allows for the inclusion of all three components of sustainable development and the participation of a larger number of stakeholders in the assessment.

4. A difference in the value of local priorities of criteria and sub-criteria was found with regard to the professional orientation of the respondents: Representatives of scientific and teaching institutions believe that social indicators are more important than economic ones, while the other two groups of respondents give priority to economic indicators.

5. Economic criteria have proven to be the most important in achieving sustainable rural development

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Conflict of interests

The authors declare no conflict of interest.

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