DIGITALISATION AND CIRCULAR ECONOMY:
forestry and forestry based industry implications

12th International Scientific Conference WoodEMA 2019

Varna, September, 11-13, 2019

SYNTHETIC MEASURES AS A TOOL FOR IDENTITYING THE POTENTIAL OF THE WOOD-BASED INDUSTRY SELECTED SECTORS

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The idea of research

- The search for adequate synthetic measures that allow to identify the potential of economic sectors is an important and active challenge of research.
- The authors made such an attempt on the example of the analysis of the potential of the sector based on wood in Poland.
- In this study, the method of linear ordering (TOPSIS), statistical verification and comparative analysis were used. Based on the indications of the proposed synthetic measure, the regional differentiation of the development potential of the sawmill industry in Poland was verified.
- Conclusions and recommendations were also formulated, in particular for sawmill enterprises

Scenario of the research (1)

- The aim of the study was to investigate the regional differentiation of the development potential of sawmill industry in Poland according to the administrative structure of voivodships (corresponding to the classification of regions).
- A controversial hypothesis was adopted for verification, which assumes that the regional development potential of the sawmill industry in Poland is relatively similar, and that there are small disproportions between regions in this respect.

Scenario of the research (2)

- Within the scope of the survey, enterprises classified in the Polish Classification of Activities (PKD 2007), section 16: "Manufacture of wood and cork products, except furniture; manufacture of products from straw and plaiting materials" are included. As of 30 June 2019, the population (and sample) selected for analysis comprised 331 economic entities.
- Targeted selection of companies was made: first according to the substantive criterion (predominance of sawmill production), and then according to the amount of annual sales revenues (at least EURO 20,000 per year).
- In terms of subject matter, the regional development potential of sawmill industry enterprises was examined, referring in spatial terms to the structure of 16 Polish voivodships.

Scenario of the research (3)

- The temporal scope of the research covered the year 2018 (in terms of data on sawmill industry companies) and additionally 2017 (in terms of general industry data of Polish public statistics).
- The research scenario was based on both qualitative analysis (according to substantive criteria), followed by a quantitative approach and a method of variable standardisation (unitarization).
- To measure the potential of the sawmill industry in Poland, the method of linear TOPSIS was used (Technique for Order Preference by Similarity to an Ideal Solution). It is based on the calculation of Euclidean distances between individual objects and a predetermined pattern and anti-pattern.
- In this way, a synthetic measure determining the potential of individual voivodeships can be determined.

Methods (1)

- The research was carried out in the following steps:

1. On the basis of substantive and statistical analysis, the features describing the studied phenomenon were selected;
2. The values of the features were normalized using the zero uniformization method;
3. Determination of pattern and anti-pattern;
4. Calculation of the Euclidean distances from the standard pattern and anti pattern;
5. Application of the value of the synthetic characteristic.

Methods (2)

- For the purposes of this analysis, the values of the synthetic indicator were grouped into 4 classes:

  1) high development level: $\mathrm{S_i} \geq \overline{\mathrm{S}} + \mathrm{SD}$ (class I);

  2) upper-medium development level (class II): $\overline{\mathrm{S}} \leq \mathrm{S_i} < \overline{\mathrm{S}}$ +SD;

  3) lower-medium development level: $\bar{S} - SD \leq S_i < \bar{S}$ (class III) and

  4) low development level: $\mathrm{S_i} < \overline{\mathrm{S}} - \mathrm{SD}$. S_i (class IV) designates the value of the synthetic characteristic for object i; $\overline{\mathrm{S}}$ is the mean value of the synthetic characteristic and SD is the standard deviation.

Results (1)

- The potential of sawmill industry, aggregating data for enterprises located in particular voivodships of Poland, was determined on the basis of 6 purposefully selected quantitative measures (M1, …, M6):

  M1: Annual sales revenues in enterprises (in thousands of EUROS);

  M2: Annual profit per employee in the company (in thousands of EUROS);

  M3: Number of companies in the industry (% rate of change [increase or decrease] over a decade, in absolute numbers, 2008-2018);

  M4: Total investment outlays in the sector (forest- and wood based sector) in thousands EUROS (2017));

  M5: Harvesting of timber (per year) per 100 ha of forest area in m^3 in 2017;

  M6: Sawnwood consumption (per year) in dam^3- cubic decameters in 2017.

Results (2)

- The selection of factors was of a substantive nature. The characteristics representing various economic categories with potentially weak correlation were selected.
- All characteristics tested are stimulants. In order to perform statistical verification of the correctness of the selection of variables, their correlation coefficients were determined.
- On the basis of the arithmetic mean value and standard deviation, classes were determined, corresponding to four categories of development capacity of the examined industry in the region. The limit ranges were determined accordingly:

  1) high development level: $1 \geq S_i > 0{,}52$; (class I);

  2) upper-medium development level: $0{,}52 \geq S_i > 0{,}40$; (class II);

  3) lower-medium development level: $0{,}40 \geq S_i > 0{,}28$; (class III);

  4) low development level: $0{,}28 \geq S_i > 0$; (class IV).

  Then the following were determined: Euclidean distances and synthetic measure values, corresponding to the ranking position of the region according to the strength of the development potential of the sawmill industry in individual voivodships in Poland .

Table 1. Selected aggregated measures of the sawmill industry potential in Poland

Voivodship (Region)	Revenues from sales [in thousands of EUROS]	Profit per employee [in thousands of EUROS]	Number of companies in the sawmill industry during the last10 years [% rate of change]	Investment outlays overall in forestry [in thousands of EUROS]	Logging per 100 ha of forest area [m^3]	Sawnwood consumption [dam^3]
Dolnośląskie	34 234	5	0,78	17484,0	558,1	282,0
Kujawsko-Pomorskie	143 686	7	0,25	7607,2	600,5	341,3
Lubelskie	60 337	10	1,00	9012,6	329,1	186,7
Lubelskie	44 035	1	0,17	14180,2	503,9	616,0
Łódzkie	70 500	4	0,27	9177,0	335,8	190,4
Małopolskie	100 812	6	0,47	8060,5	309,5	882,7
Mazowieckie	151 148	4	0,59	14415,6	287,8	415,2
Opolskie	28 349	8	0,20	3737,0	561,1	99,0
Podkarpackie	86 136	5	0,40	12524,7	381,2	312,4
Podlaskie	74 084	10	0,08	8680,5	351,5	285,7
Pomorskie	218 032	4	0,40	16853,7	726,2	432,3
Śląskie	137 146	6	0,31	8718,4	471,8	346,3
Świętokrzyskie	54 158	5	0,33	7650,9	404,1	270,4
Warmińsko-Mazurskie	84 400	13	0,13	9474,9	494,8	651,6
Wielkopolskie	437 277	6	0,53	15068,4	491,9	1427,6
Zachodniopomorskie	271 304	7	0,31	17131,2	564,7	1071,7

Table 2. Correlation coefficients for selected features characterizing the potential of the sawmill industry in Poland

Correlation coefficients	M1	M2	M3	M4	M5	M6
M1	1,00					
M2	-0,10	1,00				
M3	0,08	-0,07	1,00			
M4	0,48	-0,43	0,31	1,00		
M5	0,28	-0,11	-0,22	0,32	1,00	
M6	0,80	-0,02	-0,02	0,45	0,12	1,00

Table 3. Euclidean distances, the value of synthetic measure in the ranking

Voivodeship (Region)	d_i^+	d_i^-	S_i	Ranking position	Class division
Dolnośląskie	1,53	1,58	0,51	4	II
Kujawsko-Pomorskie	1,63	0,98	0,38	7	III
Lubelskie	1,83	0,94	0,34	11	III
Lubuskie	1,84	0,99	0,35	9	III
Łódzkie	1,98	0,57	0,22	16	IV
Małopolskie	1,65	0,99	0,38	8	III
Mazowieckie	1,68	1,15	0,41	6	II
Opolskie	2,00	0,86	0,30	14	III
Podkarpackie	1,72	0,90	0,34	10	III
Podlaskie	1,93	0,87	0,31	13	III
Pomorskie	1,34	1,56	0,54	3	I
Śląskie	1,66	0,82	0,33	12	III
Świętokrzyskie	1,90	0,61	0,24	15	IV
Warmińsko-Mazurskie	1,61	1,26	0,44	5	II
Wielkopolskie	0,91	1,86	0,67	1	I
Zachodniopomorskie	1,05	1,61	0,61	2	I

Figure 1. The regional differentiation of the main potential classes of the sawmill industry in Poland

Conclusions (1)

The following conclusions have been drawn from the qualitative verification of the development factors selected by the industry, the use of the quantitative method and the TOPSIS synthetic measure, and the comparative and descriptive analysis:

1) The largest development potential of the sawmill industry in Poland was identified in north-western voivodships (strong regions).

2) The difference in synthetic measure between the leader of the ranking (Wielkopolska region) and outside (Łódzkie region) was 0.45 (0.67-0.22). This proves that the development potential of the sawmill industry in Poland is regionally diversified. This conclusion is the basis for rejecting the main hypothesis assumed at the outset. However, it is not possible to conclude on this basis on the regional degree of diversification of development potential.

3) It was found that there is no clear leader in the ranking for the sawmill industry. The leader is a group of regions, the best of which achieved a synthetic measure of 0.67, in the range from 0 to 1.

4) It was noted that the synthetic measure of development indicators for two regions are outliers: Świętokrzyskie (0.24) and Łódzkie (0.22).

Conclusions (2)

- The correlations shown may constitute recommendations for regional development policy in the forest and wood sector in Poland, indicating regions with strong industry specialisation, which support may result in maintaining the dynamics of economic growth.
- At the same time, it allows to search for directions of specialisation of the wood processing industry in regions where the competitive potential of the sawmill industry is weaker.
- When programming the development of the industry it is worth to refer not so much to the principle of sustainable development in the regions, but rather to the concept of integral development, taking into account economic, social and specialisation diversity in the territorial dimension.

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- Благодаря за вниманието!
- Thank you for Your attention!

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