DOI: 10.1515/orga-2017-0015

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Systems Approach to Tourism: A Methodology for Defining Complex Tourism System

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Background and Purpose: The complexity of the tourism system, as well as modelling in a frame of system dynamics, will be discussed in this paper. The phaenomenon of tourism, which possesses the typical properties of global and local organisations, will be presented as an open complex system with all its elements, and an optimal methodology to explain the relations among them. The approach we want to present is due to its transparency an excellent tool for searching systems solutions and serves also as a strategic decision-making assessment. We will present systems complexity and develop three models of a complex tourism system: the first one will present tourism as an open complex system with its elements, which operate inside of a tourism market area. The elements of this system present subsystems, which relations and interdependencies will be explained with two models: causal-loop diagram and a simulation model in frame of systems dynamics.

Design/methodology/approach: Systems methodology will be shown as the appropriate one, when we discuss complex systems challenges. For illustration, systems approach and systems methodology will be applied to tourism models. With building a qualitative causal-loop diagram we will describe the tourism system complexity in forms of system's elements relations. Mutual influences among the elements will be presented with positive and negative loops, which forms circles of reinforcement and balance. This will help us to discuss the problem categorically. The final model will follow the causal-loop diagram. This will be a simulation model in a frame of system dynamics as an illustration of the discussed methodology.

Results: The methodology offers the solution of effective and holistic promotion of complex tourism system transformation, which has the potential to go beyond the myth of sustainable tourism and create significant shifts in the approach and acting of the participants (elements of the system) involved. Systems approach brings to tourism and the society, in general, broader dimensions of thinking, the awareness interdependency, interconnectivity, and responsibility for the behaviour of a system, which can be observed by feedback loops.

Conclusions: Findings about meaningfulness of systems thinking presented in the paper, are rarely presented to tourism society systemically and with the aim of designing sustainable complex tourism system. They show new approach, systems awareness and teaches thinking "out of the box". Consequently, the sustainable behaviour is achieved: tourism supply and demand meet on responsible base and they connect to responsible stakeholders.

Keywords: *systems approach; complexity; tourism system; modelling; system dynamics*

1 Introduction

The system was an axiom for a whole composed from parts in human philosophical history and ancient civilisations (Mayan civilisation lived according to systems principles). Contemporary systems theory has been recognized as an important part of world science and research when biologist Ludwig von Bertalanffy published his book on General System Theory (Bertalanffy, 1952). Systems theory was adopted by many scientists from other fields of science than biology (Boulding, 1956). As a methodology for complex phenomena research, nowadays systems theory plays an important role in different fields of scientific

Received: October 27, 2016; revised: February 4, 2017; accepted: March 3, 2017

research. The systems we research can be simple, complicated or complex. Simple systems are linear and have predictable interactions, consist only of few components, are repeatable and decomposable, Complicated systems have many components, separated cause and effect over time and space. They have something in common with simple systems: they are also repeatable, decomposable but also analysable (Baggio, 2008). Complex systems do not have predictable reactions, cannot be decomposed, they have nonlinear interactions, high sensitivity to initial conditions, they are dynamic, adaptable to the environment and produce emergent structures and behaviours, and can become chaotic. They are usually understood intuitively, as a phenomenon consisting of a large number of elements, which “nest” in each other. The word “complex” is used only to point out the fact that the problem treated here cannot be expressed only in hard (quantitative) relations and that most relevant values are qualitative (Jere Lazanski, Kljajić, 2006).

The complex system is a system of the systems, which exchange energy and information with their environment while in transit, inflected by internal and external influences. Simple and complicated systems are hard systems (technical), whereas soft systems (organisations) are complex. Tourism systems are soft, organisational systems and among its subsystems e.g. supply, demand, intermediaries, tourists, information, as well as psychological, social, material, financial, and energetic relations exist. They are goal oriented systems and their development depends on interactions that have among themselves, activities, and behaviour.

Following Einstein’s thought on a problem, which can only be solved from the higher level of consciousness and not from the same that created a problem, we can say that, complex systems have complex problems and only appropriate methodology can solve these problems. Methodology for complex systems problem solving was mentioned in the past in many works such as: *Viable Systems* (Beer, 1959), *Industrial Dynamics* (Forester, 1961) *The Tree of Knowledge* (Maturana and Varela, 1973), *Living Systems* (Miller, 1978), *Anticipatory Systems* (Rosen, 1985), *The Fifth Discipline: The Art and Practice of the Learning Organization* (Senge, 1994), *Business Dynamics: Systems Thinking and modelling for a Complex World* (Sterman 2000), *Systems Engineering: A 21st Century Systems Methodology* (Hitchins, 2007), *Thinking in Systems: A Primer* (Meadows, 2008), as well as others.

Critical thinking, soft analysis and dialectical theory of system were described in (Roosenhead, 1989 and Mulej 1992). Systems methodology used for solving tourism problems has been discussed in many articles in the last twenty years as well as in last years (Buchta and Dolničar, 2003, Lagiewski, 2005, Jere Jakulin and Kljajić, 2006, Jere Jakulin, 2016). When we talk about a tourism system, we cannot avoid complexity. So, the complexity will also be discussed and described together with its symptoms. To properly describe a complex tourism system, we will create three models. A model of an open complex tourism system, which will serve as a base of causal loop diagram (CLD) or so called qualitative diagram, which is an aid for discussing problem categorically. Finally, we will build a simulation model in a frame of systems dynamics (SD), which is a quantitative complement to causal loop diagram. The methodology will show its appropriateness for complex tourism system strategy planning and problem solving.

2 Systems Complexity

Like all systems, the complex system is an interlocking structure of feedback loops. This loop structure surrounds all decisions public or private, conscious or unconscious. The processes of man and nature, of psychology and physics, of medicine and engineering all fall within this structure. (Jay W. Forrester)

Complexity has been discussed in several scientific areas. Complexity theory in social sciences was discussed in (McMaster, 1996, Stacey, 1996, Rosenhead, 1989a, 1998). In a complex system, the interaction among components of the system, and the interaction between the system and its environment, are of such a nature that the system as a whole cannot be fully understood simply by analysing its components (Cilliers, 1999). Systems nest in each other, which represent elements of a larger system being systems themselves. Complex systems are affected by the environment. At the same time, they affect the same environment, which means that they are dynamic and change over time. Their behaviour is sometimes predictable and sometimes cannot be predicted. They change in a regular manner, e.g. solar system, and other systems lack the stability e.g. a tourist in the middle of the airport strike, the impact with an air transport, which stops due to the strike. Symptoms of complexity which can be noticed in a system were defined by Baggio (Baggio, 2008) and Cilliers (Cilliers, 1998).

Table 1 shows symptoms of complexity as Baggio and Cilliers approached them. Non-determinism says that it is impossible to anticipate precisely the behaviour of a complex (adaptive) systems because the behaviour depends strongly on the initial conditions is and appears to be extremely sensitive; the only predictions that can be made are probabilistic. Positive and negative feedback loops influence the overall behaviour of the system. Distributed natured represent a distributed system where many properties and functions cannot be precisely localized. Next, the system evolves, increasing its complexity up to the next self-organization process. One effect of such a characteristic is the capability to show a good degree of robustness to external (or internal) shocks. At the critical points of instability, the system will reorganize through feedback mechanisms. The self-similarity is evidence of possible

Table 1: Symptoms of a complexity (Source: Jere Jakulin, 2017)

Cilliers	Baggio
A large number of elements form the system	Nondeterminism
Interactions among the elements are nonlinear and usually have a somewhat short range	Presence of feedback cycles
There are loops in the interactions	Distributed nature
Complex systems are usually open and their state is far from equilibrium	Emergence and self-organization
Complex systems have a history, the “future” behaviour depends on the past one	Self-similarity
Each element reacts only to information that is available to it locally.	Limited decomposability.

internal complex dynamics of a system. The system considered will look like itself on a different scale, if made smaller or magnified in a suitable way. The last symptom of complexity is limited decomposability, which tells that it is impossible to study the properties of a dynamic structure by decomposing it into functionally stable parts (Jere Jakulin, 2017). Cilliers describes even more symptoms such as history

3 Complex Tourism System

It is always possible to break up a complicated system into separate entities and study them individually, being sure that the final object will be the (linear) composition of them (Procaccia, 1988).

If we talk about technical systems that are composed of many elements, we talk about complicated systems. Talking about the tourism system we must have in mind interactions of all elements in the tourism market: tourism supply and demand, intermediaries, tourism support institutions, transit regions, tourist flows, and environment influences. To maintain sustainability of complex tourism system or developed tourism areas the tourism policymakers must take fast and integrated decisions. Figure 1 represents tourism as a complex system from a system's points of view. Boundaries in real tourism system are permeable. We can say that complex tourism system is an open system. This openness is shown in Fig. 1 by dashed lines, and it means that the behaviour of the tourism system can be understood only in the context of its environment (Gharajedaghi, 2006).

Internal elements of the system are tourism market area, tourism demand and supply, supporting institutions, intermediaries, tourists' flows. The environment, which influences the tourism system as a whole at once as the tourism system influences the environment, presents the external part of the system. Figure 1 holds basic elements of a tourism system and is a support for building causal loop diagram (CLD), which in continuation describes mode of relationships among elements of the tourism system.

4 Qualitative Modelling with Causal Loop Diagram (CLD)

I suggest that complex systems can be modelled. The models could be computationally implemented, and may lead to machines that can perform more complex tasks. The models themselves, however, will have to be at least as complex as the systems they model, and may therefore not result in any simplification of our understanding of the system itself. (Cilliers, 1999)

Building of a tourism system qualitative model requires some procedure, knowledge, to identify the elements of the systems and theory to find the relationship between the elements. We can also say that, modelling represents the activity to describe one's experiences by using one of the existing languages in the framework of a certain theory. Tourism has seen only a very few attempts at using modelling techniques in simulating the behaviour (Walker, et al.1998) of a tourism system or in supporting strategic management decisions (Buchta & Dolnicar, 2003).

Models built by Butler (1980) and modified (Hall & Butler, 1995; Lagiewski, 2005; McKercher, 2005; Russell, 2005), are able to give a valuable description of a tourism system and are useful for managing its development. Let us explain the modelling process of a tourism systems with a triplet subject, object and model. Subject is the observer (decision-maker), object is a tourism system and model is a graphic representation of a real object (Jere Jakulin, Kljajić, 2006). For modelling, we must see the tourism system

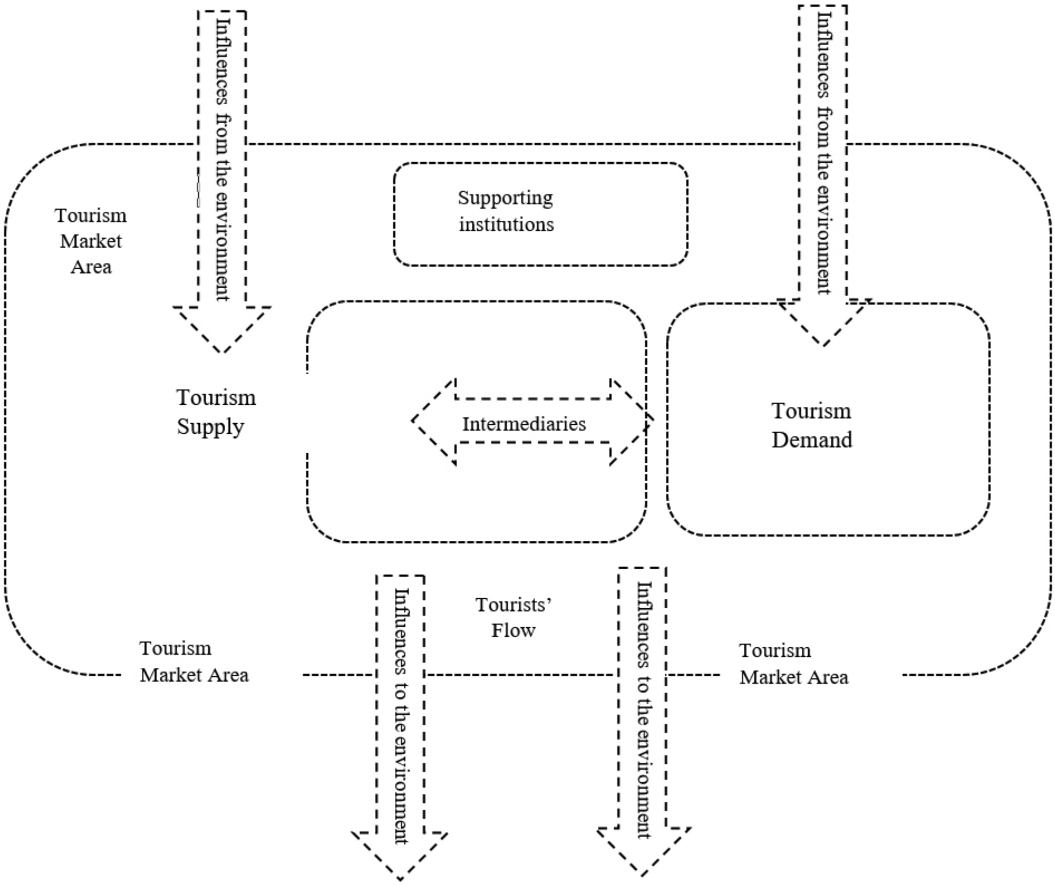

Figure 1: The Complex Tourism system (Source: author)

from the general point of view. It can be defined by a set:

$TS = (E, R)$ (1)

where $e_i \in E$, $i = 1, 2,..n$ represents the set of elements and $R \subseteq E \times E$ the relation between elements. In this way, our experiences also become accessible to others: they may be proven, confirmed, rejected, broadened or generalized (Jere Jakulin, Kljajić, 2006). This paradigm can be stated with a triplet (*TO*, *TS*, *TM)*. *TS* represents the real object (tourism system), original, independent from the observer, while *TO* represents the researcher (subject) or an observer with his knowledge, and *TM* the tourism model of the object. Their relations in the process of analysing are shown in Figure 2.

Figure 2 presents relations of the tourism decision-maker, tourism system and tourism model or so called TD-TS-TM triad. The $TD \rightarrow TS \rightarrow TM$ relationship presents an active relation of the tourism decision-maker in the phase of the tourism system's cognition. The TM $\rightarrow TS \rightarrow TD$ relation the process of learning and generalization (Kljajić, 1998). The importance of creating a model lies in a team of experts, which represent the TS entity or so called tourism decision-makers. They are a part of the tourism business process and have different tasks: the technical authority, which orders a project (tourism authority), the political authority which approves or rejects a project (a local government), the system analyst who develops the project and the stakeholders (local interest groups). The tourism expert group works on ideas and scenarios which go through modelling process. Actual performances of the system are compared in order to adapt the strategy according to changes in the environment. 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 (Jere Jakulin, 2006).

Qualitative modelling is possible as soon as we agree on the criteria, which we consider to be important for the system. Fig. 3 represents a tourism system model and an influence diagram of a simulation model, which is built after the tourism decision-makers unite their knowledge. The positive signs (+) at the arrowheads indicate that the effect is positively related to the cause (Sterman, 2000).

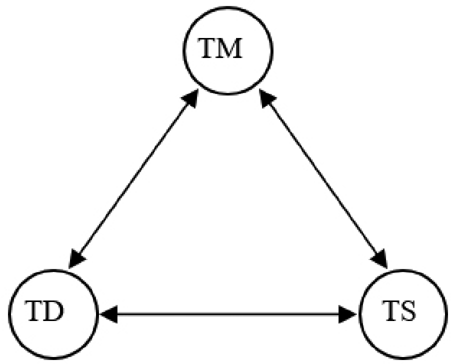

Figure 2: TD-TS-TM relations in the process of analysing (Source: author)

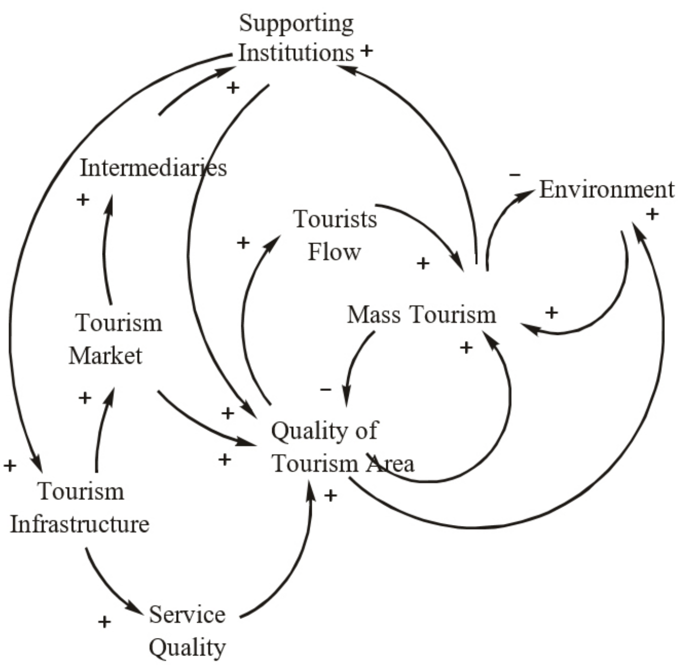

Figure 3: Causal loop diagram (CLD) of interdependent tourism system elements (Adapted and modified from Jere Jakulin & Kljajić, 2006)

The entities connected with + signs represent reinforcement cycles. Since no real entity can grow forever we must take into concern the limits of growth. These limits are created by negative feedback (-). We describe the relations among entities as follows: Supporting institutions (state administration, ministries, government positively (+) influence tourism infrastructure, which influences (+) the tourism market, and tourism market positively influences the growth of intermediaries (+) and intermediaries influence (+) supporting institutions. The described connections represent the circle of reinforcement. Every reinforced complex system needs its regulation in a form of balancing loop (-) and balancing circle. The balancing circles in Fig.3 between quality of a tourism are, which influences positively (+) the number of tourist and mass tourism and mass tourism influences (-) quality of tourism area. Another circle of balance is presented by the environment which influences the number of tourists (+) as mass tourism, and mass tourism influences ecologically the environment (-). Another reinforcement circle we can see among the entities with positive feedbacks (+) hence supporting institutions, tourism infrastructure, tourism market, intermediaries, which conclude the loop with supporting institutions. We can say that elements of a tourism market mentioned above, represent a set of entities and the directed branch represents the flow between entities. In other words, Fig. 3

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, and quality of tourism area loop represents negative feedback and the regulation of quality. This means that desired quality of tourism area depends on quality of tourism service and tourists flow (number of tourists) are functions of strategic are planning. The tourism market's growth is proportional to quality of service, but quality of service is dependent on infrastructure investment, which is a function of the difference between the target state and current state of the system. 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 in the cognitive graph, the semantic graph or influence diagrams (Jere Jakulin, Kljajić, 2006). If the above entities are considered as a Level (Stocks) in the Dynamic (Forrester, 1994) and the directed branch as a flow between Levels, one can derive a difference equation for the computer simulation.

The next diagram shows the structure of a tourism model. From this diagram, one can derive the dynamic equations, which are necessary for a computer simulation (Jere Jakulin, Kljajić, 2006). The entities are not quantitatively evaluated, since there is much work to do with analysing the details of a model. This is only an answer and a presentation of possible results.

5 Modelling in Frame of System Dynamics (SD)

All systems, no matter how complex, consist of networks of positive and negative feedbacks, and all dynamics arise from the interaction of these loops with one another. (John Sterman)

The theory of nonlinear dynamics is a base on which system dynamics models rest on. To understand system dynamics as a rigorous method we must consider it as a set of conceptual tools that enable us to understand the structure and dynamics of complex systems. It enables us to build formal computer simulations of complex systems and use them to design more effective policies and organizations (Sterman, 2000). Modelling in frame of system dynamics is slightly different in the graphic presentation of the elements and their relationships, from causal loop diagram modelling. Models are essentially simple and serve as a tool for systemic – strategic planning. Methods of modelling, which have been developed for mathematical modelling of real systems were motivated by the problem itself and the researcher in that field (SD, compartment model, block diagram, etc.). The system structure in SD consists of level elements representing state variables of the rate elements, representing the flow and the auxiliary elements connected in the flow diagram. The diagram is sufficiently abstract to allow a qualitative and quantitative analysis of the system functioning through feedback loops. As soon as one becomes satisfied with the "picture" of the model, he will proceed by writing equations of the simulation model. In our opinion, SD suggested by Forrester (1961) has some semantic advantage for users less experienced with formal methods. In a practice closely related to the SD methodology, some authors use a causal loop diagram or influence diagram (Sterman, 2000). In this case, the influence loop diagram precedes the SD stock and flow diagram because the former is more abstract while the second is more convenient for computer programming. Stocks and flows, along with feedback, are the two central concepts of dynamic systems theory. Stocks are accumulations. They characterize the state of the system and generate the information upon which decisions and actions are based. Stocks give systems inertia and provide them with memory. Stocks create delays by accumulating the difference between the inflow to a process and its outflow. By decoupling rates of flow, stocks are the source of disequilibrium dynamics in systems.

Figure 4 represent a SD model as a model, which upgrades CLD model. It shows a system dynamics model depicting the interaction among dependence on tourism market, quality of the environment, service quality, mass tourism (number of tourists), supporting institutions, and investments into infrastructure. The model is composed of stocks (rectangles), flows (inflows are represented by arrow pointing into the stock and outflows by arrows pointing out of the stock), valves which control the flows, and clouds, which represent the sources and sinks of the flows. A source represents the stock from which a flow originating outside the boundary of the model arises; sinks represent the stocks into which flows leaving the model boundary drain. Sources and sinks are assumed to have infinite capacity and can never constrain the flows they support (Sterman, 2000). The purpose of the simulation model is to help managers and decision-makers, who influences the tourism complex system understanding the basics of systems methodology and, in particular, the financial implications of various decisions. Through the process of modelling and model building they recognise the values of their decisions without having additional costs, which is not a case in real life if systems approach is not recognised as an official tool for decision-making and strategic planning.

6 Conclusions

In the paper, we discussed systems methodology, which we applied to the research area of tourism.

We presented complex tourism system with its internal elements: tourism market where meet the demand and supply, intermediaries, supporting institutions and tourists flow. We showed interrelations and role of a triplet tourism system, tourism decision-maker(s) and tourism model. We

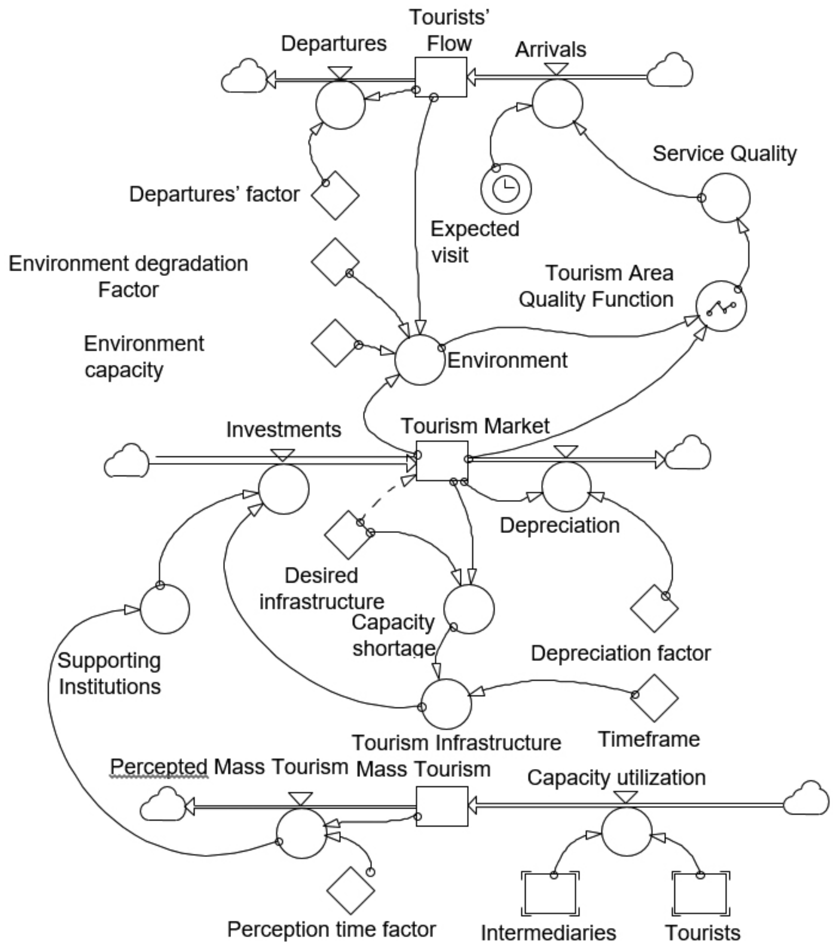

Figure 4: A simplified simulation model of complex tourism system (Adapted and modified from: Jere Jakulin & Kljajić, 2006)

treated tourism system as an object, whose relationship to a tourism decision-maker (subject, observer) explains a tourism model. As soon as tourism decision-makers as observers of a tourism system, find consensus of their tourism and modelling knowledge, they can build the qualitative CLD model of a tourism system, which serves as a model of strategic planning in tourism. The causal-loop model is followed by a system dynamic model, which is actually a simulation model. There is a difference between CLD and SD model. System dynamic model has different quantity of parameters than causal-loop diagram. It also needs concrete data for simulation, which are gathered in system dynamics. The availability of statistical data is very important. It is the essence for strategic planning and modelling of a complex tourism system since the model must represent a strategic planned reality. We can also suggest that the appropriate statistical data should be used, social and political environment and their feedback mechanisms, must be considered as well as an incorporation of work practice parameters. For a simulation model we have built, some of the data could be found and gathered in a statistical office as well as within tourism subsystems' decision-makers. Equipped with qualitative and quantitative data the system dynamics model proves that SD methodology offers new opportunities for solving virtual problems in complex systems modelling. We can conclude that the advantage of systems approach and complex system modelling lies in a fact that they are an experimental confirmation of those hypotheses, which compose the approach and modelling theory.

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