STUDIA UNIVERSITATIS MOLDAVIAE, 2022, nr.11(01)
Seria "Științe economice și ale comunicării" ISSN 2587-4446 E-ISSN 2587-4454 p.26-32

CZU: 336.13:330.34:004(478) **DOI: https://doi.org/10.5281/zenodo.6701214**

ANALYSIS OF THE PERCEPTION OF SUSTAINABLE PUBLIC PROCUREMENT IN THE REPUBLIC OF MOLDOVA USING DATA MINING TECHNOLOGIES

Natalia APETRII, Tatiana COVALSCHI

Moldova State University

Awareness of the importance of sustainable public procurement requires the search for the best solutions to strengthen the practice of public procurement in the Republic of Moldova. However, before that, it is important to assess the perception of sustainable public procurement in public institutions and authorities at the current stage in the Republic of Moldova. This research is concentrating on the analysis of this perception by using the questionnaire method and by processing of answers using data mining technologies. Following the analysis of the processed data, it was found that there is no single perception regarding the understanding of the concept of sustainable public procurement in public institutions and authorities in the Republic of Moldova.

Keywords: *sustainability, public procurement, sustainable public procurement, environmental impact, social impact, economic impact, data mining, questionnaire method.*

ANALIZA PERCEPȚIEI ACHIZIȚIILOR PUBLICE DURABILE ÎN REPUBLICA MOLDOVA CU APLICAREA TEHNOLOGIILOR DATA MINING

Conștientizarea importanței achizițiilor publice durabile necesită căutarea celor mai bune soluții pentru consolidarea practicii achizițiilor publice în Republica Moldova. Înainte de aceasta, însă, este important de a evalua cum sunt percepute la momentul actual achizițiile publice durabile în instituțiile și autoritățile publice din Republica Moldova. Această cercetare se concentrează pe analiza acestei percepții prin utilizarea metodei chestionarului și prin prelucrarea răspunsurilor folosind tehnologii Data Mining. În urma analizei datelor prelucrate s-a constatat că în instituțiile și autoritățile publice din Republica Moldova nu există o percepție unică a conceptului de achiziție publică durabilă.

Cuvinte-cheie: *sustenabilitate, achiziții publice, achiziții publice durabile, impact de mediu, impact social, impact economic, data mining, metoda chestionării.*

JEL Classification: *H570.*

Introduction. Public procurement is an important component of consumption in a national economy, and therefore an important tool available to central and local government authorities to influence the course of economic and social development. The current international trend in promoting public policies is to broaden the time horizon in planning by tracking the long-term impact of the current actions of public authorities and institutions, with sustainable public procurement being a key component in this regard.

Sustainability is the quality of human activities to be carried out without compromising the quality of life of future generations, seen in terms of three important aspects: environmental (efficient use of natural resources, waste management, improving air and water quality, reducing the use of dangerous chemicals), social (improving working conditions, reducing unemployment) and economic (developing local entrepreneurship and rural economy). All three of these aspects are equally important. Thus, "when a viable natural environment (ecological pillar) is undertaken with community development (social pillar), the environment created is bearable. When the development of the community (the social pillar) intertwines with the economic sufficiency (the economic pillar), the business environment becomes a fair one. Last but not least, when a viable natural environment (ecological pillar) is assisted by economic sufficiency (economic pillar), the environment is viable. The point that meets all these three conditions simultaneously leads to a bearable, viable and equitable development, and therefore sustainable".

The concept of sustainable public procurement means that category of procurement made by public institutions and authorities that aim to have a positive impact, or at least to reduce the negative impact on the environment, society and the economy. This concept is not new in the scientific literature, but now, in the context of enhancing human responsibility for the impact of consumption on limited environmental resources, it has become an important current topic, frequently addressed in the scientific research of various researchers, both international and domestic.

The literature in this field defines the concept of sustainable public procurement [1], the genesis and evolution of this concept [2-4], the awareness of the importance of sustainable public procurement, and the need to create legal tools for the implementation of this practice by governments [5], hence this topics will not be addressed in this article, the research being concentrated on assessing the perception of sustainable public procurement in public institutions and authorities at the current stage in the Republic of Moldova.

Thus, although there are a number of studies on sustainable public procurement in the Republic of Moldova, this paper has an original contribution to the research in the field, the aim of the paper being to analyze and appreciate the perception and practice of sustainable public procurement in public institutions and authorities in the Republic of Moldova.

Research methodology. The collection of data for the research was performed by the questionnaire method. A number of public authorities and institutions from the Republic of Moldova were identified and questionnaires were sent. Thirty-seven of them filled in the questionnaires. The questionnaire included 22 closed questions related to the characteristics that best describe the essence of the sustainable procurement. These questions were grouped into the following three categories: perception of environmental impact, of social impact and economic impact.

A pre-processing for the data analysis was performed and an electronic file, which contains the results of the survey, was obtained. Because one of the characteristics of the collected data is that it is multicriterial, cluster analysis for data processing was applied. Data Mining technology was also applied in this research. Data clustering is unsupervised learning (it is also called "learning without a teacher") and allows the grouping of data that have common features.

Statistics is a collection of mathematical procedures that ensure the organization, processing, analysis and interpretation of the collected data [6]. Statistical methods do not always contain solutions to solve certain types of problems. Human`s ability to process large volumes, however, is limited comparing to the power of modern computers.

Nowadays, the data stored is a challenge for analysts. Datasets are very large, multi-criterial, are presented in different formats, and can be structured and unstructured. Artificial intelligence, which is intelligent data processing, comes to the help. Data Mining is a technology that precedes statistical processing. This technology allows new knowledge to be obtained / extracted from large historical data.

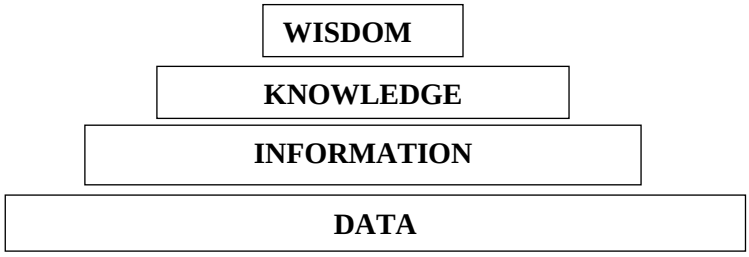


Fig.1. Evolution of data.
Source: Adapted by the authors after source [7].

Figure 1 shows the evolution from the data level to the wisdom level. The data is the lowest level of the pyramid. Data becomes information when the relationship between them is clear. Information becomes knowledge through the understanding of models and their correct interpretation [7]. Knowledge is the result of intelligent data processing.

Intelligent data processing was performed on the Deductor analytics platform using Kohonen Maps. The questions in the questionnaire and the answers obtained were selected and grouped according to the type of impact: economic, social or environmental. Each group contains a number of questions with answers, being processed separately. The grouping of questions in the questionnaire is shown in Tables 1-4. The answers to the questions are presented in the form of criteria assessment scales. Files have been prepared for processing each question group. Data from electronic files has been imported into Deductor software.

Processing the first set of questions. For the questions in Table 1 (total number = 12), the evaluation scale is as follows: very often (FDes), often (Des), not at all (Deloc), rarely (Rareori) and very rarely (FRar). Table 1 shows the questions in a general form for an easier presentation and understanding (for user and reader) of the explanation of the data processing process. For example, Question 1 is: *How often does the public authority/institution/enterprise procure goods, services and works: Copy paper, office supplies?*

Table 1

First set of questions

The content of the question					
How often does the public authority / institution / enterprise procure goods, services, works?					
1 Copy paper, office supplies	2 Electrical and electronic equipment	3 Office IT equipment	4 Lighting systems	5 Electricity; fuel, heating services	6 Cleaning products and services
7 Fertilizers; herbicides; pesticides	8 Means of transport / Machinery / Spare parts	9 Construction works	10 Office furniture	11 Food and catering services	12 Services

Source: Prepared by the authors.

Interpretation of results

How often does the public authority / institution / enterprise procure goods, services, works? [1 Copy paper, office supplies], [2 Electrical and electronic equipment], [3 Office IT equipment], [4 Lighting systems], [5 Electricity; fuels; heating services], [6 Cleaning products and services], [7 Fertilizers; herbicides; pesticides], [8 Means of transport / Machinery / Spare parts], [9 Construction work], [10 Office furniture], [11 Food and catering services], [12 Services].			
Description, **cluster 0**	Description, **cluster 1**	Description, **cluster 2**	Description, **cluster 3**
The public authority / institution / enterprise makes purchases of: office supplies, electricity, fuel; heating services, cleaning products and services, food and catering services, services – rare or very frequent; electrical and electronic, IT and lighting systems rarely; means of transport / equipment / spare parts, construction works – rarely / often; Office furniture rarely. No procurement is made for fertilizers, herbicides, pesticides.	The public authority / institution / enterprise makes purchases of: office supplies – rarely or very often; electrical and electronic equipment, IT and lighting systems – rarely; electricity, fuel, heating services, cleaning products and services, means of transport / machinery / spare parts, construction work rarely or often; office furniture, food and catering services – rarely; services – often, very often and rarely. For fertilizers, herbicides, pesticides, no or rare procurement are made.	The public authority / institution / enterprise makes purchases of: office supplies – often; electrical and electronic equipment, IT and lighting systems- rarely; electricity, fuel, heating services, cleaning products and services – often; fertilizers, herbicides, pesticides – no or rare purchases; means of transport / machinery / spare parts, office furniture, food and catering services – rarely; services and construction work – very often, often and rarely.	The public authority / institution / enterprise makes purchases of: office supplies, electricity, fuel, heating services, cleaning products and services, construction works – often or rarely; electrical and electronic equipment, IT, means of transport / machinery / spare parts, office furniture – rarely; Lighting systems – often or no procurement; food and catering services, fertilizers, herbicides, pesticides no procurement are made.

Source: Prepared by the authors.

The total number of records processed is 37 (100%). As a result of data clustering we have 4 clusters with the following distribution of records: cluster 0 (35%); cluster 1 (30%); cluster 2 (8%); cluster 3 (27%). The number of clusters has been set by the user. In order to make the information easier to understand the user can choose one of the tools for data display: map or table. As a viewer, the user can choose a table or map. The use of the Map is welcome for the analysis of a large volume of data. For processing the first set of questions, the selected table tool was chosen/applied. The result of the processing is the table with the clustered

records. Drawing 1 shows the contents of cluster 0 (records). The column names correspond to the question number in Table 1. The data presented in the viewer is interpreted by the analyst.

Processing the second set of questions. For the questions (total number = 5) in table 2 the evaluation scale is as follows: *total agreement, agreement, neutral, disagreement, total disagreement.*

1	2	3	4	5	6	7	8	9	10	11	12	Номер кластера
Des	Des	Des	Rareori	FDes	Rareori	Deloc	Rareori	Rareori	Des	Rareori	Rareori	0
Des	Des	Des	Des	Des	Des	Deloc	Rareori	FDes	Des	FDes	Des	0
Des	Des	Des	Des	FDes	FDes	Deloc	Des	Des	Rareori	Deloc	FDes	0
Rareori	Des	Des	Rareori	FDes	Des	Deloc	Rareori	Des	Des	Rareori	Des	0
FDes	Des	Des	Rareori	Rareori	Deloc	Deloc	Rareori	Rareori	Rareori	Rareori	FDes	0
Des	Des	Des	Rareori	Deloc	Des	Deloc	Des	FDes	Des	Des	Des	0
Des	Des	Des	Rareori	Deloc	Des	Deloc	Des	Des	Des	FDes	FDes	0
Des	FDes	FDes	Des	FDes	Des	Deloc	Rareori	Des	Des	Rareori	FDes	0
Des	Rareori	Des	Rareori	Des	Des	Deloc	Rareori	Rareori	Rareori	Deloc	Des	0
Des	Des	Des	Rareori	FDes	Des	Deloc	Rareori	Rareori	Rareori	Rareori	Des	0
Des	Des	Des	Rareori	Des	Des	Deloc	Rareori	Des	Des	Des	Des	0
FDes	Des	Des	Des	FDes	FDes	Deloc	Des	Des	Deloc	Rareori	Des	0
Des	Rareori	Des	Rareori	Des	Rareori	Deloc	Rareori	Des	Des	Deloc	Rareori	0

D.1. Cluster Content 0.
Source: Prepared by the authors.

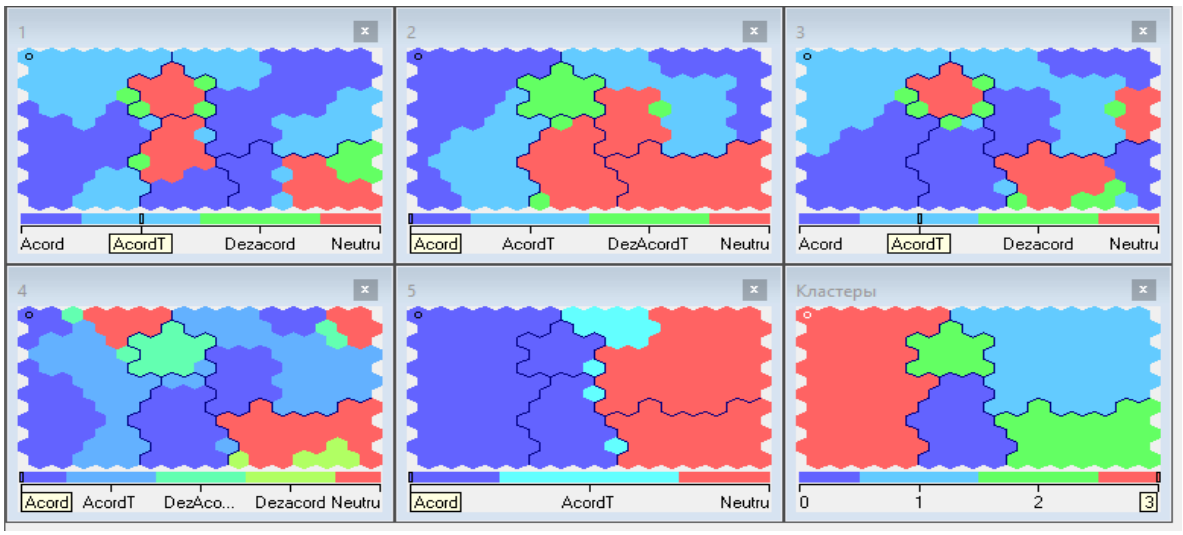
Table 2

Second set of questions

The content of the question				
The characteristics that best describe the essence of sustainable procurement in terms of ENVIRONMENTAL IMPACT are:				
1 Saving natural resources	2 Biodiversity conservation	3 Soil health and fertility management	4 Climate change adaptation	5 Others

Source: Prepared by the authors.

The total number of processed records is 37 (100%). As a result of data clustering we have 4 clusters with the following distribution of records: cluster 0 (8%); cluster 1 (35%); cluster 2 (16%); cluster 3 (41%). The number of clusters has been set to 4. The selected viewer for processing the second set of questions the Kohonen map was chosen/applied. The map names correspond to the question number in Table 2. The last map on drawing 2 shows the clusters generated by the software; the borders of the clusters are highlighted in blue; each cluster is represented by a certain color. Maps 1-5 show the answers grouped on the clusters. The color on the map shows the answer of the respondent. The analysis of all maps gives a broad description of the question from Table 2.



D.2. Kohonen self-organizing maps.
Source: Prepared by the authors.

Interpretation of results

The characteristics that best describe the essence of sustainable procurement in terms of ENVIRONMENTAL IMPACT are: [1 Saving natural resources], [2 Biodiversity conservation], [3 Soil health and fertility management], [4 Climate change adaptation], [5 Others].			
Description, **cluster 0**	Description, **cluster 1**	Description, **cluster 2**	Description, **cluster 3**
Respondents agree that saving natural resources, managing soil health and fertility, climate change adapting, and others, describe the essence of sustainable procurement in terms of environmental impact. They are not sure that biodiversity conservation describes the essence of procurement well.	Respondents agree or strongly agree that all the features describe well the essence of sustainable procurement in terms of environmental impact. Some respondents do not consider other characteristics as important ones.	Respondents said they were unsure that saving natural resources, conserving biodiversity, managing health and soil fertility, to climate changes adapting are the best features that describe the essence of sustainable procurement in terms of environmental impact.	Respondents agree or strongly agree that all the characteristics listed in the question describe well the essence of sustainable procurement in terms of environmental impact.

Source: Prepared by the authors.

Processing the third set of questions. For questions (total number = 6) from table 3, the evaluation scale is as follows: *total agreement, agreement, neutral, disagreement, total disagreement.*

Table 3

Third set of questions

The content of the question					
The characteristics that best describe the essence of sustainable procurement in terms of SOCIAL IMPACT are:					
1 Respect for rights	2 Fair remuneration	3 Freedom of association	4 Work safety	5 Training and education	6 Others

Source: Prepared by the authors.

The total number of processed records is 37 (100%). As a result of data clustering, we have 4 clusters with the following distribution of records: cluster 0 (16%); cluster 1 (14%); cluster 2 (46%); cluster 3 (24%). The number of clusters has been set to 4. The selected viewer for processing the third set of questions the Kohonen map was chosen/applied.

Interpretation of results

The characteristics that best describe the essence of sustainable procurement in terms of SOCIAL IMPACT are: [1 Respect for rights], [2 Equitable remuneration], [3 Freedom of association], [4 Labor security], [5 Training and education], [6 Others].			
Description, **cluster 0**	Description, **cluster 1**	Description, **cluster 2**	Description, **cluster 3**
The characteristics that best describe the essence of sustainable procurement in terms of social impact are: job security, training and education and others. Respect for rights - some respondents agree.	The characteristics that best describe the essence of sustainable procurement in terms of social impact are: respect for rights, Equitable remuneration, job security, training and education.	The characteristics that best describe the essence of sustainable procurement in terms of social impact are: respect for rights, equitable remuneration, job security, training and education - I totally agree / agree. A large part of the respondents agrees with freedom of association.	50% of respondents consider that the characteristics that best describe the essence of sustainable procurement in terms of social impact are: respect for rights, equitable remuneration, freedom of association, job security, training and education.

Source: Prepared by the authors.

Processing the fourth set of questions. For the questions (total number = 7) from table 4 the evaluation scale is as follows: *total agreement, agreement, neutral, disagreement, total disagreement.*

Table 4

Fourth set of questions

The content of the question						
The characteristics that best describe the essence of sustainable procurement in terms of ECONOMIC IMPACT are:						
1 Investments and innovations	2 Fair competition	3 Transparency and access to information	4 Justified prices in relation to quality	5 Local economic development	6 Development of the SME sector	7 Others

Source: Prepared by the authors.

The total number of processed records is 37 (100%). As a result of data clustering we have 3 clusters with the following distribution of records: cluster 0 (22%); cluster 1 (59%); cluster 2 (19%). The selected viewer for processing the fourth set of questions the Kohonen map was chosen/applied.

Interpretation of results

The characteristics that best describe the essence of sustainable procurement in terms of ECONOMIC IMPACT are: [1 Investment and innovation], [2 Fair competition], [3 Transparency and access to information], [4 Reasonable prices in relation to quality], [5 Local economic development], [6 Development of the SME sector], [7 Others].		
Description, **cluster 0**	Description, **cluster 1**	Description, **cluster 2**
50% of respondents consider that the characteristics that best describe the essence of sustainable procurement in terms of economic impact are: investment and innovation, fair competition, transparency and access to information, justified prices in relation to quality, local economic development.	Respondents consider that the characteristics that best describe the essence of sustainable procurement in terms of economic impact are: investment and innovation, fair competition, transparency and access to information, justified prices in relation to quality, local economic development, development of the SME sector.	Respondents consider that the characteristics that best describe the essence of sustainable procurement in terms of economic impact are: investment and innovation, local economic development, the development of the SME sector. 50% of respondents consider that justified prices in relation to quality, fair competition, transparency and access to information do not describe well the essence of sustainable procurement.

Source: Prepared by the authors.

The results of research

Data Mining technology was used to group similar responses into clusters and draw the following conclusions:

Most respondents *agreed* on the features that best describe the essence of sustainable procurement in terms of *environmental impact*, namely: saving natural resources, conserving biodiversity, managing health and soil fertility, climate changes adapting.

Regarding the characteristics that best describe the essence of sustainable procurement in terms of *social impact*, namely: respect for rights; equitable remuneration; freedom of association; work safety; training and education and others, the answers given are as follows: a large part of the respondents consider that the listed characteristics describe well the essence of sustainable procurement and other respondents have different opinions.

Most respondents consider that the characteristics that best describe the essence of sustainable procurement in *terms of economic impact are*: investment and innovation, fair competition, transparency and access to information, reasonable prices in relation to quality, local economic development, development of the SME sector. The other part of respondents gave heterogeneous answers.

Conclusions

Public procurement is an efficient tool for the state that can increase the quality of life of future generations by encouraging the efficient use of natural resources, waste management, improving air and water quality,

reducing the use of hazardous chemicals, improving working conditions, reducing unemployment, development of the local entrepreneurship and the rural economy etc.

Following the analysis of the processed data, it was found that there is no single perception regarding the understanding of the concept of sustainable public procurement, the answers provided by the people who participated in the survey being quite heterogeneous. We can see that the representatives of public institutions and authorities understand differently the concept of sustainable public procurement, but there are still some peculiarities (formulated in questions) regarding the impact of public procurement with which most respondents agreed.

The implementation of the practice of sustainable public procurement should start with those categories of goods that are most often purchased by public institutions and authorities such as: copy paper, office supplies, electrical and electronic equipment, office IT equipment, electricity, fuels, heating services, cleaning products and services.

References:

1. GANEA, V. *Aspecte teoretice cu referire la eficientizarea achizițiilor publice în contextul dezvoltării durabile. Achiziții publice și dezvoltare durabilă: schimbarea de paradigmă*: Monografie, 2020, p.23-39. ISBN 978-9975-3493-1-4.
2. CHENG, W. ș.a. Green Public Procurement, missing concepts and future trends – A critical review. In: *Journal of Cleaner Production*, 2018, vol.176, p.770-784, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2017.12.027.
3. CHERSAN, I. ș.a. Achizițiile publice ecologice în literatura de specialitate. În: *Amfiteatru Economic*, 2020, nr.22, p.82-101. ISSN Online: 2247-9104.
4. SÖNNICHSEN, S.D., CLEMENT, J. Review of green and sustainable public procurement: Towards circular public procurement. In: *Journal of Cleaner Production*, 2020, vol.245, p.118901, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2019.118901.
5. PISARENCO, O. *Contextul legal de realizare a achizițiilor publice durabile în Republica Moldova*. *Achiziții publice și dezvoltare durabilă: schimbarea de paradigmă*. Monografie, 2020, p.8-22. ISBN 978-9975-3493-1-4.
6. STANCU, S. *DATA SCIENCE in mediul R. Teorie si aplicații*. București: Editura ASE, 2020.
7. BOLOGA, R. (coordonator). *Bazele informaticii economice*. București: Editura ASE, 2018.

Data about the authors:
Natalia APETRII, PhD student, assistant lecturer, Faculty of Economics, Moldova State University.
E-mail: apetrii.natalia@usm.md
ORCID: 0000-0002-7189-4342
Tatiana COVALSCHI, PHD, university lecturer, Faculty of Economics, Moldova State University.
E-mail: covalschi.tatiana@usm.md
ORCID: 0000-0003-0331-6724

Presented on 12.05.2022