TADEJA JERE LAZANSKI
College of Tourism, Slovenia
MIROLJUB KLJAJIĆ
ANDREJ ŠKRABA
Faculty of Organizational Sciences, University of Maribor, Slovenia

A CONCEPT OF A MULTI-CRITERIA DECISION-MAKING SYSTEM IN TOURISM, USING MODELS OF SYSTEM DYNAMICS

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Preliminary report

Tourism is a type of inter-organisational system with global and local properties. Problems are defined softly and phenomena are uncertain. There are demands for fast and integrated decisions for guest satisfaction as service users and tourism organisations as service providers. There are many different methodologies and methods that master softly structured problems. Here one encounters methods of systems dynamics and systems thinking. These tools were first brought into force in the educational and training area in the form of different computer simulations and later as tools for decision-making and organisational re-engineering. System dynamics models are essentially simple and can serve only as describers of the activity of basic mutual influences among variables. Attention will be paid to the methodology for parameter model values determination and the so-called mental model, which is the basis of causal connections among model variables. Thus, a connection between qualitative and quantitative models will be restored.

Key words: tourism, organisation, multi-criteria decision-making, system dynamics.

1. INTRODUCTION

Tourism is a relatively recent socio-economic activity, encompassing a large variety of economic sectors, players and academic disciplines. The complexity of its composition makes it inherently difficult to develop universally acceptable definitions, which would help to describe it conceptually (Fayos Sola, 1997). The rapid development of information technology, especially the Internet, has also caused change in organisational systems. Their structure has become flatter, more open and more flexible with new interconnections. The way of work as well as borders and organisations of systems has been changed.

The main properties and driving forces of contemporary organisation are information processing, decision-making and learning. Typical of such organisations, the market environment for tourism is becoming increasingly like this. Problems are

defined softly and phenomena mostly uncertain. On the other hand, turbulence in the world market is demanding on the entire service industry's flexibility and reaction time. There are demands for fast and integrated decisions and guest satisfaction as service users and tourism organisations as service providers. It requires decisions, frequently reflecting opposite interests. Thus, an excellent methodological approach to these problems is urgently needed.

There are many different methodologies and methods, which try to master softly structured problems. Here one encounters the methods and tools of systems dynamics and systems thinking, which became common management tools in the 1990s (Senge1994). These tools were first brought into force in the educational and training area in the form of different computer games and later as tools for decision-making and organisational re-engineering.

System dynamics models are essentially simple and can serve only as describers of the activity of basic mutual influences among variables. These models can be excellent learning tools but not tools for daily use. One must find a compromise between simplicity, limited usefulness and complexity. One will pay the attention to the methodology for parameter model values determination and the so-called mental model, which is the basis of causal connections among model variables. Thus, one will restore a connection between qualitative and quantitative models (Rosenhead, 1989). In this article, a critical analysis and evaluation of the methodologies will be attempted and, thus, applied to a development model to tourism.

2. SYSTEM SIMULATION METHODOLOGY FOR DECISION-MAKING SUPPORT IN A BUSINESS SYSTEM

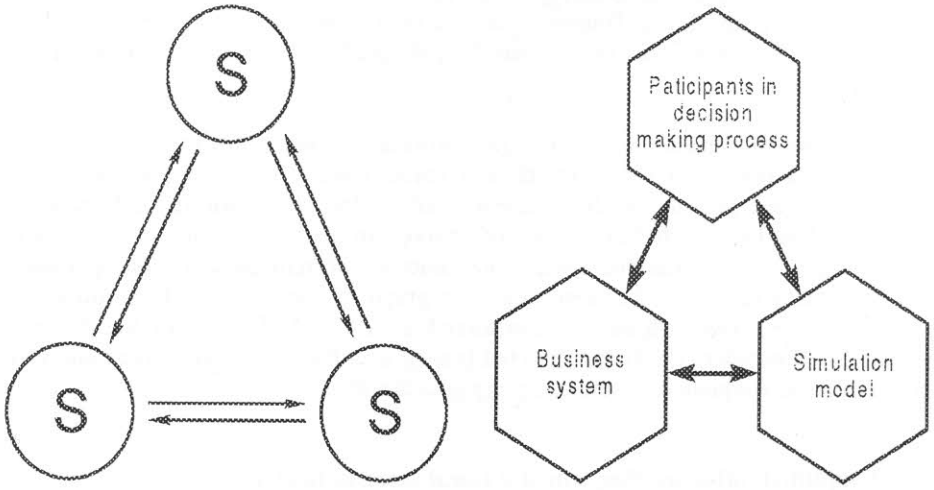
The decisions that include a wide variety of financial, technical and logistical resources require simulation by decision-makers before they are put into action or production (Kljajić, et al., 1998). The decision-makers in the business process are supported by a simulator, which enables decision testing to be an integral part of a business plan. As in all organisational systems, subjective factors such as human skills and creativity play an important role in successfully solving problems. Teamwork plays the most important role in the process of achieving the optimal decisions.

A simulation model included in a user-friendly simulator enables the decision-makers to analyse different simulation scenarios. The implementation of the Group Support Decision System (GDSS) enables the participants in a decision-making process to test different business scenarios and share a common view when considering a problem. Later, the indirect effects of testing scenarios can be understood in the environment without risking direct implementation into a production process.

Use of simulations as a base for certain decisions gives a new value to anticipated information, which facilitates the adapted nature of the decision-making process. The main paradigm of problem solving via simulation is shown on Fig. 1 a) and b). The entities Simulation, Scenario and Selection represent a way of problem solving, while fig 1b) represents relations among participants (decision makers), the

business system and its simulation model. The simulation approach seems to be one of the better methodologies used to achieve and anticipate information for decision-making in enterprise systems.

Fig. 1.
a) Simulation, Scenario and Selection, b) Simulation methodology determination with participants' involvement



a) b)

Roughly speaking, it means the concepts of state, goal, criteria, alternative and the state of nature are connected in a dynamic model interacting with decision-making groups. The business process was designed on the concept of the state-variable approach. It signifies a quantity, which represents the main entity relevant for decision-making at the top and operative level, for example: raw material storage, final product storage, backlog, finance, production tools, etc. Therefore, the system for decision assessment has been organised in two hierarchical levels. The model at the top level is used for the assessment of enterprise strategy. At the bottom level, the model is used for discrete event simulation, necessary for operation planning and testing of production performance.

The concept of state is convenient for achieving harmony among different levels throughout the whole system. In a practical sense, this means that when the discrete-event process is considered, variables are considered as entities as the level and rate in the system dynamics SD when the process is considered continuous. The proposed approach supports man-machine interaction in operational planning, and the evaluation of the strategy (Kljajić, 2000).

3. CAUSAL LOOP DIAGRAM OF TOURISM SIMULATION MODEL

Fig. 2 represents a causal loop diagram CLD of tourism macro-model, which is the base of a simulation model (Kljajić and Jere Lazanski, 2001, Jere Lazanski, 2002). Gross Domestic Product (GDP), Tourist Population, Global tourism market etc. It represents a set of entities. The directed branch represents the flow between entities. In other words, Fig. 2 represents the directed graph of the system. On the outline, one can find the polarity of the causal loop and estimate the qualitative trend of the system behaviour. For example, the Quality of Service, Tourist Population, Local Tourism Market, Crowding and Local Tourism Market loop represents negative feedback and the regulation of quality. This means that desired Quality of service is a function of strategic planning.

The tourism market's growth is proportional to quality of service, but quality of service is dependent on investment and attractiveness of the region, which is opposite with the growth of the tourism market due to crowding and ecology devastation. This loop is the basis for all other loops in the system, most of which are positive loops. In the example, similarities among different methods of operating complex systems can easily be seen: cognitive graph or semantic graph or influence diagrams. If the above entities are considered as a Level (Stocks) in the System Dynamic SD (Forrester, 1994) and directed branch as a flow between Levels, one can derive a difference equation for the computer simulation.

Fig. 2. **Simplified influence diagram of a Local tourism model**

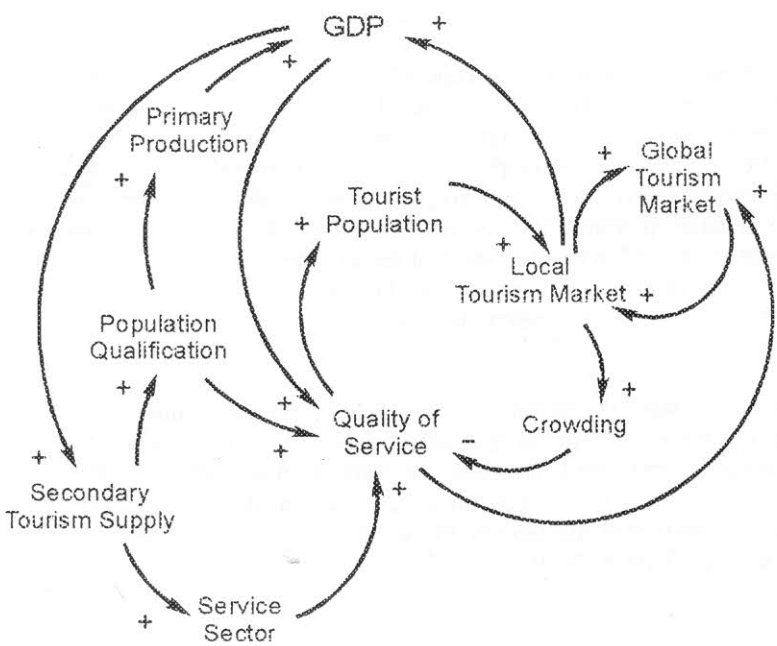
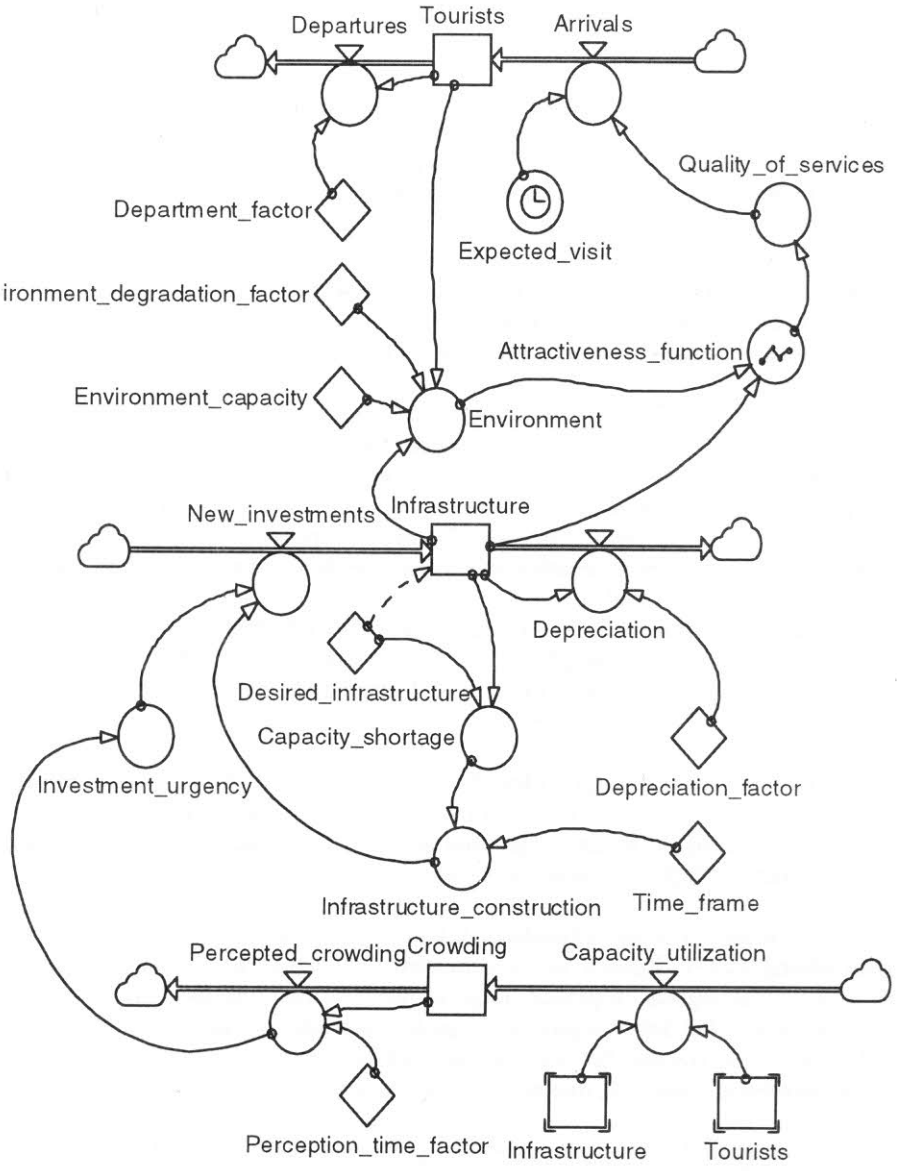


Fig. 3 represents SD diagram of a tourism macro-model. From this diagram, one can derive the dynamic equations that are necessary for a computer simulation. The process of parameters identification and model validation are in progress.

Fig. 3. **SD diagram of a tourism simulation model for decision support**



4. A CONCEPT OF A DECISION-MAKING MODEL IN TOURISM

The core of the business system simulator is a simulation model. The problem solving method with simulation model follows standard steps: state analysis, development of causal-loop diagrams, writing of the model's equations and model implementation. Particular scenarios that form and determine a tourist market in a certain environment are tested on simulation system. A simulator is connected to the GSS (Group Support System). The participants using GSS work directly with the system simulator. A system simulator is connected to a database necessity for simulation model activation.

Simulation results are evaluated both with the group decision-making support system and with expert systems. In all of this, the understanding of the system increases. With the described model, the experimental loop on a simulation model has been finished with the help of system simulator and scenarios ranking. Elements of the decision-making support system:

- Powersim – a tool for the construction and use of a simulator
- Ventana Group Systems– Ventana- group working support system
- DEX – a shell of an expert system expert
- Expert Choice – evaluation with the AHP method

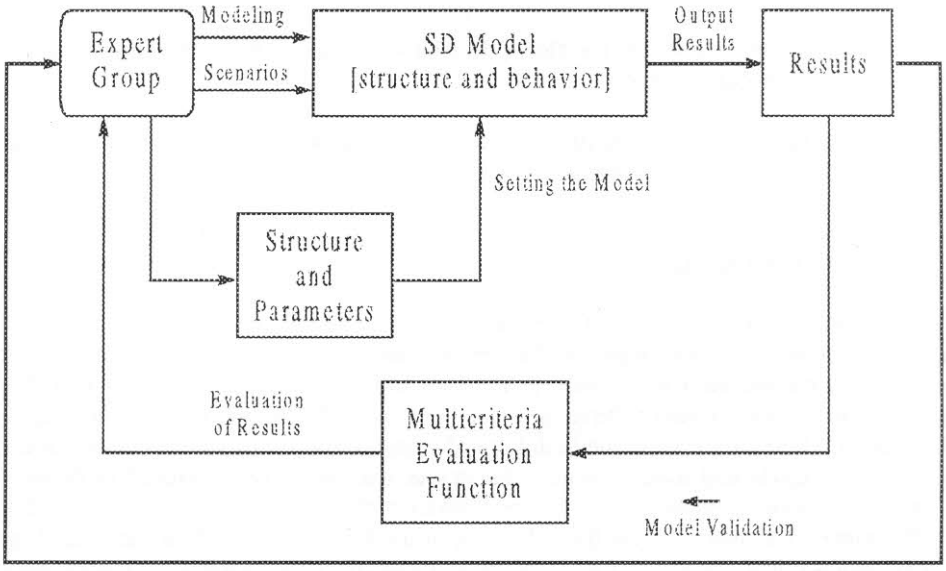
The implementation of above described methodology is shown in Fig. 4. It presents the principle scheme of simulation system for decision assessment in tourism. Modelling and scenario determination represents a knowledge capturing process in the form of the structure and behaviour of the model. Once the model is defined and validated, experimentation with different scenarios is possible. The expert group determines the set of different scenarios, which represents the possible future action in the real system. The results gathered as the output of the model are evaluated with the multicriterial evaluation function. At this stage, many different multicriterial evaluation methods may be used from weighted average (Vincke, 1992) to the Analytical Hierarchy Process (AHP), (Saaty, 1990) and Expert systems (ES) (Rajkovič and Bohanec, 1991).

Information feedback provides the expert group with the possibility to creatively determine a new set of scenarios and multicriterial evaluation functions relating to the given situation. Simulated and actual performances of the system are compared in order to adapt the strategy according to changes in the environment.

Implementation of the simulation system enhances learning processes (David and Richardson, 1997). Results are continuously mediated to the expert group, providing an informational feedback loop in the learning process, which has a significant impact on the decision process, as preliminary analysis has indicated.
Figure 4 shows the interaction between the business system and the people involved in it – the participants in a decision-making process and simulation model.

The participants in a decision-making process are a part of the tourism business process. The model can be use as a basis for accepting business decisions.

Fig. 4. **The principle scheme of simulation methodology for decision-making support in enterprises**



During the experiment, a group decision-making tool was used: the Ventana Corporation's A Group Systems. The tool is promoted as being helpful in the following activities:

- Brainstorming
- Data-collecting
- Formation of registers
- Idea-ranking
- Voting
- Making reports

Work with this tool is anonymous, which enables a greater flow of ideas and reduces unwanted influences. The participants become more relaxed since no one knows where the ideas come from and thus creativity is released; this simply would not be the case in the more "classical" ways of working. The work time decreases and the efficiency of participants increase. The final result is better as the decision becomes a group decision with which conflict between polarised groups is minimized and a consensus is achieved for the development of further actions. Present opportunities and future needs for this kind of decision- making system must be mentioned. A holidaymaker can play a dual role on his vacation as a creative worker with distant work. For this purpose, a tourist organisation must provide him with high-quality information systems for internet, intranet, teleconferences, group decision support systems, GSM and other means. An important role can be given to expert systems and virtual wizards.

A decision-making support system must satisfy both tourism service users and tourism service providers:

1. Tourism industry decision making for rational and excellently provided service together with the participation of holidaymakers and...
2. Enabling a system for global decision-making and different working areas for holidaymakers.

Therefore, one can include tourism organisations into inter-organisational systems with local and global elements.

5. CONCLUSION

This paper has attempted to present a concept of meaningful use of a system of simulating methods, techniques and expert systems as a functional part of decision-making and participation in tourism. In the contemporary world, we can see that the problematic situations encountered are complex as well as poorly structured and formulated. Therefore, a good methodology of systems approach is a necessity. There are many methods and methodologies that try to master softly structured problems. Methods and tools of system dynamics and systems thinking, which were used in the 1990s primarily as management tools, have been used. These methods are still used in newly independent countries for developing faster decision-making processes and successful teamwork building. Finally, yet importantly, a causal loop diagram of a local tourism model was developed as well as its simulation model. SD methodology was used. The work on model testing and validation are in progress.

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Sažetak

KONCEPT MULTIKRITERIJSKOG SISTEMA DONOŠENJA ODLUKE U TURIZMU, UPOTREBOM MODELA DINAMIKE SISTEMA

Turizam je vrsta inter-organizacijskog sistema sa globalnim i lokalnim svojstvima. Problemi su jasno definirani, a pojave su neizvjesne. Potrebne su brze i sveobuhvatne odluke u svezi zadovoljstva gosta kao korisnika usluge i turističke organizacije kao dobavljača usluga. Postoje mnoge različite metodologije i metode koje brzo ovladavaju strukturalnim problemima. Ovdje se sukobljavaju metode dinamike sistema i sistema razmišljanja. Ovi alati uvedeni su prvo u područje obrazovanja i usavršavanja u obliku različitih simulacija na kompjutoru a kasnije su služili kao alat za donošenje odluka i organizacijski re-inženjering. Modeli dinamike sistema su u biti jednostavni i mogu poslužiti samo za opisivanje aktivnosti uzajamnih temeljnih utjecaja među variabilama. Posvetit će se pažnja i metodologiji za određivanje vrijednosti modela parametra i takozvanog psihičkog modela, koji je temelj uobičajenih veza unutar varijabli modela. Tako će se uspostaviti veza između kvalitativnog i kvantitativnog modela.

Ključne riječi: turizam, organizacija, multikriterijsko donošenje odluka, dinamika sistema.

Zusammenfassung

EIN KONZEPT DES MULTIKRITERIENSYSTEMS FÜR ENTSCHEIDUNGSTREFFEN IM TOURISMUS MIT SYSTEMDINAMIK MODELLEN

Tourismus ist ein inter-organisatorischem System mit globalen und lokalen Eigenschaften. Die Probleme sind klar bestimmt und die Erscheinungen sind ungewiß. Es bestehen Forderungen nach schnellen und allumfassenden Entscheidungen bezüglich Gästezufriedenheit als Benutzer der Dienstleistung und Tourismus - Organisationen als Dienstleistungslieferanten. Viele verschiedene Methodologien und Methoden beherrschen langsam die strukturellen Probleme. Hier stoßen die Methoden der Dynamiksysteme mit den Denkungssystemen zusammen. Diese Werkzuege wurden zuerst im Ausbildungs- und Fortbildungsbereich in Form verschiedener Komputer-Simulationen und später erst als Werkzeuge für das Entscheidungstreffen und den organisatorischen Re-engineering eingesetzt. Die Dynamiksystem–Modelle sind im wesentlichen einfach und können nur als Aktivitätsbeschreiber gegenseitiger Grundeinflüße binnen Variablen dienen. Besondere Achtung wird auch der Wertbestimmung-Methodology des Parameter-Models und dem sogenannten psychischen Model, welches die Grundlage der gewöhnlichen Verbindungen innerhalb der Modelvariablen bildet, gewidmet. So wird die Verbindung zwischen qualitativen und quantitativen Modellen hergestellt.

Schlüßelwörter: Tourismus, Organisation, Entscheidungstreffen durch Multikriterien, Dynamiksystem.