APPLICATION OF AHP BASED DSS FOR STRATEGIC PLANNING OF LOCAL SUSTAINABLE DEVELOPMENT

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ABSTRACT

Local Agenda 21 (LA21) is a process of strategic planning where the three sectors implement sustainable development (SD) at local level. Application of decision support systems (DSS) in this process increases its effectiveness and efficiency. More specifically, DSS can be used in decision-making processes in LA21, which are usually long, with numerous meetings and serious discussions about priority setting. By application of the developed DSS in this research, these problems are eliminated.

The authors are experienced in the field of LA21 implementation and they have sufficient knowledge about DSS and the opportunities they offer, especially with application of AHP methodology. On the other hand, in the authors' analyses of researches they have not found the application of DSS with AHP method in implementation of LA21 methodology. Taking this in consideration, this research was initiated, and an AHP based model and appropriate DSS software was developed.

The created software was tested and applied in a real situation for preparing the Strategy for regional development between the municipalities in four Balkan countries, within the frame of the project, approved by the European Commission. The results show that decision makers are satisfied with the application of DSS based on AHP methodology in strategic planning processes and decision-making.

Keywords: Social issues application, GDSS, AHP, LA21 strategic planning, decision making

1. Introduction

Strategic planning is the process of identification of problems, general goals and specific objectives of organization and providing the necessary range of decisions for achievement of these objectives. Strategic planning in local government is a creative process with which local community plans and

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imagines a desired future and develops the necessary resources, procedures and operations to achieve that vision. Sustainable development is development that meets the needs of present generations without compromising the ability of future generations to meet their needs. The essence of the concept is the belief that social, economic and environmental goals should complement and be interdependent throughout the development process. Actual practice of sustainability will be achieved by incorporating principles of sustainable development in the strategic plan for sustainable development of local government. Local Agenda 21 (LA21) is a strategic planning process, accepted by the UN, which aims to implement sustainable development through partnership cooperation of all stakeholders. The research, undertaken by ICLEI in 2001, showed that 6416 local authorities in 113 countries have expressed an official commitment to LA21. Decision Support Systems (DSS) are computer-based information systems that support decision makers and are faced with ill-structured problems through interaction with data and models for analysis. DSS ensure continuity, consistency and efficiency in decision-making and therefore they can be used in the process of creation of a local strategic development plan especially for determining and ranking of priority problems and actions in the frame of the plan. These priority rankings require multiple decision-making by different teams, which mean numerous meetings, characterized by long discussions. Given that the application of DSS greatly simplifies and accelerates decision-making, this research was initiated. In the frame of it, an appropriate AHP model was established and practically implemented with specifically developed software in the realization of the international regional project in the Balkans, which included four municipalities from Macedonia, Greece, Albania and Bulgaria.

2. A review of published researches

From the analysis of previous researches, it can be concluded that there is a widely used method of AHP, in different fields and regions in the world. However, the authors have not met the application of AHP-based DSS in local government in the field of strategic planning of local development according to LA21 process. Another important conclusion is that commercial programs are commonly used as decision support tools. The previous, and the fact that in Macedonia authors have not met the application of DSS in any field, were primary motives for this paper: creating an AHP model and its applicable software, designed for the needs of a particular research, which will also have wider application.

3. Description and application of the AHP model for DSS

The AHP general model for ranking priority problems in the implementation of the strategic planning process of local sustainable development with DSS is defined in the frame of the paper. Decision making in strategic planning means existence of one goal and many criteria. Therefore, as the most appropriate, DSS was modeled and designed with MADM (multi-attribute decision making) model, based on the AHP mathematical method. The process of developing AHP model consists of three phases: intelligence, design and choice. The goal, criteria and sub-criteria for problem priority ranking are given with the hierarchical structure shown in Figure 1. The goal is "Setting local priority problems" resulting from the uncontrolled exploitation of resources and the unmet needs of citizens in the municipality. To get a list of problems, stakeholders should prepare Lists of resources and needs.

A List of resources is needed to examine the quantity and quality of the natural, social and economic resources in the municipality. In terms of sustainability, human needs are classified into four categories in the economic, environmental, social sphere and the sphere of governance. Since the citizens' opinion is very important, a research with questionnaires has to be conducted to determine the List of problems, i.e. alternatives, which will be then prioritized.

3.1. Criteria generating
According to the LA21 methodology, the hierarchy of the criteria is:

- &so; *Severity* of the particular problem, defined by two sub-criteria: *state* (specific data and facts that define the current state of this particular problem), and *pressure* (specific data that describe the assumed dynamics and change of the state of the problem, i.e. its future deterioration).
- &so; *Size (Dimension)* of the problem at issue defined by number of inhabitants and/or geographic area that are affected by this particular problem.
- &so; *Negative Impact* of the problem covers the impact of specific problems on creating additional problems in the municipality, or emphasizing the actual ones.
- &so; *Public Opinion* of the problem defined in the opinion of representatives from various sectors for the present problem, which is defined by three sub-criteria for the opinion of representatives of: *Local Government, NGOs/COs (non-governmental/civil society organizations),* and *Business sector.*

Public opinion is obtained through surveys and their results, as averages of individual scores of all surveyed participants, are taken into account with their specific values in the comparisons as a quantitative criteria.
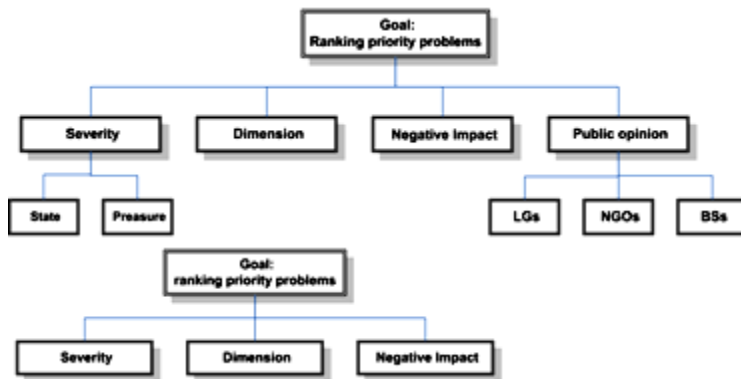
Figure 1. General AHP model of criteria for prioritizing local municipality problems.

Figure 2. Simplified AHP model of criteria for prioritizing local municipality problems.

This hierarchical model of goal, criteria and sub-criteria, according to the LA21 process, (given in Fig. 1) can be applied to any list of problems, as alternatives. For simplified application of the model, when it is applied by a large number of participants, only three criteria can be taken into account, according to the simplified AHP hierarchical structure shown with Figure 2: Severity, Size and Negative impact.

Criteria "Public opinion" may be taken into consideration by conducting a survey as a starting point in forming a List of problems that need to be prioritized with AHP method. Then competent persons define the weights of the criteria through comparisons of the criteria in pairs using the AHP method. The next step is defining the weights of the evaluators, which can be different or the same. After that, evaluators can conduct the evaluation with DSS software application.

3.2. Defining of alternatives and application of the AHP model and software for decision making in real terms

A simplified variant of the specific AHP model developed together with appropriate software were applied in real conditions for preparation of the Strategy for regional development in order to identify priority fields of problems in four rural municipalities in Macedonia, Greece, Albania and Bulgaria within the International project approved by the European Commission through EACEA Agency.

Activities included four educational seminars with workshops. Analysis of current situation began with consideration of SWOT analysis of the strategic documents of the four municipalities within the first seminar. After that, according to LA21 process, a survey with 50 questions was conducted. This was needed for analysis of all problems in the field of economic, social, environmental issues, health, education, culture, sport and recreation, as well as in the field of governance. From the results of the

questionnaires that were completed by 155 respondents, an average of 35 to 40 per municipality (all mayors, decision makers, employees in public administration, representatives of COs, experts, and citizens), problems in local communities given in Table 1 were identified. At the second seminar in the municipality of Pustec working sessions were realized in order to introduce the participants with AHP methodology and DSS. The results of the survey were presented, too, and after a joint analysis of local priorities of municipalities, participants approached to grouping the problems identified in five strategic regional priority areas (Social and Health, Agriculture and Environment, Culture and Sport, Rural Tourism and Economic Development with Infrastructure) for future actions that are of common interest to the four municipalities.

Later, at the third seminar in Borovan, Bulgaria, decision makers from 4 countries applied the software for determining the priority areas of problems in the regions. Through group work, evaluation and analysis of the results was done and a final list of priorities was identified, followed with development of the draft Strategy. In addition to mayors, from all four municipalities involved in the project, evaluators included 16 other decision-makers and experts from each city, as major deputies, executives of the department for development and Public enterprises managers, heads of developmental project departments, heads of departments for local economic development and legal services in the municipalities, civil engineers, tax officers, lawyers and representatives of COs and citizens.

For simplified analysis, taking in consideration the number of participants, the involvement of representatives from 4 countries, and the conditions for the application - a joint seminar, a simplified AHP model with three criteria for priorities ranking was applied. The opinion of representatives of all sectors was a base in the formation of the list for prioritization. In the present model, the goal is "Setting the priority fields of action in the region, i.e. in the involved municipalities." Five priority areas as alternatives to be ranked are the following: Social issues and health, Development of agriculture and environmental protection, Economic development and infrastructure (with the development of modern transport and technical infrastructure), Rural tourism and Culture and Sport.

Figure 3. Hierarchy of the specific AHP model.

Based on the aforementioned AHP model a software tool in Microsoft.NET platform was developed. More specifically, in development of Strategy, ASP.NET was implemented. It is comprised of three software components that manage two databases. Software can be applied for an individual and group decision making and can prioritize alternatives under simplified AHP model criteria. However, this software can generally be used for modeling different AHP models for the prioritization of other alternatives with other criteria.

All decision makers have specific knowledge that make them competent to assess which are the priority fields that need to streamline the activities of the municipalities involved in the project. Detailed instructions for the software tool were previously given to the participants. 5 groups of 4 participants, including: Mayors, representatives of local governments, local project coordinators, experts and representatives of NGOs and citizens were formed. After defining the goal, criteria and sub-criteria,

representatives of decision makers (experts) from all countries determine the weight of all criteria by applying AHP method (Figure 4), as well as the weight of all groups of evaluators, who have the same values in this project.
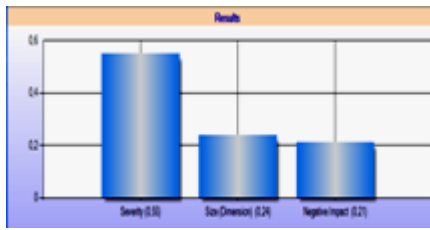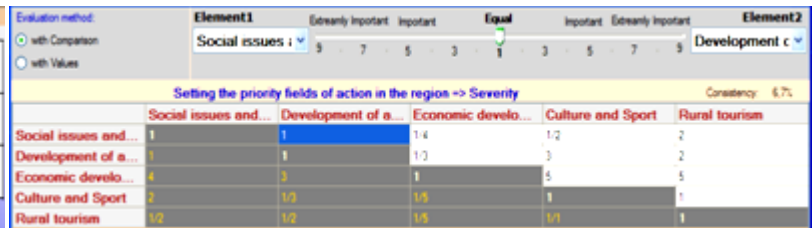

Fig. 4. Weights of criteria   Fig. 5. The evaluation of one group according to one criterion

Table 1. Weights of criteria

Criteria	Severity	Size (Dimension)	Negative Impact
Weights of criteria	0,55	0,24	0,21

In the next step group-members filled matrices with comparisons between each alternative in relation to all criteria, taking in consideration local problems of each municipality, as well as data from the strategic documents of 4 municipalities. An assessment of the groups in relation to one criterion is given in Fig. 6. The decision-maker is allowed to change the preferences (values) of his/her grades and test the results as to whether the level of inconsistency is very high (it must not be above 0.10). Evaluation of this group in relation to other criteria and evaluations of other groups in terms of all criteria are similar.

3.3. Analysis of the results

In this way, separate evaluation results of each group are received first (Figure 6), and then are combined into a team model, which synthesized the following priorities (Figure 7) (Servini Z., Nedelkovski I. and Servini J., 2011): 1. Economic development with development of modern transport and technical infrastructure; 2. Development of agriculture and environmental protection; 3. Social and Health; 4.Culture and Sports; 5. Rural tourism.
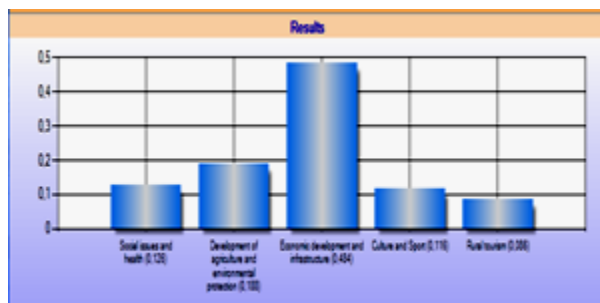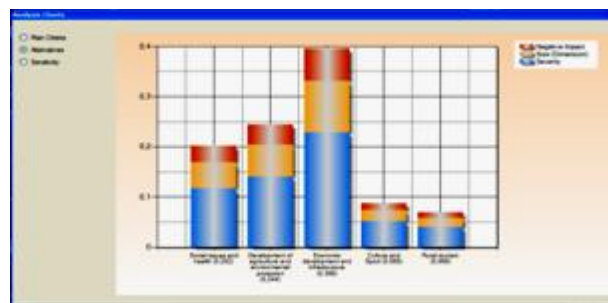

Fig.7. Final evaluation of 5 groups

Fig. 6. Individual assessment

Tab. 2 Results of separate and group priorities

Groups Alternatives	G_0	G_1	G_2	G_3	G_4	Aggregate priority
Social and health	0,130	0,135	0,174	0,166	0,403	0,202

Agriculture dev. and environmental protection	0,174	0,183	0,252	0,325	0,289	0,244
Economic development and infrastructure	0,480	0,459	0,459	0,394	0,186	0,396
Culture and Sport	0,098	0,141	0,066	0,063	0,073	0,089
Rural tourism	0,118	0,082	0,049	0,052	0,049	0,069

From the analysis of the results it can be concluded that although there are differences in preference of individual assessments, all groups accepted the aggregate result since it was reached by application of group DSS, which they actively participate in. This achieved complete consensus. Sensitivity analysis with respect to all three criteria, which is extremely important, was conducted within the analysis of the results.

On the fourth meeting in the municipality of Kufalija, Greece, the Strategy was accepted and the participants commented on the characteristics of the software and they gave suggestions for its improvement. Other applications of the software to support decision making, such as opportunities for prioritizing actions and projects, were tested.

4. Conclusion

The problem of prioritizing the fields, where the priority problems in the municipalities of the four Balkan countries belong, was determined by using one-goal and multi-criteria decision making modeling. An AHP model was developed and validated during the process of group DSS implementation. The opinions of the evaluators, including written opinions of the Mayors of the four municipalities, in terms of regional priorities, is that the priority, obtained with the software, is fully acceptable for them and increase the effectiveness and efficiency of decision making, because it is real and it is made for the shortest possible time and without long and exhausting discussions, and, since they were all involved in assessment, considered that the final priority really reflects the real situation in the Balkan region in their countries. There are strategic documents of the involved municipalities to support this, where priorities in each individual municipality are determined. This paper represents a modest contribution to the development and application of DSS in the strategic planning of local sustainable development. With its development a series of new opportunities for research in this area are opened.

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