

ASSESSMENT OF COMPETITIVENESS OF CONFECTIONERY ENTERPRISES FOR THE NEEDS OF ECOLOGICAL MANAGEMENT

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Abstract:

The article deals of assessing the competitiveness of enterprises in the confectionery industry to improve information and analytical support of ecological management. A unified methodology for assessing the competitiveness of business entities in the context of ecological management has not yet been developed. The article proposes to assess the competitiveness of confectionery enterprises on the basis of an integral index. Its peculiarity is that, in addition to economic production, market characteristics, it also includes environmental ones, which reflect significant environmental aspects (air emissions and the formation of hazardous waste). Calculations were made and the results of the study were tested on the basis of the leading confectionery enterprises of Ukraine. This made it possible to identify among the studied set of enterprises leaders who improved economic results and strengthened their market positions by reducing anthropogenic impact on the environment, introducing ecological management and corporate social responsibility. Taking into account their successful experience will contribute to the improvement of the ecological management system at other enterprises of the confectionery industry.

Key words: *ecological management, analysis, competitiveness, confectionery industry, information support, environmentally responsible business*

INTRODUCTION

In the modern conditions of the Fourth Industrial Revolution, the importance of studies of competitiveness at the macro and micro levels, in particular the economies of countries, regions, business entities, and the like, is increasing. «Over the last decade, promotion of competitiveness represents one of the central goals of economic policy of most of the countries. Moreover, in recent years, the promotion of competitiveness has been seen as a way of achieving desirable changes in economy and society» [1]. Assessment of the competitiveness of national economies allows for the analysis of their advantages and weaknesses. The results of assessing 141 countries of the world in terms of the level of competitiveness of their economies using the Global Competitiveness Index 4.0

(GCI 4.0) are of scientific and practical interest in this regard. In its calculations, a scoring scale was used, taking into account 12 main parameters of long-term growth for the following constituent structural blocks and their parameters:

- I. *Enabling Environment*: Institutions, Infrastructure, ICT adoption, Macroeconomic stability;
- II. *Human Capital*: Health, Skills;
- III. *Markets*: Product market, Labour market, Financial system, Market size;
- IV. *Innovation Ecosystem*: Business dynamism, Innovation capability (The Global Competitiveness Report, 2018; 2019).

The ranking of the 39 countries of the first group according to the Global Competitiveness Index 4.0 (GCI 4.0) for

2019 and its changes compared to 2018 are shown in Table 1.

Table 1
Distribution of countries with a high level of competitiveness according to the Global Competitiveness Index 4.0 (GCI 4.0) in 2019

Ranking	Country	Points		Ranking	Country	Points	
		2019	until 2018, +/-			2019	until 2018, +/-
1	Singapore	84.8	+1	21	Austria	76.6	+1
2	United States	83.7	-1	22	Belgium	76.4	-1
3	Hong Kong SAR	83.1	+4	23	Spain	75.3	+3
4	Netherlands	82.4	+2	24	Ireland	75.1	-1
5	Switzerland	82.3	-1	25	United Arab Emirates	75.0	+2
6	Japan	82.3	-1	26	Iceland	74.7	-2
7	Germany	81.8	-4	27	Malaysia	74.6	-2
8	Sweden	81.2	+1	28	China	73.9	-
9	United Kingdom	81.2	-1	29	Qatar	72.9	+1
10	Denmark	81.2	-	30	Italy	71.5	+1
11	Finland	80.2	-	31	Estonia	70.9	+1
12	Taiwan, China	80.2	+1	32	Czech Republic	70.9	-3
13	Korea, Rep.	79.6	+2	33	Chile	70.5	-
14	Canada	79.6	-2	34	Portugal	70.4	-
15	France	78.8	+2	35	Slovenia	70.2	-
16	Australia	78.7	-2	36	Saudi Arabia	70.0	+3
17	Norway	78.1	-1	37	Poland	68.9	-
18	Luxembourg	77.0	+1	38	Malta	68.5	-2
19	New Zealand	76.7	-1	39	Lithuania	68.4	+1
20	Israel	76.7	-				

Source: *The Global Competitiveness Report, 2018; 2019* [2, 3].

Thus, the most powerful in comparison with other countries that have significant competitive advantages for functioning in modern conditions are the top ten countries: Singapore, United States, Hong Kong SAR, the Netherlands, Switzerland, Japan, Germany, Sweden, United Kingdom and Denmark. Unfortunately, Ukraine was in 85th place (57 points) and worsened its position by 2 levels (from 83rd place) compared to 2018.

Attention is drawn to the fact that, based on the materials of the 2019 Global Competitiveness Report, one can observe the mutual influence of countries' competitiveness, their economic growth and environmental sustainability. Having discovered a similar trend in 2013, Despotovic D., Cvetanovic S., Nedic V., formulated a hypothesis about the positive impact of the social and environmental blocks included in the Global Competitiveness Index on the competitiveness of individual countries. Based on the results of a study of data from 34 countries, scientists have confirmed that social parameters have an undeniable positive impact on competitiveness. In this case, the influence of environmental parameters is variable and requires further careful scientific study [4].

Thus, at the macro level, the methodological approaches of comparative analysis and assessment of competitiveness, taking into account environmental factors, are

mainly developed and are actively used to compare countries and regions. However, at the grassroots level i.e. the level of business entities, methodological approaches have not yet been sufficiently developed. Therefore, now the assessment of the competitiveness of enterprises taking into account environmental indicators is especially relevant for enterprises engaged in foreign economic activity.

Many countries around the world are actively developing national environmental development strategies aimed at meeting global environmental commitments under the Paris Agreement. It should be expected that in the near future environmental requirements and restrictions in relation to enterprises - manufacturers and exporters of products are expected to increase significantly. On the one hand, this will create significant barriers for producers who do not pay due attention to environmental aspects in their economic activities. On the other hand, the market conditions for businesses that develop and implement environmental strategies will improve. Thus, the European Union is considering the possibility of introducing carbon import regulations for Ukraine. This mechanism will make it possible to display in the price of goods imported into the EU the volume of emissions of all greenhouse gases that were formed during the production process. That is, the carbon footprint of the product will be converted into a carbon duty at the border. Thus, products manufactured at enterprises with outdated resource-intensive technologies will rise in price and lose competitiveness [5].

In these conditions, the largest environmental and market risks arise in export-oriented manufacturers, among which one can single out the enterprises of the confectionery industry, which may lose their competitive advantages. To maintain market positions in foreign markets, adapt to drastic changes in environmental and trade regulation, it is important to analyze the impact of environmental factors on the competitiveness of confectionery enterprises, to identify problem areas for further solutions.

Thus, the urgent requirement of the time is to develop a methodology for assessing the competitiveness of confectionery enterprises, taking into account environmental factors. Identification of the most significant environmental factors will allow timely implementation of measures to strengthen their competitive advantages. The scientific substantiation of such a methodology will contribute to the improvement of information and analytical support of ecological management, increasing its efficiency and integration with other management subsystems.

The aim of the article is to improve the methodology for assessing the competitiveness of enterprises in the confectionery industry in terms of taking into account environmental aspects to improve information support for ecological management and its implementation into an integrated management system. In this paper the model including environmental factors for assessing the competitiveness of confectionery industry was established. The described methodology was tested at five enterprises in Ukraine.

Methodological approaches to assessing the competitiveness of confectionery enterprises are proposed, which allow taking into account not only economic indices, but also indices of anthropogenic impact on the environment (emissions of pollutants into the air, formation and recycling of production waste, fines for violating environmental legislation, costs of preventive measures to reduce the negative impact of production on the environment). The proposed approaches make it possible to influence environmental factors on the competitiveness of enterprises, formulate priority environmental goals of environmental management, and determine competitive advantages in the course of implementing environmental policy.

LITERATURE REVIEW

Theoretical and methodological principles of assessing the competitiveness of enterprises, taking into account the impact of environmental factors on their activities have been the subject of research by many scientists. A. Balyte, M. Tvaronavieiene, S. Stavropoulos, R. Wall, Y. Xu, A. Kasztelan and others in their studies outlined the importance and problems of assessing the competitiveness of economic entities in the context of sustainable economic development [1, 5, 6, 7]. The complexity of competitive growth of economic entities taking into account the strengthening of environmental factors was considered in detail by M. Porter and others [8, 9, 10].

X. Cheng, R. Hong, C. Li argue that the traditional regional competitiveness assessment system pays too much attention to economic performance. Its application does not allow to fully assess regional competitiveness. To solve this problem, scientists have proposed to use the green competitiveness index. This integral index includes indices of the competitiveness of natural resources, the competitiveness of the ecological environment and energy consumption, economic and social sustainable competitiveness, as well as the competitiveness of human health [11]. For government regulation and strategic management, the assessment of competitiveness, taking into account the environmental factors of individual industries and enterprises, is equally important. Their competitiveness certainly affects the place of the country in the global competitive ranking, and, in fact, determines it.

The introduction of strict restrictions on the use of natural resources and anthropogenic impact on the environment, the growth of stakeholder requirements for the environmental friendliness of products at all stages of the life cycle increase the influence of environmental factors on the activities and competitiveness of enterprises. Numerous scientific studies prove that the implementation of an active environmental policy contributes to the formation of competitive economic, financial and market advantages for enterprises [12]. Scientists M. Larrán, J. Madueño, D. María, P. Sancho, by modeling structural equations based on 481 small and medium enterprises from southern Spain, found that environmental performance has a positive, direct and significant impact on the competitiveness of companies, as well as on the intermediary effects of image and

relational marketing [13]. The authors concluded that enterprises that improve their environmental performance create positive interactions with their stakeholders.

S. Chuang, S. Huang investigated the impact of environmental corporate social responsibility (ECSR) on business competitiveness. After analyzing the data of 358 enterprises in Taiwan, scientists have found that the development and implementation of corporate social responsibility has an important positive impact on green IT human capital, green IT structural capital and IT relational capital. They, in turn, have a positive effect on the competitiveness of enterprises [14]. The specifics of developing corporate social responsibility of enterprises to increase their competitiveness were disclosed by U. Andrusiv, J. Streimikis, O. Lyashenko, V. Yakubiv, M. Lyzun, M. Ali, A. Jaharadak [15, 16].

The scientists paid special attention to the substantiation of the factors affecting the competitiveness of enterprises, taking into account the technical and economic parameters of production, the intensity of anthropogenic impact, the potential for increasing the environmental safety of products [17, 18, 19]. W. Zhao, H. Zhang found that the competitiveness of the local agricultural eco-brand is influenced by the state of the environment in the region, the activities of the industrial cluster and the initiative of stakeholders [20]. Agreeing with the obtained results, meanwhile, we note that the study does not take into account other, no less important factors, namely natural and recreational support, the activity of enterprises to reduce anthropogenic impact, and others. F. Belz and H. Hugenschmidt made a comparative analysis of existing environmental problems and their impact on the competitiveness of the food and transport industries in Switzerland [21]. By constructing a "matrix of environmental problems" and a "matrix of environmental rates", the authors found that competition is affected by environmental problems. Scientists have concluded that in order to be prepared for environmental change, companies must develop strategies that meet not only economic but also environmental requirements.

A separate area of research is the substantiation of new and improvement of existing methods for assessing competitiveness, incl. by taking into account environmental factors.

A. Obikhod, O. Ambrosenko substantiated the methodological foundations for assessing the competitive environmental potential of the regions, taking into account the problems of environmental safety [22]. Scientists have proposed integral indicators of natural and anthropogenic threats, built a competitive rating of the regions of Ukraine. However, this technique is difficult to apply to specific business entities due to the irrelevance of the object and analysis indicators.

J. Fahy proposed an analysis of competitive advantages based on the resource approach [23]. The author developed a resource model of global sustainable competitive advantage (GSCA), which he tested on the materials of in-

dividual enterprises in the automotive industry. The proposed methodology is of great theoretical and methodological significance for the analysis of the competitive positions of firms in global production chains. However, the author ignores environmental indicators, such as waste management, CO₂ emissions, etc.

M. Heriyantoa, A. Febriana, T. Handokob and Syofianc substantiated the application of structural equation modeling (SEM) methods to develop an environmental strategy to create innovations and competitive advantages of palm oil producers [24]. Thus, the scientists noted the production and environmental features of this type of activity. However, the weak point of this method is the need for complex mathematical calculations using specially designed software.

M. López-Gamero, J. Molina-Azorín combined two theories – the institutional theory and the resource method to study the influence of external (voluntary norms and stakeholders) and internal factors (company resources) on gaining competitive advantages by the enterprise [25]. Despite the conducted researches, the received scientific results are not enough for the analysis of the competitiveness of enterprises, taking into account the of confectionery industry characteristics, the urgent problems of environmental management. There is no information on the confectionery industry in the literature. O. Gorb, I. Yasnolob, N. Protsiuk determined that adaptation to international environmental standards is one of the important challenges for maintaining the competitive position of Ukrainian enterprises in connection with entering international markets [26].

METHODOLOGY

In the context of promoting the ideas of environmentally responsible business, the consumption of high-quality and safe food, buyers prefer manufacturers who implement an active environmental policy, develop and market environmentally friendly products, implement projects in the field of environmental restoration and preservation. Thus, for the enterprises of the confectionery industry, environmental factors act as an important reserve for the formation and strengthening of competitive advantages in the development and implementation of various competitive strategies, in particular, strategies for "price leadership", "strengthening market positions", "product development".

In the management system of confectionery enterprises, the assessment of competitiveness, taking into account environmental indices, is of information and analytical importance for strategic planning and ecological management. In strategic management, such an assessment allows to determine the priority areas of environmental activities of the enterprise, which will provide environmental as well as market-economic competitive advantages. That is, it will contribute to a synergistic environmental and economic effect.

A practical tool for the implementation of the identified priority areas of environmental activities is ecological management, where they acquire a quantitative dimension in the form of environmental goals and objectives (Fig. 1).

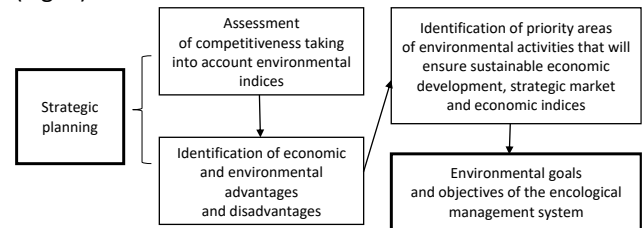


Fig. 1 Assessment of the competitiveness of the confectionery industry enterprises, taking into account environmental indices for the needs of strategic planning and ecological management

The need to identify the environmental aspects of the enterprises of the confectionery industry, to determine the most significant of them is due to a variety of environmental factors, their versatile influence. Environmental aspect as "an element of an organization's activities, products or services that can interact with the environment" is defined by the international standard ISO 14001. The environmental aspect is important as it significantly affects the environment. Managing such aspects in the ecological management system would lead to the best environmental, economic and financial results.

The environmental aspects of the confectionery industry enterprises may include:

- emissions of pollutants into the air;
- discharges of pollutants into water bodies;
- waste generation, recycling;
- use of raw materials, water, energy;
- noise pollution, dust and other visible pollution (Fig. 2).

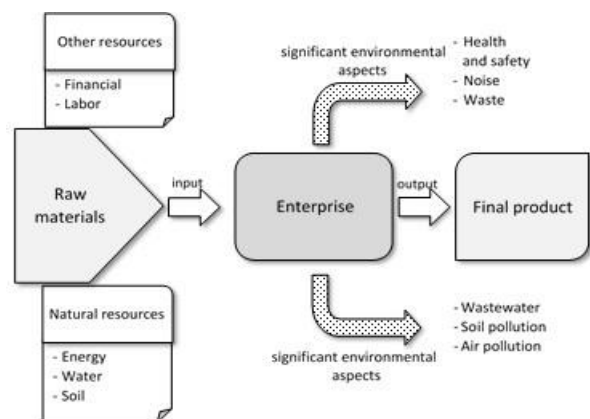


Fig. 2 Environmental aspects of production activities of confectionery enterprises

Depending on the ability to manage and control, the environmental aspects of the confectionery industry can be divided into two groups – direct and indirect. Direct environmental aspects are those that the enterprise can control. Indirect aspects include aspects over which enterprises do not have full control (Table 2).

Table 2
Groups of environmental aspects in the direction of influence and control at confectionery enterprises

Direct influence	Indirect influence
Emissions of pollutants into the air	Environmental externalities
Discharges of pollutants into water bodies	Concentration of pollutants in the air
Production waste, its processing and recycling	Water quality for industrial needs
Use of raw materials and energy	Local environmental crises
Use of mobile sources of air pollution	Unauthorized landfills of household and industrial waste near the territory of the enterprise
Environmental emergencies	Groundwater pollution
Environmentally harmful packaging of finished products, packaging recycling, packaging during transportation	Decrease in water supply in the region

For qualitative and quantitative assessment of direct environmental aspects, it is advisable to use the following indices (Table 3).

Table 3
Indices that characterize the environmental aspects of the confectionery industry

Environmental aspect	Index
Water consumption	Water consumption for production needs, thousand m ³ Water consumption for general production needs, thousand m ³ Water consumption by individual structural divisions, thousand m ³
Energy consumption	Electricity consumption, thousand kWh Thermal energy consumption, thousand Gcal Natural gas consumption, thousand m ³ Consumption of renewable energy sources, thousand tons of oil equivalent
Consumption of raw materials and resources	Consumption of raw materials used by the type of recovery (renewable/non-renewable), t
Environmental impact, health of people/workers when using chemicals	Number of chemicals used in production by type, t, kg, l Volume of hazardous substances used by types, t, kg, l
Emissions of pollutants into the atmosphere	Volume and hazard level of pollutants emitted into the air, t, class Over-limit volumes of pollutants emitted into the air, t Share of cleaning pollutants in emissions,%
Discharges of pollutants into water bodies	Volume and hazard level of pollutants discharged into water bodies by type, t, class Over-limit volumes of pollutants discharged into water bodies, t Share of cleaning pollutants in discharges,%
Waste management operations	Volume, level and hazard class of waste by type, t Share of waste reuse,%

Assessment of the competitiveness of enterprises in the confectionery industry, taking into account environmental factors, organizationally provides for the implementation of the following stages:

1. Identification of a set of economic, market and production indices that form the competitive advantages of enterprises in the market and are included in the assessment of competitiveness.
2. Determination of significant environmental aspects of the industry, taking into account environmental and technological features, urgent environmental problems.
3. Calculation of the integral index of competitiveness.
4. Comprehensive assessment of the level of competitiveness of the enterprise, taking into account the influence of each of the characteristics on the integral index.
5. Determining the strengths and weaknesses of enterprises in comparison with competitors.
6. Assessment of the influence of all characteristics among themselves, that is, how much each of them affects the other, in order to ensure effective management.

Schematically, the assessment of the competitiveness of enterprises in the confectionery industry can be displayed as follows (Fig. 3).

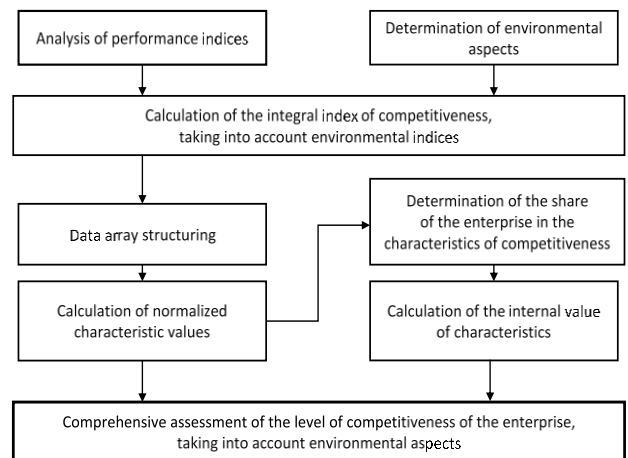


Fig. 3 Structural and logical scheme of a comprehensive assessment of the competitiveness of confectionery enterprises in Ukraine, taking into account environmental factors

When determining the significant environmental aspects of enterprises in the confectionery industry, it is necessary to take into account the following main criteria: impact on the environment, requirements of stakeholders, requirements of legislation and other governing bodies (Fig. 4).

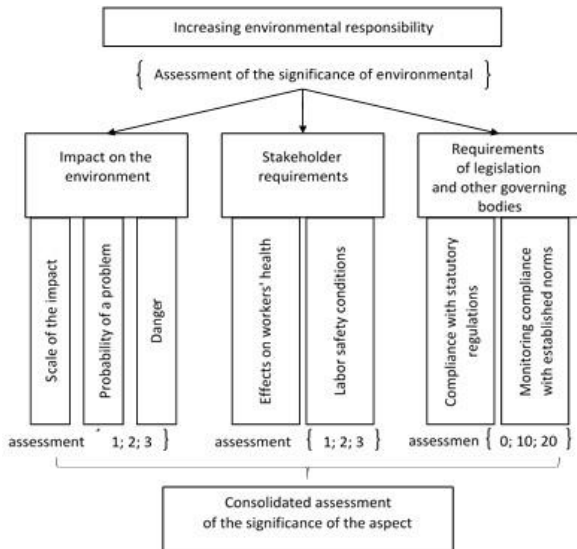


Fig. 4 Methodical approaches to the definition of significant environmental aspects in the ecological management of confectionery enterprises

The assessment of the significance of the impact on the environment is carried out according to the three above criteria.

1. Impact on the environment

a) The scale of the impact (I) or the magnitude of the impact on the environment is usually assessed on a three-point scale:

- 1 – small volumes of emissions/discharges into the environment,
- 2 – average volumes,
- 3 – significant (large) volumes.

b) Probability of a problem (Pr) or frequency of impact. Impact rates are used to assess normal operating conditions, and the likelihood of a problem occurring for potentially hazardous situations. The frequency of impact is also assessed on a three-point scale:

- 1 – low frequency (impact occurs infrequently),
- 2 – average frequency (impact occurs sometimes, several times a year),
- 3 – high frequency (regular or continuous impact).

Probability of a problem is assessed on a three-point scale:

- 1 – low probability (a problem is unlikely),
- 2 – medium probability (a problem may arise),
- 3 – high probability (there is a real threat of a problem occurring at any time).

c) Danger (D) – how dangerous is the potential impact on the environment under consideration. Some aspects can have dangerous consequences for it. For example, leaks of various chemicals that not only disrupt the balance of the ecosystem but also threaten the health of workers, can reduce the quality of drinking water, and the like. As well as other indices, danger is estimated on a tribal scale:

- 1 – low danger,
- 2 – average danger,
- 3 – high danger.

2. Stakeholder Requirements (St)

Aspects concerning stakeholder interests are also considered significant. For example, an aspect that affects the

health of employees of an enterprise and threatens labor safety conditions should be of paramount importance. A three-point assessment system is also used here:

- 1 – the issue does not concern the interests of interested parties,
- 2 – the issue will concern the interests of the parties in the near future,
- 3 – the issue directly concerns the interests of the parties at the present time.

3. Requirements of legislation and other governing bodies (L)

In this methodology, the legally regulated aspect is considered significant by default, since ISO 14001 requires compliance with the legislation, therefore it is necessary to ensure constant control and monitoring of this aspect. Here, a 20-point scale is used:

- 0 – the aspect is not regulated by legislation,
- 10 – the aspect is regulated by legislation and the company meets its requirements,
- 20 – the aspect is regulated by legislation, but the company does not meet its requirements.

Taking into account the above designation, the calculation of the significance of environmental aspects is carried out according to the formula:

$$Aspect\ significance = I \times Pr \times D \times St + L \tag{1}$$

Significant environmental aspects determined according to the results of preliminary analysis are included in the matrix of indices (primary data) to assess competitiveness. In addition to them, the matrix preliminarily includes economic and market indices ($X_1, \dots .m$) (Table 4).

Table 4 Matrix of economic, market and environmental indices of enterprises of the confectionery industry

Competing enterprises	Characteristics				
	X_1	X_2	X_3	...	X_m
1	X_{11}	X_{12}	X_{13}	...	X_{1m}
2	X_{21}	X_{22}	X_{23}	...	X_{2m}
3	X_{31}	X_{32}	X_{33}	...	X_{3m}
...	...	...	...	X_{ij}	...
n	X_{n1}	X_{n2}	X_{n3}	...	X_{nm}

Indices in Table 5 have different units of measurement. To bring all indices into a commensurate look, the primary matrix of indices must be transformed into a matrix of relative (dimensionless) indices (Table 6) using the formulas:

$$\overline{X}_{ij} = \frac{\min_{1 \leq i \leq n} X_{ij}}{X_{ij}}, \tag{2}$$

$$\overline{X}_{ij} = \frac{X_{ij}}{\max_{1 \leq i \leq n} X_{ij}} \tag{3}$$

where:

\overline{X}_{ij} is a dimensionless value of the characteristic;

X_{ij} is an absolute natural value of the characteristic;

$\min_{1 \leq i \leq n} X_{ij}, \max_{1 \leq i \leq n} X_{ij}$ is the minimum or maximum value of the characteristics of competing enterprises;

n is the number of analyzed objects of research (competing enterprises);

m is the number of characteristics that are common to all objects;

i is an ordinal number of the object under analysis;
 j is a number of characteristic that is common to all objects.

Thus, we obtain a matrix of normalized values of the characteristics of competing enterprises (Table 5).

Table 5
Matrix of normalized values of the characteristics of competing enterprises

Competing enterprises	Characteristics				
	X_1	X_2	X_3	...	X_m
1	$\frac{X_{11}}{\bar{X}_{11}}$	1	$\frac{X_{13}}{\bar{X}_{13}}$	...	$\frac{X_{1m}}{\bar{X}_{1m}}$
2	1	$\frac{X_{22}}{\bar{X}_{22}}$	$\frac{X_{23}}{\bar{X}_{23}}$	...	1
3	$\frac{X_{31}}{\bar{X}_{31}}$	$\frac{X_{32}}{\bar{X}_{32}}$	$\frac{X_{33}}{\bar{X}_{33}}$	...	$\frac{X_{3m}}{\bar{X}_{3m}}$
...	...	...	...	\bar{X}_{ij}	...
n	$\frac{X_{n1}}{\bar{X}_{n1}}$	$\frac{X_{n2}}{\bar{X}_{n2}}$	1	...	$\frac{X_{nm}}{\bar{X}_{nm}}$

In order to calculate the internal significance for each characteristic the formula presented below was used. The formula allows to calculate the share of each object in the corresponding characteristic (F_{ij}):

$$F_{ij} = \frac{\bar{X}_{ij}}{\sum_{i=1}^n \bar{X}_{ij}} \tag{4}$$

where:

\bar{X}_{ij} stands for dimensionless values of characteristics, which are determined depending on the optimal value of the corresponding characteristic;

$\sum_{i=1}^n \bar{X}_{ij}$ is the sum of dimensionless values of characteristics for all enterprises for each of the characteristics.

The calculation of the importance of each enterprise in the studied characteristic is made on the basis of a matrix of dimensionless indices. Its results are shown in Table 6.

Table 6
The share of each enterprise in the characteristics of the competitiveness of enterprises

Competing enterprises	Characteristics				
	X_1	X_2	X_3	...	X_m
1	F_{11}	F_{12}	F_{13}	...	F_{1m}
2	F_{21}	F_{22}	F_{23}	...	F_{2m}
3	F_{31}	F_{32}	F_{33}	...	F_{3m}
...	...	...	...	F_{ij}	...
n	F_{n1}	F_{n2}	F_{n3}	...	F_{nm}
Total:	1	1	1	1	1

Based on the share of each of the characteristics calculated in Table 7, we determine the internal (functional) significance. To calculate the coefficient of internal significance, first we calculate the value of entropy (E_j) by the formula:

$$E_j = -\frac{1}{\ln n} \cdot \sum_{i=1}^n F_{ij} \ln F_{ij} \tag{5}$$

Internal (functional) significance k_j is defined as:

$$k_j = 1 - E_j \tag{6}$$

The share of the corresponding index of each competing enterprise in a certain characteristic (the coefficient of significance of the characteristic – \bar{K}_j) is calculated for each characteristic as:

$$\bar{K}_j = \frac{k_j}{\sum_{j=1}^m k_j} \tag{7}$$

It is advisable to reflect the significance of each of the characteristics in the form of the following Table (Table 7).

Table 7
Determining the coefficients of significance of the characteristics of competing enterprises

Characteristics	Entropy	Significance
X_1	E_1	\bar{K}_1
X_2	E_2	\bar{K}_2
X_3	E_3	\bar{K}_3
...	...	
X_m	E_m	\bar{K}_m
Total		1

Taking into account a number of ecological management factors in the characteristics of enterprises whose competitiveness is being considered, the proposed model will make it possible to determine the significance of such factors (their influence on competitiveness) and form the final comprehensive assessment of the competitiveness of each enterprise (C_i^{int}), calculated by the formula:

$$C_i^{int} = \sum_{j=1}^m \bar{X}_{ij} \cdot \bar{K}_j \tag{8}$$

where:

\bar{K}_j are the calculated indices of the significance of each characteristic;

\bar{X}_{ij} are the dimensionless normalized values of characteristics.

The results of calculations to determine the level of competitiveness of all enterprises operating in the market are given in Table 8.

Table 8
Parameters for assessing the level of competitiveness of competing companies

Competitors	Normalized values of parameters of competitiveness of enterprises					Level of competitiveness	
	X_1	X_2	X_3	...	X_m	in relation to the ideal	in relation to the market average
1	$\frac{X_{11}}{\bar{X}_{11}}$	1	$\frac{X_{13}}{\bar{X}_{13}}$	...	$\frac{X_{1m}}{\bar{X}_{1m}}$	C_1^{int}	$\frac{C_1^{int}}{C^{int}}$
2	1	$\frac{X_{22}}{\bar{X}_{22}}$	$\frac{X_{23}}{\bar{X}_{23}}$	...	1	C_2^{int}	$\frac{C_2^{int}}{C^{int}}$
3	$\frac{X_{31}}{\bar{X}_{31}}$	$\frac{X_{32}}{\bar{X}_{32}}$	$\frac{X_{33}}{\bar{X}_{33}}$	...	$\frac{X_{3m}}{\bar{X}_{3m}}$	C_3^{int}	$\frac{C_3^{int}}{C^{int}}$
...	...	...	...	\bar{X}_{ij}	...	...	...
n	$\frac{X_{n1}}{\bar{X}_{n1}}$	$\frac{X_{n2}}{\bar{X}_{n2}}$	1	...	$\frac{X_{nm}}{\bar{X}_{nm}}$	C_n^{int}	$\frac{C_n^{int}}{C^{int}}$
Significance	\bar{K}_1	\bar{K}_2	\bar{K}_3	...	\bar{K}_m	–	–
The average value of competitiveness (C^{int})						$\frac{\sum_{i=1}^n C_i^{int}}{n}$	

Further, the general complex index of the competitiveness of confectionery enterprises is determined, the structure of the significance of factors is formed and the

polygon of competitiveness is built, taking into account all factors and their significance for each enterprise.

RESULTS

The proposed methodology for assessing the competitiveness of confectionery enterprises, taking into account environmental factors, has been tested at the most powerful confectionery enterprises in Ukraine: PJSC "Production Association" KONTI, "Vinnytsia Confectionery Factory", PJSC Kremenchug confectionery factory "ROSHEN", PJSC "Kyiv confectionery factory" ROSHEN, PJSC "Confectionery factory" AVK "Dnepropetrovsk". These enterprises were selected taking into account the following criteria:

- Market position. These enterprises occupy up to 70% of the domestic confectionery market, providing almost 2/3 of confectionery exports abroad.

- Environmental policy. Each of the enterprises has developed an environmental policy, which provides for the implementation of various measures to reduce anthropogenic impact, increase environmental safety at all stages of the product life cycle.

They cover over 50% of the confectionery market. Economic and environmental indices of the analyzed enterprises for 2014-2018 are given in Table 9.

In view of the fact that the indices have different units of measurement, we will carry out the calculations to obtain commensurate values given in the matrix of normalized values (Table 10).

Given the previous methodology, in Table 11 shows a complex assessment of the level of competitiveness of confectionery enterprises in Ukraine in 2018.

Table 9

Natural economic and environmental indices of confectionery enterprises in Ukraine, 2014-2018, mln. UAH*

Enterprise	Year	Net income from sales of products	The cost of goods sold	Equity	Aggregate liabilities	Pollutants emitted into the atmosphere (except carbon dioxide), t	Carbon dioxide emitted into the atmosphere, t	Extremely and highly hazardous waste generated, t	Little and moderately hazardous waste generated, t
A	B	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈
PJSC Production Association "KONTI"	2014	3393.1	2386.1	1292.1	1743.1	18.7	10687.3	11.4	2420.4
	2015	3554.2	2401.1	1289.9	2313.4	12.77	10662.0	22.7	693.9
	2016	2616.3	1724.7	1299.6	2349.3	11.6	6302.8	0.9	715.1
	2017	1499.6	1082.1	1367.1	1540.7	9.5	6379.2	1.7	753.2
	2018	1004.3	758.1	935.2	1488.5	8.0	5107.6	4.2	799.6
PJSC "Vinnytsia Confectionery Factory"	2014	510.5	381.3	676.3	155.5	50.9	14101.8	3.9	2402.9
	2015	641.0	431.3	1618.3	1692.6	49.6	16316.6	4.3	2202.1
	2016	674.5	481.1	1933.9	1611.9	46.4	14981.6	3.0	2202.1
	2017	703.4	638.5	4004.6	141.6	56.6	14356.9	3.7	1889.7
	2018	751.0	690.7	4007.5	327.5	55.4	13511.5	3.7	2036.4
PJSC Kremenchug confectionery factory "ROSHEN"	2014	189.9	174.1	92.9	132.1	19.0	6721.9	0.7	530.6
	2015	157.2	140.8	90.1	111.9	15.0	6721.9	1.1	463.6
	2016	120.0	112.6	84.7	91.6	14.9	6721.9	0.9	461.8
	2017	179.7	160.7	87.0	223.0	15.1	6791.4	4.6	619.4
	2018	183.7	167.9	86.3	344.3	16.1	7295.8	2.3	696.1
PJSC Kyiv confectionery factory "ROSHEN"	2014	671.6	625.6	197.7	294.6	30.1	14581.1	5.5	8983.3
	2015	497.6	456.0	484.6	332.8	25.0	13750.2	2.5	10211.1
	2016	294.4	256.2	519.4	264.9	19.2	11075.5	1.2	3644.4
	2017	250.5	215.8	530.4	174.6	18.9	10721.3	0.7	2828.8
	2018	232.3	204.3	535.2	1238	18.0	10100.0	1.1	2579.9
PJSC "Confectionery factory" AVK "Dnepropetrovsk"	2014	388.4	353.5	156.3	84.6	62.1	8032.5	2.8	1231.8
	2015	338.4	305.8	185.5	50.1	37.1	7194.3	1.0	1197.4
	2016	310.7	287.6	182.9	152.6	29.1	5744.4	0.2	377.8
	2017	434.2	413.3	183.6	13.5	27.9	5722.9	0.2	657.9
	2018	822.6	753.6	184.6	332.7	36.6	6476.4	0.3	649.4

* UAH – national currency of Ukraine – grivna

Source: Given by the authors based on statistical and financial reporting of confectionery enterprises.

Table 10
Normalized economic and environmental indices of confectionery enterprises, 2014-2018, mln. UAH

Enterprise	Year	Net income from sales of products	The cost of goods sold	Equity	Aggregate liabilities	Pollutants emitted into the atmosphere (except carbon dioxide), t	Carbon dioxide emitted into the atmosphere, t	Extremely and highly hazardous waste generated, t	Little and moderately hazardous waste generated, t
A	B	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈
PJSC Production Association "KONTI"	2014	1.00	0.07	1.00	0.05	1.00	0.63	0.06	0.22
	2015	1.00	0.06	0.80	0.02	1.00	0.63	0.05	0.07
	2016	1.00	0.07	0.67	0,04	1.00	091	0.19	0.53
	2017	1.00	0.15	0.34	0,01	1.00	0.90	0.09	0.82
	2018	1.00	0.22	0,23	0.08	1.00	1.00	0.08	0.81
PJSC "Vinnytsia Confectionery Factory"	2014	0.15	0.46	0.52	0.05	0.37	0.48	0.18	0.22
	2015	0.18	0.33	1.00	0.03	0.26	0.41	0.24	0.21
	2016	0.26	0.23	1.00	0.06	0.25	0.38	0.05	0.17
	2017	0.47	0.25	1.00	0.10	0.17	0.40	0.04	0.33
	2018	0.75	0.24	1.00	0.38	0.15	0.38	0.09	0.32
PJSC Kremenchug confectionery factory "ROSHEN"	2014	0.06	1.00	0.07	0.64	098	1.00	1.00	1.00
	2015	0.04	1.00	0.06	0.45	0.85	1.00	0.96	1.00
	2016	0.05	1.00	0.04	1.00	0.77	0.85	0.18	0.82
	2017	0.12	1.00	0.02	0.06	0.63	0.84	0.03	1.00
	2018	0.18	1.00	0.02	0.36	0.50	0.70	0.14	0.93
PJSC Kyiv confectionery factory "ROSHEN"	2014	0.20	0.28	0.15	0.29	0.62	0.46	0.13	0.06
	2015	0.14	0.31	0.30	0.15	0.51	0.49	0.41	0.05
	2016	0.11	0.44	0.27	0.35	0.60	0.52	0.13	0.10
	2017	0.17	0.74	0.13	0.08	0.50	0.53	0.21	0.22
	2018	0.23	0.82	0.13	1.00	0.45	0.51	0.31	0.25
PJSC "Confectionery factory" AVK "Dnepropetrovsk"	2014	0.11	0.49	0.12	1.00	0.30	0.84	0.25	0.43
	2015	0.10	0.46	0.11	1.00	0.34	0.93	1.00	0.39
	2016	0.12	0.39	0.09	0.60	0.40	1.00	1.00	1.00
	2017	0.29	0.39	0.05	1.00	0.34	1.00	1.00	0.94
	2018	0.82	0.22	0.05	0.37	0.22	0.79	1.00	1.00

Source: Given by the authors based on statistical and financial reporting of confectionery enterprises.

Table 11
Matrix of complex assessment of the level of competitiveness of confectionery enterprises of Ukraine, 2018

Name of enterprise	Normalized characteristic values									Level of competitiveness	
	Net income from sales of products (goods, works, services)	The cost of goods sold (goods, works, services)	Equity	Aggregate liabilities	Pollutants emitted into the atmosphere*	Carbon dioxide emitted into the atmosphere	Extremely and highly hazardous waste generated	Little and moderately hazardous waste generated	In relation to the ideal	In relation to the average value	
PJSC Production Association "KONTI"	1.00	0.22	0.23	0.08	1.00	1.00	0.08	0.81	0.37	0.91	
PJSC "Vinnytsia Confectionery Factory"	0.75	0.24	1.00	0.38	0.15	0.38	0.09	0.32	0.50	1.23	
PJSC Kremenchug confectionery factory "ROSHEN"	0.18	1.00	0.02	0.36	0.50	0.70	0.14	0.93	0.31	0.77	
PJSC Kyiv confectionery factory "ROSHEN"	0.23	0.82	0.13	1.00	0.45	0.51	0.31	0.25	0.39	0.96	
PJSC "Confectionery factory" AVK "Dnepropetrovsk"	0.82	0.22	0.05	0.37	0.22	0.79	1.00	1.00	0.46	1.14	
Entropy of the characteristic (E_j)	0.89	0.86	0.58	0.86	0.88	0.97	0.70	0.92	-	-	
Functional weight of the characteristic (k_j)	0.11	0.14	0.42	0.14	0.12	0.03	0.30	0.08	-	-	
Significance of the characteristic (\bar{K}_j)	0.08	0.10	0.31	0.11	0.09	0.02	0.22	0.06	-	-	

* Except carbon dioxide

Source: Calculated by the authors based on statistical and financial reporting of confectionery enterprises.

Thus, by 2018, the IV enterprise had the lowest comprehensive competitiveness index in comparison with others. However, during the study period, this index tends to in-

crease, which is associated with the introduction of ecological management and, accordingly, a decrease in the negative impact on the environment in the form of emissions of pollutants into the air. As a result, in 2018 the

company took the third place in terms of competitiveness, taking into account environmental factors, compared to the last place in 2014.

Based on the results of assessing the competitiveness of confectionery enterprises in 2014–2018 a stable tendency of the impact of emissions of pollutants into the atmosphere has been revealed. The weight of the impact of emissions into the air on the overall competitiveness index is 6–12% in the overall result. Waste management reaches 29% of importance, which is decisive for a comprehensive index of competitiveness.

CONCLUSION

The degradation of the components of the natural environment, the acceleration of climate change, the strengthening of state environmental regulation are increasingly affecting the continuity and performance of business entities, especially in the field of food production. The passivity of confectionery enterprises in the field of environmental protection, ignoring the environmental needs of consumers lead to a decrease in their competitive positions, a decrease in income and market share. To strengthen the competitive position of enterprises in the market, it is necessary to develop and apply a methodology for assessing the competitiveness of confectionery enterprises, taking into account environmental factors.

Assessment of the competitiveness of confectionery enterprises is of great information and analytical value for strategic planning and ecological management. This allows businesses to identify and enhance environmental competitive advantages and/or identify weaknesses that can serve as potential for efficiency enhancement.

To optimize labor costs and use the results obtained in ecological management, the assessment of the competitiveness of the confectionery industry, taking into account environmental factors, should include the following stages: identification of a set of economic, market and production indicators; determination of significant environmental aspects of the industry taking into account ecological and technological features, actual environmental problems; calculation of the integral index of competitiveness; identification of strengths and weaknesses of enterprises compared to competitors.

Despite the variety of environmental factors influencing the activities of confectionery enterprises in determining the significant environmental aspects of ecological management, three main criteria must be considered: environmental impact, stakeholder requirements, requirements of legislation and other authorities.

The practical significance of the obtained scientific results lies in the development of unified methodological approaches to assessing the competitiveness of confectionery enterprises to identify leaders who have achieved results by reducing the anthropogenic impact on the environment and improved the environmental characteristics of finished products. The developed methodological approaches will allow to substantiate the strategy of environmental development of the enterprise, to strengthen the methodological foundations of ecological manage-

ment by identifying priority environmental goals and objectives that can increase profits, improve market position.

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