UNIVERSALLY APPLICABLE CONCEPT FOR SPATIAL DECISION SUPPORT, DEDICATED TO STAKEHOLDERS IN SPATIAL PLANNING, WITH FOCUS ON TRAFFIC SAFETY

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Abstract

Urban and regional development have proved to be a recipe for economical growth, however uncontrolled development bears risks for population and environment. Today's technology enables early warning, prevention and rescue operations however the sustainable spatial planning can be considered as one of the most effective measures. Spatial planning measures require expert analyses and political decisions, therefore it can be considered as a consistent process. This article presents the concept for a map based universally applicable decision support in spatial planning, which will focus from the thematic point of view to traffic safety and will set up into centre of attention an Executive Information/Support system (EI/SS), for political decision makers.

Due to this focus, the concept bases on theory and the methods of the decision-making processes, but also on cartographic visualization and communication as well as on the theories and methods of spatial development and infrastructure, traffic planning and management, with the aim of prevent the oncoming disaster. The presented EI/SS will give the decision maker the opportunity to choose the instantaneous and best solution for the region and the population in a factual, comprehensible and non personal way.

1. Introduction and motivation

Urban areas which attract numerous people can be considered ideal places for interaction, exchange of goods, services, information and knowledge. Parts of urban areas such as airports, train stations, express highways or certain districts are highly frequented locations and represent mobility nodes which carry potential risks regarding traffic safety.

The phenomenon of increasing exchange possibilities in mobility nodes is contrary to the risk potential which the traffic itself represents. Such a phenomenon can be observed predominantly in strongly expanding cities and regions, as for example the new Member States of the European Union in Eastern Europe. Traffic safety is more than the strict legislation and rigorous application, a corresponding land use planning appears as inevitable, as it can be considered in the responsibility of territorial authorities, i.e. the national state, regions and towns. Land use planning within this context can be

considered as decisions for development (measures/strategies) and location planning in order to enable the exchange of goods, services, information and knowledge.
Within the sphere of territorial authorities the following stakeholders, who influence the decision making processes, can be identified:

- Experts/technocrats, who are planning and offering solutions,
- Civil servants, who participate in the planning process and implementation, and
- Democratically legitimised politicians, who decide on proposed solutions, approve financial resources and determine priorities.

Therefore it is possible to conclude that spatial planning, and traffic planning in particular, can be considered as political entitlement and governmental competence (Bökemann 1999, S.14) and principally formed by the stakeholders, experts, civil servants and politicians.
Core point of this publication is a concept for spatial decision support, which shall support traffic planning in development (measures/strategies) and location planning, aiming at increasing of traffic safety. Target group of the concept, and its output, a software-orientated executive information support system (EI/SS), are decision makers in local and regional authorities. The software shall offer the possibility to take the decisions based on knowledge and evidences. Evidenced-based planning is considered to be also an advantage for political decision makers, not only to justify the investment of funds but also to allocate them in order to achieve better results. Moreover, measures for traffic safety would not only reduce accident costs and costs for the healthcare system, but would finally also save human lives.
A territorial authority which was interested in deciding evidence-based on this topic is the Prefecture of the Brasov County, Romania. The project start was based on an agreement between Rumanian Ministries for Interior and Transport, which was targeting to reduce traffic accidents and to improve the quality of rescue missions after accidents.

2. Significance of evidence-based decisions in spatial planning

Space-orientated projects require for their implementation public-administrative decisions. Especially the process of implementing development and location projects, including projects for the traffic planning, require a number of steps, ranging from the idea, to the planning itself, the political decision up to the realization.
In general, decisions over the implementation of development and location projects are connected to decisions over alternatives. In case of locations projects alternatives are often related to location conditions, while in case of development decisions are connected to different concepts. The alternatives themselves have to be grounded on specific plannings.
The theoretical foundation for evidence-based decision processes bears on decision theories. By using the formalized decisional models, the decision maker shall be informed and decide interactively on the sectoral plannings developed by the experts. This method of decision-making is in conformity with the principles of “Good Governance” and “Evidence-based policy”, propagated by international organizations

such as the European Union (European Commission 2001) and the United Nations (ESCAP 2007). The basics of the "Evidence-based policy" can be led back to the publications of the British Government in 1999, „Modernising Government" (Cabinet Office 1999a) and „Professional policy making for the 21st Century" (Cabinet Office 1999b). The principles of "Evidence-based policy" are more specifically and deeper defined as those of the "Good Governance". They refer more to the political evolutions in Europe and especially criticize the lack of transparency and knowledge in the decision-making process, but also the lack of closeness to citizens. Thus decisions of political decision makers shall be rather based more on scientific facts than on their dogmas.

As a direct consequence, in order to fulfil the requirements of the principles, a of a concept for a decision support system was need, which shall enable stakeholders of the spatial planning to decide evidence-based. By expressing their point of view with regards to certain space-orientated problems and their evaluation of solutions, a step forward to political decision making can be assured.

3. Evidence-based decision making processes for stakeholders of spatial planning

The basics for the explanation of decision-making processes trace back to Nobel laureate Herbert A. Simon (1978), one of the leading theoreticians in the field of artificial intelligence. Simon's main question, regarding decision making processes was: "How do people solve problems and take decisions?", which led to the theory of "Bounded Rationality". According to Simon (1960) a decision is composed of two steps, the searching process for alternatives and the selection. Simon has demonstrated in a phase model that the decision-making process proceeds in four phases:

1. „*Intelligence activity*": The decision maker is searching the environment for conditions (technical, economical, social, political) calling for a decision,
2. „*Design activity*": Experts are inventing, developing and analyzing possible courses of action (alternatives), based on objectives of the decision maker,
3. „*Choice activity*": Selecting/evaluating a particular course of action from those available by the decision maker,
4. „*Review activity*": Assessing the chosen decision

The phase model of H. A. Simon is suitable for the stakeholders of the spatial planning as politician, civil servants and experts are not forming a homogenous group. They recognize and formulate problems, work or let work out solutions, choose and evaluate alternatives in a very subjective and different way.

Considering the role model of the stakeholders and their competences, an evidence-based decision-making process (according to Simon) can be represented as in figure 1:

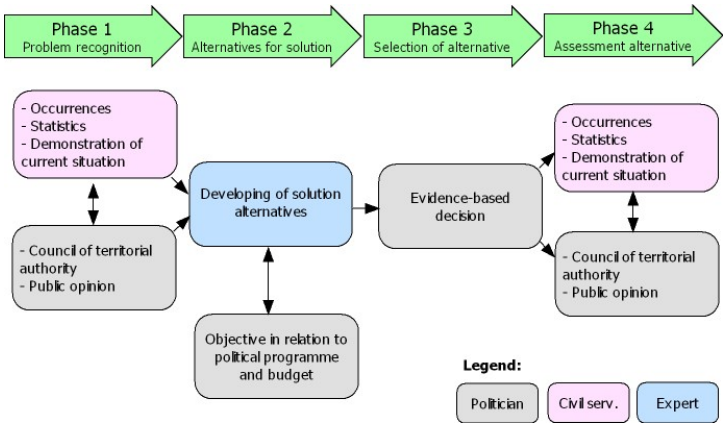

Fig.1: Phase model fort he evidence-based decision making process in spatial planning

Considering the activities of a political decision maker in all four phases (fig.1), it can be concluded that it's the person which is leading the whole process. Thus, the authors considered to focus on the support of the leading stakeholder. By supporting political decision makers, the principles of „Good Governance" and „Evidence-based policy" would be respected. The support shall be offered by means of decision supporting software, based on a general concept. Its characteristics have been developed in a European Union funded INTERREG IIIB project, under the participation of authorities from eight Member States. Among the most important characteristics have been identified:

- Optimization and transparency within the process of decision-making, by using the software as a platform for all the involved stakeholders,
- Economical advantages by analyzing resources and impacts,
- Exchange of planning materials and possibility of communication between the involved stakeholders, by using the software platform, and
- Facilitation of simple evaluation methods for political decision makers.

4. Computer-aided decision support systems for the decision process

As potential computer-aided decision support systems for spatial planning processes, the following systems could be enumerated (for more details see Lechthaler & Todor (2008)):

- Geographic Information System (GIS),
- Cartographic IS (CIS),
- Spatial DSS (SDSS),
- Expert System (ESS), and
- Executive Information/Support System (EI/SS).

Considering the various support systems, it is necessary to identify which type of system fits to which stakeholder, but also to correlation between structure of the problem and the field of application. Therefore, the authors present in table 1, based on Schlenzing (1998), a matrix, which connects structure of problem to frequency of use:

Application area	**Structur**	**Frequency of**	**Choice of decision support**

	of problem	use	system
Tactical operative planning	Well structured	Regular	**GIS (generally: operative software)**
Strategic planning	Partially structured	Irregular	**Spatial Decision Support System (SDSS)**
Crises management	Poorly structured	Seldom, unique	**Expert system (ESS)**
Management	Solution alternatives, variable prepared	Seldom, unique	**Executive Information/Support System (EI/SS)**

Tab. 1: Selection of decision support system in relation to its application

As mentioned above, the current paper focuses on the management application area, an area which requires unique solutions, but nevertheless embed in common concept, which shall be repeatable for different projects. An Executive Information/Support Systems (EI/SS) offers the possibility for democratically legitimate decision makers to be informed in a compact and figurative way about planning realities and complex planning alternatives. The EI/SS incorporates in an integrative system the analytical data and the tools which are necessary for the decision-making process on the management level.

5. The concept for an evidence-based decision making process in spatial planning

On the basis of the knowledge presented in the previous chapters, the authors have developed a general scheme (figure 2) for the evidence-based decision making process, in spatial planning, with focus on development (measures/strategies) and location planning. The practical approach, visualized in figure 2, contains 13 steps, which will be hereafter explained. The complex interactions between the stakeholders are represented by means of colouring.

1. Determination of the needs for a measure: Reality view by the decision maker, influenced by the occurrences and the public opinion.
2. Description of the task and involvement of the experts
3. Acquisition and provision of geometric data, attributes and spatial information, with technical or non-technical characteristics, coming from the reality or from data archives. According to Greve (2007) spatial information are relevant planning information, processed from geometric data and attributes. They are indispensable for the decision-making process.
4. Technical-conceptual analysis, including processing by the experts. This working process contains the geometric data and attributes data procession (technical and non-technical data).
5. Determination of the decisional models and mathematical algorithms, in compliance with the problem definition and adequacy.
6. Development of the software (programming and configuration) for the decision supporting platform, as main tool for communication and decision.
7. Agreement on the planning alternatives, by the leading experts, whereat the political decision maker has later on to evaluate and take the decision.

8. Visual transformation of the GIS processed geometric and attributes data. By applying cartographical principles information are transferred to a cartographic information system (CIS). A CIS is characterized by having spatial information scale-dependent to map information, graphical elements defined and adapted to the output medium (Lechthaler & Stadler 2006). Furthermore a CIS enables the access to different kind of information due to the interactivity of maps, cartograms and model elements with certain content. The system developer has to assure the compatibility between the diverse interactive and multimedia functions and to offer to the decision maker easy understandable cartographic models. Combined with other non-cartographic information they form the materials, coming from the experts and dedicated to the decision maker.
9. The evidence-based decision cognitive and decision-making process of the legitimated decision maker on the planning alternatives.

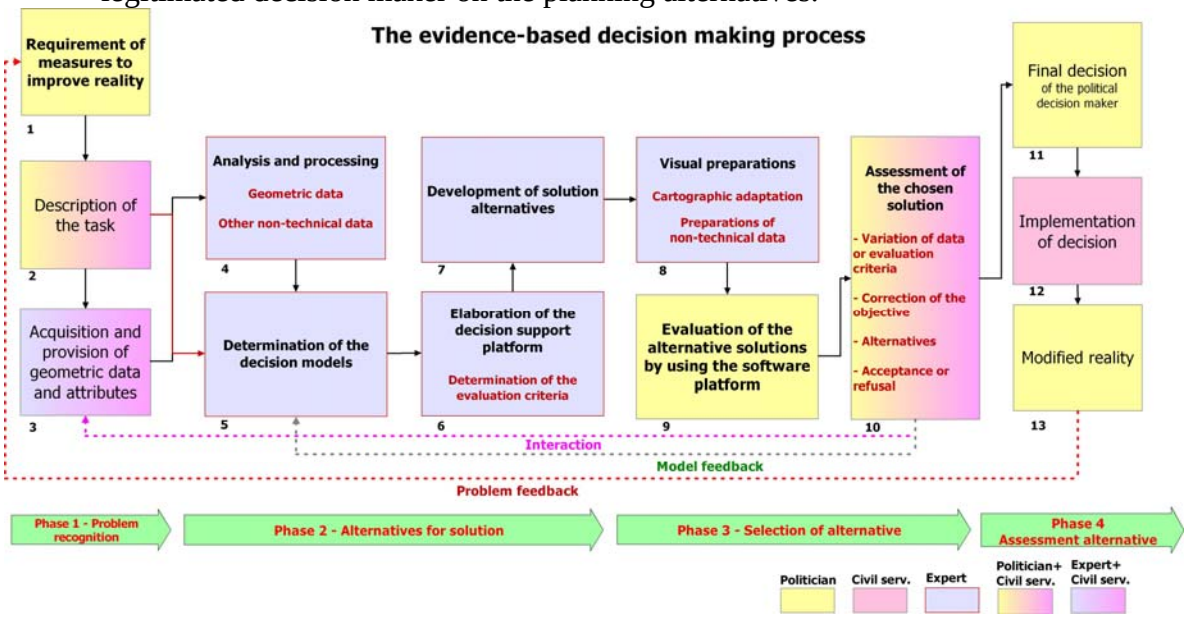

Fig. 2: Concept of the evidence-based decision making process, based Strasser & Todor (2007)

10. During the decision-making process of a politician, the process eventually could be stopped in order to expand the knowledge base, to remodel the targets or the evaluation criteria. Therefore a feedback has to be sent to the experts, to resume work from the 5th step. Do not appear any problems, the process can be finalized.
11. As final step of the interactive decision-making process, the final decision over the alternatives has to be documented. This happens system-orientated, at the end of the process, and by signature of the decision maker over the final document.
12. The decision is to be implemented as a function of the priorities within the territorial authority. It is also necessary to mention that even a final decision can be changed or postponed by a legitimated political leader, independently of the result of the evidence-based decision making process.

13. After the realization of the measure, it is required to reanalyze the modified reality and to assess impacts.

6. The computer-aided decision support platform

The decision support systems, presented in chapter 5, differ according to Schlenzig (1998), Mora (2003) and Lechthaler & Todor (2008) about their conceptual formulation, structure of problems and the frequency of use.
In the opinion of the authors, the platform can be comprehended as an ample instrument which manages the whole decision making process (figure 2). As a consequence, a platform is formed from more computer-aided decision support systems which belong to different types (chapter 4) and can be of different origin (proprietary software, OpenSource or customized solution).
Related to the use of decision support systems in the field, the authors aim to present within the following chapters their work of an Executive Information/Support System for political decision makers, as part of the overall decision platform.

The Executive Information/Support System for political decision makers and its functions

The realized software for the EI/SS contains the essential components such as:

- Graphical user interface (GUI)
- Database with spatial information, expert analyses, planning alternatives and solutions
- Main tools for visualization of the database contains, input and evaluation of the assessment, visualization of interactive question process for the decision maker, visualization of a final protocol, and
- Algorithm for evaluation of the alternatives, in relation to the decisional model (Laux 2003)

Figure 3 shows the GUI of the EI/SS, which the decision maker has to use to evaluate the spatial planning issues. It is formed of:
❶ Visualization of the decision criteria: relevant criteria for the decision maker, containing the analysis and planning issues of the experts.
❷ Window for visualization of a decision criterion: The planning alternatives are visualized by using maps and cartograms, 3D visualizations, multimedia, graphics, texts, statistics. The visualizations are activated from the window❶, whenever the decision maker chooses a thematic criterion.

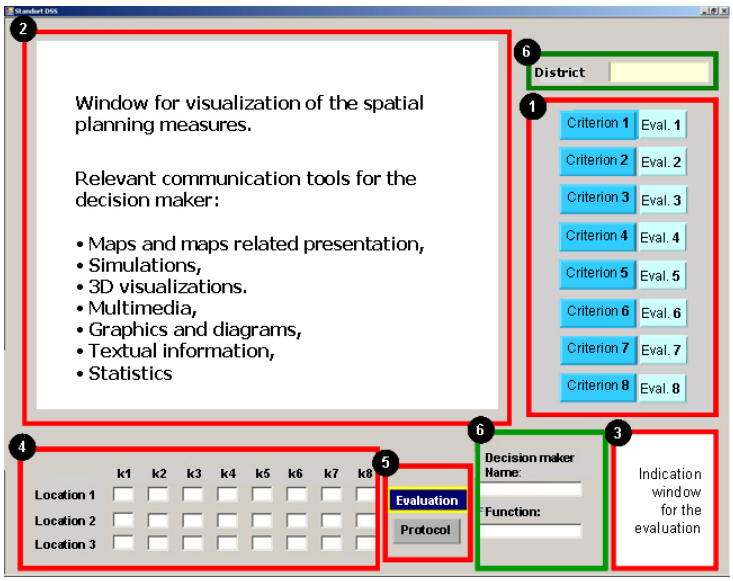

Fig. 3: GUI of the EI/SS

❸ Indication window for the evaluation: enables the questions to the decision maker, which correspond to the thematic criterion ❶ and the visualized information❷.
❹ Valuation box: The place where decision makers give their evaluation for each criterion. Each criterion, belonging to a solution alternative, has to get a value from 1 to 10 (max).
❺ Announcement of the evaluation: At the end of the evaluation, has the decision maker the possibility to get the final result, on the one hand on the screen and on the other hand in a file, as a protocol, that shows the criteria and the evaluation figures.
❻ Fields for identification: Are to be filled by the decision maker. All information about the decision-maker appear afterwards within the final protocol.
The output of the evaluation, which appears as a protocol, showing all the information about the decision maker, its evaluation and the final result provides however also information about the weight of the experts for the criteria. This fact should compensate dogmatic preferences of a political decision maker.

8 The EI/SS in practice, as planning tool for traffic safety

A first use of the concept for EI/SS in traffic planning has been realized in the City of Brasov (Romania). Due to an increased number of traffic accidents within the municipal area, it was necessary to determine the zones of major risks, in order to begin with the re-planning. Two of these zones are pictured on the figure 4. By using the model helicopter, many aerial pictures have been taken, which were useful in planning and demonstration of the problems. Those two exemplary zones show a typical problem for Brasov, having hazardous areas are at the periphery, close to the areas of industry and offices. One of the main reasons which lead to high number of accidents was the conflict of interests between a very fast growing development of the economy, partial uncontrolled development, and the road infrastructure that has not been improved substantially.

Fig. 4: Aerial pictures of hazardous zones, taken by the model heli of GEODIS Todor Ltd.

As a consequent step to a new traffic concept, besides the location analyse, it was also required to classify the types of accidents. The classification has been done according to Knoflacher (2005) and reported the types of accidents and their reasons. In compliance with the concept for a decision supporting system presented in chapter 5, the above presented facts, represent the steps 1-4. The fifth step, the determination of the decisional models and the mathematical algorithms, requires already the implication of different kind of experts, as the coordinator has to understand the finality of the project. As interdisciplinary knowledge is required to realize the project, an ideal coordinator would be a specialist in spatial planning. The interdisciplinary knowledge is considered as essential not only for the 5th step, but also for the following two, the 6th step where the exchange platform for planning data and planning solution is elaborated and the 7th step where the planning solutions and the planning alternatives are identified.
In practice, for step 5, as mathematical algorithms foremost the Fuzzy Logics and the multi-criteria analysis (Rinner 2007) are adopted:

- The Fuzzy Logics i.e. used in SDSS modules, that correlates opposed spatial characters.
- The multi-criteria analysis, i.e. used in EI/SS, allows modelling a system, suitable for a political decision maker to evaluate criteria. In the presented case by the authors it has been used an algorithm with goal weighting.

Finally, it is to mention that within the process of implementation (step 8), due to the professional competences of cartographs, the map materials are prepared in correspondence with the visualisation principles for displays (Lechthaler & Stadler 2006).

9. Conclusions

The universally applicable concept of decision support in spatial planning, presented within this paper, has been specifically adopted for traffic planning, in order to reduce acute problems of traffic safety in highly agglomerated places in an Eastern European city. The main goal was to bring transparency within the process, achieving the

standards of the “Evidence-based policy” and “Good Governance” by implementation of an overall decision-making concept and as tool of a software platform. Mainly it was focused on an Executive Information/Support System (EI/SS), used at the end of the decision-making process in order to transport the information and alternatives from the experts to the political decision makers and to offer them a systematized way to express their opinion. As critics and outlook, the authors have to conclude that this process is only suitable to considerable spatial planning projects, due to complexity and costs.

10. Acknowledgement

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