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THE POTENTIAL OF SOFTWARE SUPPORT IN RAISING THE QUALITY OF STRATEGIC DECISION-MAKING IN ENVIRONMENTAL PROTECTION

Abstract: *Making strategic decisions in the environmental sector is a complex process because circumstances require rapid results in the conditions of inherited decades of problems. The entry of the Republic of Serbia into the EU implies redefining environmental decisions and priorities, which in expert, theoretical and practical terms brings with it a number of challenges. The potential of software support for strategic decision-making in a highly turbulent environment, in a Covid 19 pandemic, could contribute to shortening the time dimension of decision-making, a clearer perception of the relationship of individual environmental factors to the environment, and thus a different approach to solving this problem. The paper presents the development of a software support model for quantitative analysis of the environment presented through the SWOT matrix and its importance in the strategic determination of the use of software decision-making potential in environmental protection, specifically in the importance of its application in construction waste management.*

Keywords: *Quality; Environment; Software support; SWOT matrix*

1. Introduction

Technological development has enabled the necessity of applying software solutions in almost all activities (Hřebíček et al., 2017; Jakeman et al., 2008). Ecological awareness implies the application of such support in environmental protection, which has so far been most clearly expressed through the operational part of waste management, translated into electronic reports on the type and amount of waste, location and source of waste, disposal, transport, etc. (Agarwal, 2008; DK, 2019; Turner et al., 2003).

The ISI 14001 quality system significantly improves the environmental performance of organizations, but its alignment with the organization's strategy and policy can be improved. Global IT progress in all segments of society can not but affect the management of environmental protection. Namely, the application of new software solutions in this area can significantly improve the quality of environmental management, from the creation of basic databases, to the decision-making process. ISO 14001 procedures can give significantly better results if the quality of the strategic management concept in organizations dealing with environmental protection is raised to a higher level.

ISO 14001 "specifies the requirements for an environmental management system that an organization can use to improve its environmental performance. ISO 14001

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helps an organization achieve the intended outcomes of its environmental management system, which provide value to the environment, the organization itself, and stakeholders. In accordance with the environmental policy of the organization, the anticipated outcomes of the environmental management system include:

- Improving environmental performance
- Fulfillment of compliance obligations
- Achieving environmental goals.

ISO 14001 is applicable to any organization, regardless of size, type and nature, and applies to environmental aspects of its activities, products and services that the organization determines can control or influence with respect to the life cycle perspective. ISO 14001 does not specify specific criteria for environmental protection. " (G-Certi System Service, 2021).

However, business policies, procedures and rules stem from the strategic decisions of organizations. As can be seen in Figure 1, ISO 14001 stems from the strategic context of the organization. The strategy process is very complex and consists of the following steps:

- Environmental analysis
- Directing the organization
- Strategy formulation
- Implementation
- Control.

The quality of environmental analysis and strategic decision making in environmental management can be significantly improved by software decision support. It is understood that software support can significantly facilitate the strategic orientation of environmental management in Serbia, offering a very quick comparative overview of the relationship between environmental factors in different alternatives, with different impacts and probabilities, in order to draw parallels and adopt the most favorable strategic decision.

Figure 1. ISO14001 (https://asq.org/quality-resources/iso-14001)

Precisely on this principle, we will consider the decision on the importance and potential of software support for strategic decision-making using the SWOT matrix in environmental protection on the example of SDA Serbian Demolition Association, an organization that deals with improving construction waste management in the Republic of Serbia. Furthermore, the presented software support could become a new paradigm in the practice of construction waste management because "the openness of the quality paradigm conditioned the inclusion of new scientific approaches, methods and development of new scientific disciplines, which later grew into new paradigms." (Arsovski, 2016).

2. SWOT matrix

The goal of using SWOT analysis (Pahl & Richter, 2009; Sarsby, 2016; Snelling, 2012; Böhm, 2009; Fine, 2009) in organizations dealing with environmental protection is reflected in:

- consideration of business opportunities for achieving more successful business in the field of environmental protection
- efficient use of resources
- analysis of competition and dangers of environmental dependence on

other countries
- new opportunities and use of existing opportunities
- warning and prevention of threats from the environment.

The procedure for creating a SWOT can be divided into the following steps:
- Formulation (by experts) of strengths and weaknesses, chances and threats
- Processing (consolidation) of the obtained estimates on a demonstration example
- Analysis of results in order to formulate strategies.

Environmental analysis involves defining external and internal factors that have a decisive influence on the strategic orientation of organizations. Only by weighing these factors and assessing their interactions (it is assumed that this is done by experts in this field) can we see the consequences of these factors and the strength of their impact on the organization (Verma, 2009). Qualitative SWOT matrix does not measure the interaction of these factors and for this reason may have certain shortcomings, and thus affect the quality of strategic decisions. Using the analysis of the environment shown in the following example of the SDA Serbian Demolition Association, the possibility of error is reduced, which is especially important in the case of strategic decisions where the time frame to which the decisions relate is quite long, thus the degree of uncertainty is higher.

In the continuation of the paper, an example of the analysis of the environment of the Serbian Demolition Association SDA organization is presented in order to improve the quality of the strategic orientation of the organization by creating software support. Strengths and weaknesses, chances and threats from the environment are defined.

2.1. Strength

1. Experience in creating software solutions (in relation to the surrounding countries SDA Serbian Demolition Association has human resources for significant experience in creating software solutions);

2. Expertise for key areas of environmental business (SDA Serbian Demolition Association has the resources and human resources to perform accurate and valid expertise;

3. SDA is part of the global IT group (SDA Serbian Demolition Association in the Republic of Serbia is a branch of the EDA European Demolition Association, thus part of a much broader context than the national one)

4. Members of the SDA Serbian Demolition Association have experience in the use of IT equipment and consumer electronics in the field of ecology;

2.2. Weaknesses

1. Lack of conditions for entering the market (Covid 19 has brought many changes in the way of life and business. The use of IT tools in the business process at this time, has become more important than ever. This determines that we must fit into such a way of working that requires a new quality of decision-making;

2. Errors in software management (bearing in mind that this is software support for creating a SWOT matrix that is introduced for the first time in the environmental management system, we must take care not to underline errors);

3. Financial inability of SDA Serbian Demolition Association to follow all the dynamic changes in the field of ecology and business (We are witnessing accelerated changes in the environment, so it is necessary to constantly monitor them and possibly correct the strategy in accordance with the changes);

4. Poor assessments during the creation of a new program (regardless of the perfection of the software solution, expert assessment still remains the most important link in determining the strategic orientation of organizations dealing with environmental protection);

2.3. Opportunities

1. Distribution of software on the market of Northern Europe (if this software solution proves to be good in the Republic of Serbia, we can implement it with the help of EDA European Demolition Association in all member states;

2. Creating new software and business solutions (This software is only the primary link. It can be upgraded, comparisons can be made, the percentage of error reduction in the process of strategic decision-making over time, etc. can be monitored);

3. Growth and profit in European countries (any growth implies greater openness to new tools and acceptance of software support that will provide quality and comfort to organizations. In this sense, we see a chance to place this software);

4. Strengthening the staff structure (The number of members of the SDA Serbian Demolition Association is growing every day and implies the number of human resources.

5. Opening new organizations in the countries of the region (EDA European Demolition Association is developing and growing, by permanent expansion to other countries. We see a serious chance in this);

2.4. Threats

1. Entry of competition (there are permanent attempts to create parallel organizations in the Republic of Serbia. In the European Union, it is the only organization that has no alternative;

2. Adoption of unfavorable laws (in the field of environmental protection, numerous problems are expected in the process of harmonization of legal regulations and construction waste management, which is a priority of the SDA Serbian Demolition Association;

3. Economic crisis at the global level;

4. Development of new technologies (the speed of development of new technologies will significantly influence strategic decisions. The question is to what extent we can predict changes in the long run, which of course poses a threat to the objectivity of strategic analysis);

Tabular presentation of internal and external environmental factors:

- In the table in the section Odds "O", the columns are filled with a list of favorable odds, (from 1 to n) that may appear in the future.
- In the Threats section "T" also fill in for threats (from n + 1 to m).
- In the section Power "C" fill in the ranks of forces in the activities of the company (from 1 to k).
- In the section Weaknesses "W", fill in the rows of weaknesses in the company's activities (from k + 1 to r).

Then, for each pair of factors, an estimate of their interaction aij (from -1 to 1) is introduced in the direct dependence of the positive estimate (or the inverse dependence of the negative estimate) and the stronger the dependence, the higher the modulo score aij $\in$ (-1;1) (Table 1).

In the quadrants SO, ST, WO, WT, set the cells (aij) to assess the impact of the appropriate factors S and W on the use of favorable chances (opportunities, opportunities) or on the protection (or worsening) of threats, applying the following rules:

- Grade +1 - the factor gives the full opportunity to use favorable chances (opportunities) or prevent the negative effects of threats (dangers);

- Grade from +0.8 to +0.6 - help with the use of favorable opportunities or protection from threats
- Rating from +0.4 to +0.2 -positive impact on the use of favorable opportunities or on protection against threats;
- Grade 0 - no practical influence of factors on specific factors O and T;
- Score from -0.2 to -0.4 – negative impact on the use of favorable opportunities or encourages the strengthening of threats;
- Score from -0.6 to -0.8 - strong negative impact on the use of favorable opportunities or clearly affect the strengthening of the threat;

Grade -1 - disabling the use of a favorable chance (opportunity) and preventing the action of the threat.

Table 1. SWOT matrix

SWOT analysis		Opportunities					Threats			
		1	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*
Strengths	*1*	0.4	0.8	0.4	0.5	0.6	0.5	0.4	0.2	0.8
	2	0.3	0.2	0.3	0.6	0.6	0.5	0.6	0.1	0.3
	3	0.8	0.7	0.3	0.3	0.3	0.6	0.4	0.2	0.6
	4	0.8	0.4	0.4	0.3	0.4	0.6	0.4	0.3	0.6
Weaknesses	*1*	0.4	0.4	0.4	0.3	0.5	-0.6	-0.1	-0.6	-0.3
	2	-0.2	-0.3	-0.4	0.7	-0.2	-0.6	-0.2	-0.3	-0.5
	3	-0.2	0.2	0.3	-0.2	0.3	-0.2	-0.2	-0.3	-0.3
	4	-0.6	-0.5	-0.4	0.7	-0.4	-0.6	-0.2	-0.2	-0.4

Table 2 introduces the coefficient of influence and the probability of occurrence. In line Kj put the coefficient of influence on the activity of the company of specific favorable opportunities or threats, guided by the following rules:

- Does not affect the company's activities - coefficient of influence 0;
- Creates new opportunities or in case of realization of the threat the activity of the organization may stop - coefficient of influence 1.

Interstitial (central) cases:

- Weak impact 0.1 - 0.3;
- Average impact 0.4 - 0.6;
- Strong impact 0.7 - 0.9.

In the PJ line, put the probabilities (in the range from 0 to 1) of the occurrence of favorable chances (opportunities) and threats.

In the column of Strength "S" Ai put estimates of the intensity of these factors in the range from 1 to 5, using the following rules:

- Grade 5 - special advantage;
- Grade from 4 to 3 - intensity higher than the industry average (industry);
- Grade from 2 to 1 - the intensity is probably higher than the industry average, but it is not significant.

Also, fill in column Ai for weaknesses in the company's activities, written in the column Weaknesses "W", using the following rules:

- Grade 5 - in the activity of the company this weakness is not represented;
- Grade 4, 3 - the position on this factor is weaker than the industrial average;
- Grade 2, 1 - the intensity of the urinary factor is lower than the industry average, but it is unreliable.

Expert ratings in cells a_{ij} are then transposed into ratings

$A_{ij} = A_i \times K_j \times P_j \times a_{ij}$

where:

- A_{ij} is the rating of the strong (weak) side of the company;
- The degree of impact of the opportunity or danger
- P_j - probability of occurrence of external environment factors
- a_{ij} - degree of interaction of pair analysis factors.

Table 3 presents final results of Swot matrix.

Table 2. SWOT matrix - intermediate results

SWOT Analys			*Opportunities*					*Threats*			
			1	*2*	*3*	*4*	*5*	*1*	*2*	*3*	*4*
Coefficient of influence K_j			0.9	0.6	0.8	0.8	1.0	0.3	0.6	0.4	0.7
Probability of occurrence P_j		A_i	0.9	0.8	0.9	0.8	0.5	0.7	0.8	0.8	0.6
Strengths	*1*	*5.00*	4.05	2.40	3.60	3.20	2.50	1.05	2.40	1.60	2.10
	2	*3.0*	2.4	1.4	2.2	1.9	1.5	0.6	1.4	1.0	1.3
	3	*4.0*	3.2	1.9	2.9	2.6	2.0	0.8	1.9	1.3	1.7
	4	*5.0*	4.1	2.4	3.6	3.2	2.5	1.1	2.4	1.6	2.1
Weaknesses	*1*	*4.0*	3.2	1.9	2.9	2.6	2.0	0.8	1.9	1.3	1.7
	2	*4.0*	3.2	1.9	2.9	2.6	2.0	0.8	1.9	1.3	1.7
	3	*4.0*	3.2	1.9	2.9	2.6	2.0	0.8	1.9	1.3	1.7
	4	*3.0*	2.4	1.4	2.2	1.9	1.5	0.6	1.4	1.0	1.3

Table 3. Swot matrix - final results

SWOT analysis			*Opportunities*						*Threats*				
			1	2	3	4	5	∑	1	2	3	4	∑
Coefficient of influence K_j			0.9	0.6	0.8	0.8	1.0		0.3	0.6	0.4	0.7	
Probability of occurrence P_j		A_i	0.9	0.8	0.9	0.8	0.5		0.7	0.8	0.8	0.6	
Strengths	1	*5*	1.6	1.9	1.4	1.6	1.5	8.1	0.5	1.0	0.3	1.7	3.5
	2	*3*	0.7	0.3	0.6	1.2	0.9	3.7	0.3	0.9	0.1	0.4	1.7
	3	*4*	2.6	1.3	0.9	0.8	0.6	6.2	0.5	0.8	0.3	1.0	2.5
	4	*5*	3.2	1.0	1.4	1.0	1.0	7.6	0.6	1.0	0.5	1.3	3.3
	∑		8.2	4.5	4.4	4.5	4.0		2.0	3.6	1.2	4.3	
Weaknesses	1	*4*	1.3	0.8	1.2	0.8	1.0	5.0	-0.5	-0.2	-0.8	-0.5	-2.0
	2	*4*	-0.6	-0.6	-1.2	1.8	-0.4	-1.0	-0.5	-0.4	-0.4	-0.8	-2.1
	3	*4*	-0.6	0.4	0.9	-0.5	0.6	0.7	-0.2	-0.4	-0.4	-0.5	-1.4
	4	*3*	-1.5	-0.7	-0.9	1.3	-0.6	-2.3	-0.4	-0.3	-0.2	-0.5	-1.4
	∑		-1.5	-0.1	0.0	3.4	0.6		-1.6	-1.2	-1.7	-2.4	

After the transposed factor estimates, we obtain the results of the interrelationships for each pair of factors in the four quadrants. In the quadrant of the Municipal Assembly, in which the relationship between internal forces and external chances is observed, we notice that the first chance represents our best chance in relation to the total forces. Therefore, strategic decisions in this case should focus on the distribution of software to the Northern European market. Our greatest strength is the experience in creating software solutions.

It is interesting to see in the WO quadrant that the first chance is also the most sensitive chance in relation to the overall weaknesses of the organization. Taking into account the relationship between the factors of weakness and chance, the table clearly shows that our biggest weakness is poor assessment during the creation of a new program (in the table this weakness has the most negative value in relation to overall chances), which can jeopardize and even very negatively affect our the biggest chance, the chance - the distribution of software on the market of Northern Europe.

In the ST quadrant, we also see the strongest influence of the first force - the experience in creating software solutions, on the overall threats in the environment. Also, in this quadrant we see that our biggest threat from the external environment is the speed of development of new technologies.

In the WT quadrant, the relationship between weaknesses and threats, again the 4th threat - the speed of development of new technologies stands out with the most negative effect in relation to internal weaknesses.

3. Example of the software support

Having in mind the above results obtained by assessing the probability of occurrence and impact of phenomena in the external environment, and the intensity of internal factors on their relationship, we obtain significantly better data in the analysis of the environment necessary as guidelines for strategic orientation. In this example, the matrix indicates the strategy of entering a foreign market (distribution of software to the market of Northern Europe) and directing the organization towards permanent monitoring of new technologies. The percentage of error in making strategic decisions in this way is drastically reduced.

The software solution is based on the previously described method of calculation. By automating the calculation with this methodology, the analysis of all areas of the SWOT matrix calculation is performed (Figure 2):

- Strengths – Opportunities
- Strengths – Threats
- Weaknesses – Opportunities
- Weaknesses – Threats.

Figure 2. Forms for analysis of individual pairs

On each form there is an option for entering initial values, automatic calculation of all sizes, Subtotal and Total values, as well as the final results of Max and Min sizes Figure 3.

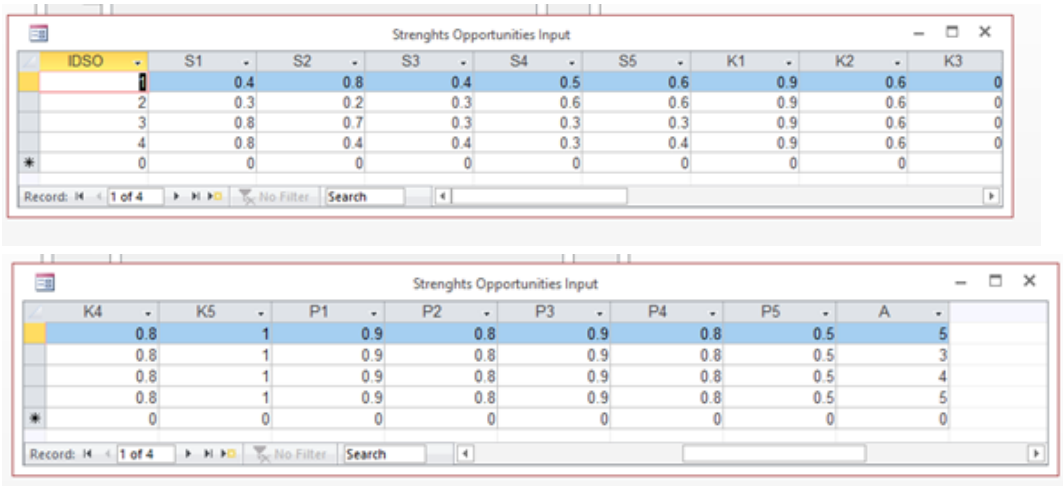

Figure 3. Form for entering initial values Strenghts Opportunities

The basis of the calculation of the displayed program is based on the SQL language. SQL language is a universal language for accessing relational databases. This approach allows data manipulation over databases from software developed on different platforms and different programming languages. This enables the use of universal program code of all budget segments by switching to new software solutions. The following listing shows one of the key segments of the budget related to the SWOT matrix of Strengths Opportunities. The calculation for other segments of the matrix is performed analogously.

The following listing shows one of the key segments of the budget related to the SWOT matrix of Strengths Opportunities. The calculation for other segments of the matrix is performed analogously.

*UPDATE TableStrenghtsOpportunities SET TableStrenghtsOpportunities.MR1= TableStrenghtsOpportunities!A*TableStrenghtsOpportunities!K1*TableStrenghtsOpportunities!P1, TableStrenghtsOpportunities.MR2= TableStrenghtsOpportunities!A*TableStrenghtsOpportunities!K2*TableStrenghtsOpportunities!P2, TableStrenghtsOpportunities.MR3= TableStrenghtsOpportunities!A*TableStrenghtsOpportunities!K3*TableStrenghtsOpportunities!P3, TableStrenghtsOpportunities.MR4= TableStrenghtsOpportunities!A*TableStrenghtsOpportunities!K4*TableStrenghtsOpportunities!P4, TableStrenghtsOpportunities.MR5 = TableStrenghtsOpportunities!A*TableStrenghtsOpportunities!K5*TableStrenghtsOpportunities!P5, TableStrenghtsOpportunities.R1= TableStrenghtsOpportunities!A*TableStrenghtsOpportunities!K1*TableStrenghtsOpportunities!P1 *TableStrenghtsOpportunities!S1, TableStrenghtsOpportunities.R2= TableStrenghtsOpportunities!A*TableStrenghtsOpportunities!K2*TableStrenghtsOpportunities!P2 *TableStrenghtsOpportunities!S2, TableStrenghtsOpportunities.R3 = TableStrenghtsOpportunities!A*TableStrenghtsOpportunities!K3*TableStrenghtsOpportunities!P3 *TableStrenghtsOpportunities!S3, TableStrenghtsOpportunities.R4 = TableStrenghtsOpportunities!A*TableStrenghtsOpportunities!K4*TableStrenghtsOpportunities!P4 *TableStrenghtsOpportunities!S4, TableStrenghtsOpportunities.R5= TableStrenghtsOpportunities!A*TableStrenghtsOpportunities!K5*TableStrenghtsOpportunities!P5 *TableStrenghtsOpportunities!S5*

- IDSO - primary key, ordinal number of the initial value of Sternghts Opportunities
- S1, S2, S3… - initial values of Sternghts Opportunities
- K1, K2, K3… - The degree of impact of the opportunity or danger

- P1, P2, P3…- probability of occurrence of external environment factors
- MR1, MR2, MR3… - Strenghts Opportunities Subtotal
- R1, R2, R3… - Strenghts Opportunities The sizes of other pairs are entered and displayed in the same way.
- SUM – Sume Total

The sizes of other pairs are entered and calculated in the same way as in Figure 4.

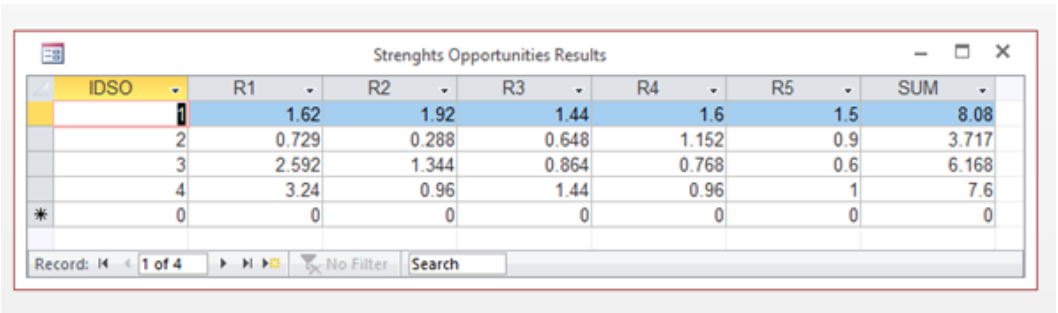

Figure 4. Form for showing the final results of Strenghts Opportunities

4. Conclusion

The importance of the quantitative SWOT matrix is unquestionable in strategic decision making. The quality of decisions made in this way has significantly improved. With the software support of the analysis of the environment presented in the paper, the processing time of the input data is shortened, possible calculation errors are eliminated and the number of input factors is no longer a burdening element. Considering such an approach to SWOT analysis, it is clear that the use of SWOT analysis conducted by organizations in the Republic of Serbia is only the initial part of the entire SWOT matrix and definitely does not give clarity of priorities in strategic action. Software support for this way of applying the SWOT matrix, which mathematically shows the results of the impact, intensity in the interrelationships of factors, should facilitate the application of this analysis and bring it closer to a larger number of organizations.

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