UNIVERSITY OF ALGARVE
FACULTY OF ECONOMICS

System Dynamics in Tourism: A Systematic Literature Review

POOYAN SEDARATI

Dissertation

Master in Tourism Economics and Regional Development

Work made under the supervision of

Dr. Pedro Pintassilgo
Dr. Sérgio Santos

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Work Authorship Declaration

Pooyan Sedarati

Copyright

To my Parents

For their support and encouragement

Acknowledgment

First and foremost, I have to thank my parents for their love and support through my life. Thank you both for encouraging me to follow my dreams. Thanks too, to my sister Niloufar and my brother Aarash for their support. Also I am very grateful to my girlfriend Golya for her patience and great support.

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Thanks to all my friends for their support and help. Special thanks to my friend Rita who helped me through my work with her comments.

Abstract:

Background: The System Dynamics method has the ability to capture the dynamic behavior of a complex system over time. Due to the myriad of interactions of the tourism industry with its related sectors, it can be considered as a complex system. In the last two decades, there has been an increase in the number of publications using System Dynamics to study complex tourism systems.

Objective: The goal of this dissertation is to assess the implementation of the System Dynamics method in the tourism industry.

Method: A systematic literature review was performed in order to identify and assess the application of System Dynamics in tourism.

Results: In our initial search 531 papers appeared which directly or indirectly referenced to the application of System Dynamics in tourism. Among these papers, 25 met our inclusion criteria. The analysis of the selected papers shows that the System Dynamics method has been used to address a multitude of different problems, with a special focus on the areas of transportation and sports & recreation. It also shows that there is an upward trend in the use of System Dynamics in the tourism sector.

Conclusion: After conducting the systematic literature review a new perspective was gained regarding the applicability of System Dynamics in tourism. The result of our literature review shows what has been done and what can be done in this field. Overall, we conclude that the number of publications is still limited and there is a lack in the use of a holistic approach to address complex problems in tourism, offering several opportunities for System Dynamics researchers and practitioners.

Keywords: System Dynamics, Tourism and Hospitality, Systematic Literature Review.

Resumo:

Enquadramento: A Dinâmica de Sistemas é um método que permite captar o comportamento dinâmico de um sistema complexo ao longo do tempo. A indústria do turismo pode ser considerada um sistema complexo devido à miríade de interações que apresenta. Ao longo das últimas duas décadas assistiu-se a um aumento do número de publicações que utilizam a Dinâmica de Sistemas para estudar sistemas turísticos complexos.

Objetivo: Esta dissertação pretende avaliar a aplicação da Dinâmica de Sistemas ao estudo da indústria turística.

Método: Efetuou-se uma revisão da literatura sistemática por forma a identificar e avaliar a aplicação da Dinâmica de Sistemas ao turismo.

Resultados: Na pesquisa inicial foram identificados 531 artigos que, direta ou indiretamente, se referiam simultaneamente a Dinâmica de Sistemas e Turismo. De entre estes artigos, apenas 25 satisfizeram os nossos critérios de inclusão. A análise dos artigos selecionados mostra que a Dinâmica de Sistemas tem sido utilizada para abordar uma variedade de problemas, com enfoque especial nas áreas dos transportes, desporto & recreio. É patente uma tendência crescente na aplicação da Dinâmica de Sistemas ao estudo do turismo.

Conclusão: A revisão sistemática da literatura proporcionou uma perspetiva global sobre a aplicação da Dinâmica de Sistemas ao turismo. Os resultados mostram o que já foi feito e o que é necessário fazer neste domínio. Em termos gerais, conclui-se que o número de publicações é ainda bastante reduzido. Os problemas complexos no turismo requerem uma abordagem holística, o que proporciona várias oportunidades de investigação no âmbito da Dinâmica de Sistemas.

Palavras-chave: Dinâmica de Sistemas, Turismo e Hotelaria, Revisão Sistemática da Literatura.

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1. Introduction

Tourism has become one of the biggest industries in the world. It is an industry that is growing rapidly internationally and which has a direct impact on economic, environmental and social aspects. Also, tourism has become an economic driving force in sustainable development, encouraging many developing countries to promote tourism policies in order to improve their economic development (UNWTO 2013).

Tourism offers a multitude of activities spread across different sectors in order to meet tourists' preferences. Goeldner and Ritchie (2003) proposed a model of the tourism industry components which acknowledges that tourists use different services such as transportation, food services, accommodation, travel trade, cultural activities, sport and recreation and retail trade. Among these sectors, transportation plays a fundamental role in tourism since every industry and service provider depends on it (Egilmez & Tatari 2012). All the mentioned sectors have been active in tourism industry and some have been trending up recently, such as ecotourism in the sport & recreation sector.

Tourism is known for having various positive influences on economic growth which can contribute to create job opportunities, generate income for local people and motivate them to increase their production. The financial flow resulting from tourism activities is fundamental to support investment on infrastructures, fostering competitiveness, economic growth and development (Balaguer & Cantavella-Jordá 2002). Nowadays, developing or less developed countries are attracting more tourists by having different cultural, environmental, art, landscape and wildlife resources which make this industry a key contributor to economic development and poverty eradication.

Although tourism is considered a major driving force in development, the negative impacts of tourism should not be neglected. Recently tourism has been playing a significant role in CO2 emissions by using transportation, accommodation and other tourism facilities which make tourism one of the important contributors to climate change (Egilmez & Tatari 2012; Law et al. 2012). The presence of tourists in a destination increases local pollution, consequently contributing to higher production of solid and liquid waste and causing serious problems for destinations where a suitable infrastructure does not exist. Poor management and uneducated visitors in sensitive destinations can

cause a synergy which leads to negative impacts on biodiversity or cultural heritage. Tourism can also contribute to the creation of new phenomena such as sex tourism which may not fit in the destination's values. All these negative impacts should be carefully analyzed and managed to provide an opportunity for the implementation of adequate policies in favor of stakeholders.

Many destinations thrived into a mature touristic spot through an early introduction of a correct and adaptive management plan along with a suitable infrastructure. In order to maintain the high quality of a destination it is necessary to observe and control the activities and elements of the place. By developing adequate management plans, tourism destinations will be able to respond to any changes. The tourism industry, due to interaction with different sectors at the same time, can be considered as a complex system. Tourism destinations are complex systems due to the numerous interactions between the sectors operating within the destinations, stakeholders, services and industries, which make all these elements interdependent. Their relationship cannot be explained as a linear progression with a simple model and variables to forecast the future. Therefore, the nonlinearities of the relations in tourism systems have drawn researchers' attention to a different interdisciplinary approach for managing tourism destinations.

All the components of the tourism industry are in interaction with each other and they are offering the same final product which is an attraction and experience for tourists (Sánchez et al. 2006). A well-managed and systematic plan is necessary to develop and promote the destination as a whole. Generally speaking, it refers to the idea of sustainable tourism development and the necessity of giving a simultaneous and holistic approach to this concept. The duty of sustainable tourism is not only environmental protection, but also includes the livelihood, social and economic dimensions of stakeholders in a touristic area (Angelevska-Najdeska & Rakicevik 2012).

The tourism system faces constant change with all its related sectors working together and interacting with each other as a complex system. All these interactions demonstrate how intricate and complex the relations in this system are. Hence, this complexity could not be described briefly in a simple model. There is lack, therefore, of a powerful tool to capture and structure a comprehensive model to illustrate the outcomes of tourism systems precisely.

The purpose of this study is to systematically review the implementation of System Dynamics in the tourism industry in order to find the works and applications of System Dynamics in this context. In particular, we intend to scrutinize what has been done in this field, and present possible future areas of research. The remainder of this dissertation is organized as follows. Section 2 discusses the concept of System Dynamics and overviews the main steps of the System Dynamics modeling approach. Section 3 discusses the methodology we have used to collect and analyze the papers that make part of our systematic review of the literature. Section 4 discusses the main results of our research. Finally, section 5 concludes with some closing remarks and gives ideas for further research in this area.

2. What is System Dynamics?

System Dynamics (SD) is a computer-based approach to understand and analyze a system's behavior over time. It can be used to study complex dynamic problems and be applied to different fields of study such as engineering, management, medicine, social, environmental and ecological sciences.

The concept of System Dynamics comes from the idea of "industrial dynamics" which arose from the work of Forrester (1961) at the Massachusetts Institute of Technology, and at first it was used in engineering and management. The System Dynamics approach is based on internal interaction, information feedback, and cause and effect. Forrester explains industrial dynamics as follow:

> *"Industrial dynamics is the investigation of the information-feedback character of industrial systems and the use of models for the design of improved organizational form and guiding policy. Industrial dynamics grows out of four lines of earlier development-information-feedback theory, automatizing military tactical decision making, experimental design of complex systems by use of models, and digital computers for low cost computation."(Forrester 1961:13)*

Senge (1997), in turn, defines our world and all human actions as a system whose elements are bound together by something which he calls "invisible fabrics". The impacts can be seen in the short term and some will be seen in the long term due to their delays. According to Senge (1997) being an element of a system makes it harder to have an

overview on the whole system. System thinking and in particular System Dynamics is a useful framework and a tool to help us look at the big picture and its changes, instead of looking for answers in smaller parts of the system.

System Dynamics is known as a powerful and practical method which has the ability to model complex systems in order to study how they behave over a period of time. To understand the problems and behavior of a system, it is necessary to look into the cause and effect among the elements of the system. It is well known that some effects are caused by simultaneous consequences of different elements in one system. By breaking down the whole system's structure into smaller segments and increasing the possibility of studying dynamic relationships among elements of the system, System Dynamics can be considered as one of the best tools for a modeler to have a holistic approach in analyzing models of the system as a whole.

According to Richardson and Pugh (1981) the aim of using System Dynamics should focus on the system's problem, not the system by itself. Dynamic problems have two main features which make them complex and difficult to analyze. The first one is that these problems contain quantities which will change over time. The second one is that feedback structures are included in these dynamic problems.

Feedback loop and stock and flow diagrams are the most important parts in System Dynamics modeling. The ability to find out the relations of feedback processes, stock and flow diagrams, time delays and nonlinearities in the system is considered as an art in System Dynamics modeling (Sterman 2000). The relations among elements of the system and all the causes and effects are shown in the feedback loop diagrams. Causal loop Diagrams (CLD) are very helpful in structuring a mental model of the system and forming the relations among elements. When the objective is to analyze the system by developing quantitative simulation models, it is common to precede the development of these models with stock and flow diagrams. In these diagrams the stocks represent the state of the system, which changes by increases or decreases in the flow rates. Also, stock and flow models provide a useful view over the status of the system's data due to the implementation of different decisions and policies. After defining the diagrams and components of the system, computer simulation will show the behavior of the past data. Then the outputs will be compared with the real behavior of the system to determine

whether the System Dynamics model is valid or not. In order to evaluate the different outcomes, a variety of policies can be tested by running the model and comparing the results with the baseline.

A System Dynamics approach is capable of breaking a system into pieces and examining each element of the system to find the impacts and outcomes on a macro-level. System Dynamics has been applied in different contexts such as learning organizations (Senge 1997), transportation (Egilmez & Tatari 2012), ecological modeling (Semeniuk et al. 2010) and other different fields of study.

2.1. System Thinking Applications

Maani and Cavana (2000) in their book explain that System Dynamics can be applied to a variety of fields and purposes. For instance, it can be used in designing a new system or restructuring and improving an existing system. System Dynamics is used to predict the behavior of complex systems and how each element and segment of a system interacts with other components.

System Dynamics modeling consists of two different methods: qualitative and quantitative modeling. There has been a lot of discussion among experts regarding the advantages and disadvantages of using these methods. Originally, System Dynamics was developed as a quantitative computer-based simulation method aiming at using computer calculation power to analyze socio-economic issues. Using the ability of computers in manipulating data and running simulations helps to observe the dynamic behavior of systems, which gives us a deeper understanding of the dynamic problems. One of the disadvantages of using the quantitative method is the lack of information which is considered as one of the problems of quantification (Wolstenholme 1999).

The qualitative method uses causal loop diagrams to show the interactions of the system and gain a better understanding of its dynamics. It also helps the modeler to easily convert dynamic models into quantitative ones. Furthermore, causal loop diagrams are frequently used to study dynamic problems and are aimed at giving an insight towards the problem rather than at its quantification. The usefulness of interpreting and describing the dynamic

behavior of a complex systems to help understand complex problems has been discussed by Coyle (2000).

2.2. Steps of the System Dynamics Modeling Approach

The steps and process of developing a System Dynamics model have been an important subject among experts and authors during the past years. Richardson and Pugh (1981) proposed a framework for this process which is composed of seven stages. In Figure 2.1, the interaction and relations between these stages are shown. Many authors have suggested a similar framework for this process (e.g. Wolstenholme 1990; Nancy et al. 1994; Coyle 1996; Sterman 2000)

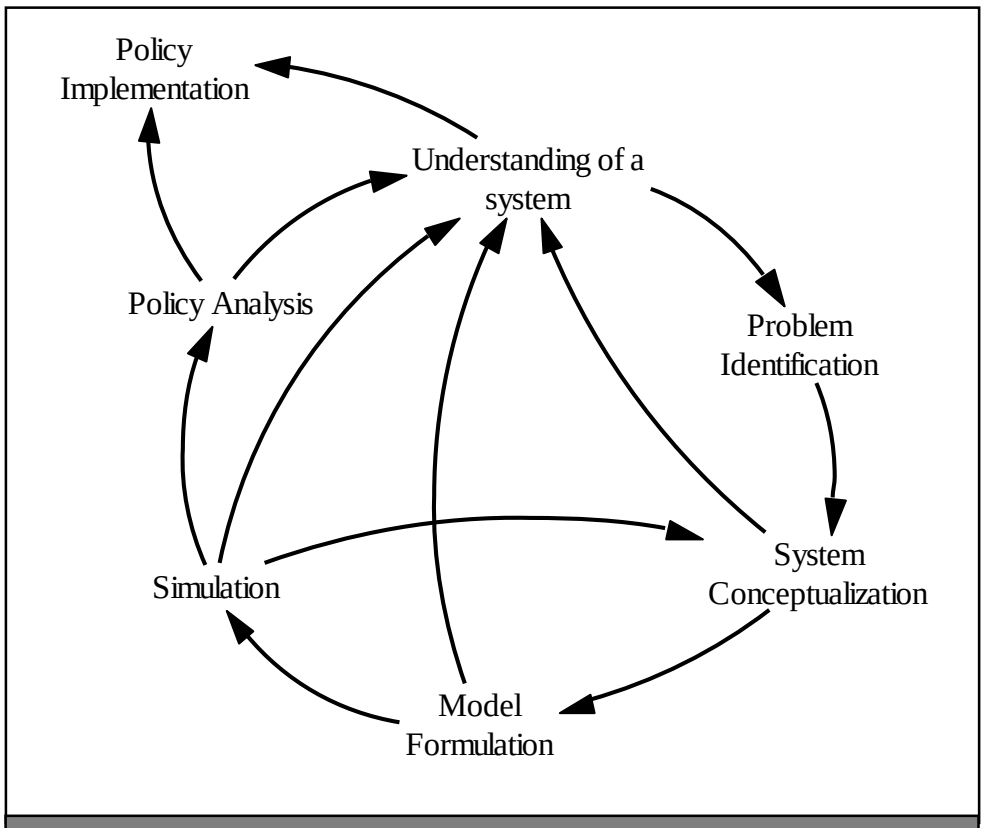


Figure 2.1 - The System Dynamics Modeling Approach

Source: (Richardson & Pugh III 1981)

As shown in Figure 2.1, every System Dynamics modeling process starts and finishes with understanding the system. The main purpose of analyzing a system by using the System Dynamics method is to gain a better understanding about the system and its dynamic problems. In order to carry out dynamic modeling studies, first we have to

identify what the problem of the system is. Then, by structuring the models we conceptualize and formulate our problem and run simulations to explore the behavior of the system. Based on the testing of different scenarios, results will be analyzed and policy interventions will be recommended. Based on Sterman (2000), the System Dynamics modeling steps are explained as follows.

2.2.1 Problem Identification and Definition

The first and most important issue to address when a System Dynamics intervention is being planned is to identify the problem. In particular, it is important to answer the following questions: What is the main problem in the system? Is the problem a consequence of deficiencies in the system?

Learning more about the purpose of conducting a dynamic modeling intervention can facilitate the process of defining the problem. Afterwards, it is necessary to find the related variables to the problem which helps to structure a better model of the real system. A time horizon should be defined to know how far we are looking in the past and future of the problem.

2.2.2. System Conceptualization

Every system has specific complexities. In order to conceptualize the problem, the dynamic characteristics of the system should be identified. These characteristics can be observed in feedback loop and stock and flow diagrams of the system which help to understand how problems emerge. Different approaches exist for structuring a model such as causal loop diagrams and stock and flow maps.

2.2.3. Model Formulation

After developing a conceptual model of the dynamic problem we need to test it. In order to test the validity of the model, sometimes it is possible to test the data set in the real system. However, generally, due to the complexity of the real world, conducting such test is difficult. Formalizing the model helps to have a better perspective towards the problem. Therefore, it is necessary to put the model through a lot of tests in order to give us a better understanding and confidence about the functioning of the system.

2.2.4. Simulation

Once the model is formalized through the writing of several equations, capturing the dynamics of the system, the model is tested with the use of specific software. The first structured model of the system which shows all the interactions among its variables will be considered as the reference model. Running different tests helps to compare the simulated behavior with the reference model. In order to get reliable answers, it is necessary to check all the variables in the model in terms of meaning and unified dimension. After running the simulations and checking the behavior of the system with the reference model, the model should be checked and tested by using extreme conditions and scenarios. Testing a model under extreme conditions can be very helpful to find loopholes and flaws in the system and to improve our understanding about the model.

2.2.5. Policy Analysis

This stage focuses on designing new policies, scenarios and structures in the system which means manipulating the dynamic structure of the system. Changing different parameters and elements shows the interactions and relationships among components of the system which helps to produce new information about the model for further decision making and policy planning.

2.2.6. Model Use or Implementation

The outcomes of model simulations help us to gain a better understanding of the system and can be used to improve it. Some models are structured based on specific data obtained from a system. Subsequently, the results and different policies will be implemented in the real world which will contribute to changes or improvements in the system.

3. Methodology

In order to scrutinize the application of the System Dynamics method in tourism a systematic approach is used to analyze and explore the literature regarding this subject. Using this method will enable us to look for the papers which applied System Dynamics to the tourism industry and gain an overview on what has been done and what is lacking. The methodology section is composed of two parts. The first part explains what a systematic literature review is, the basic concepts, and the main advantages of this method. Then, the second part describes each of the steps in carrying out a systematic literature review.

3.1.What is a Systematic Literature Review?

The systematic literature review initially arose in the field of medical science and health care (Higgins & Green 2008). One of the first definitions of this technique was proposed by Sweet and Moynihan (2007) which describe it as a good tool for gathering and assessing the studies on a specific topic and minimize the bias when compared to non-systematic reviews. In order to find and evaluate the previous studies on a research question or a problem, the systematic literature review can be used as a powerful tool to summarize the results. In comparison with the traditional literature review methods, systematic literature reviews aim at specific research objectives or questions. There are some advantages and disadvantages for such a method. For instance, it takes a lot of time and effort in comparison with traditional methods but provides a broader perspective toward a problem.

3.2.Main Steps of Carrying Out a Systematic Literature Review

There are some steps for carrying out a systematic review which are as follows.

3.2.1 Scope of the Research and Review Objective

The scope of this work was based on the application of System Dynamics in tourism. For this reason, we gathered all the necessary documents and evidences regarding the application of this method in tourism. To conduct a systematic literature review, a

research objective has been defined which is: Assessment of the implementation of the System Dynamics method in tourism.

3.2.2. Searching for the Existing Papers

At first, a search was conducted in order to check the existence of systematic literature reviews on this subject. The results showed us that no systematic literature review was carried out on the application of the System Dynamics method in tourism.

To conduct the search, the "Web of Science" bibliographic database was used and a set of terms was searched in the titles, abstracts and keywords of the papers indexed in this database.

The study search terms were inspired both from the International Standard Industrial Classification of All Economic Activities (ISIC), Revision 4 (United Nations 2008) and the Components of Tourism and Tourism Management Model (Goeldner & Ritchie 2003). Figure 3.1 shows the selected keywords' list on tourism and hospitality and it contains seven sectors which are divided into several sub-sectors.

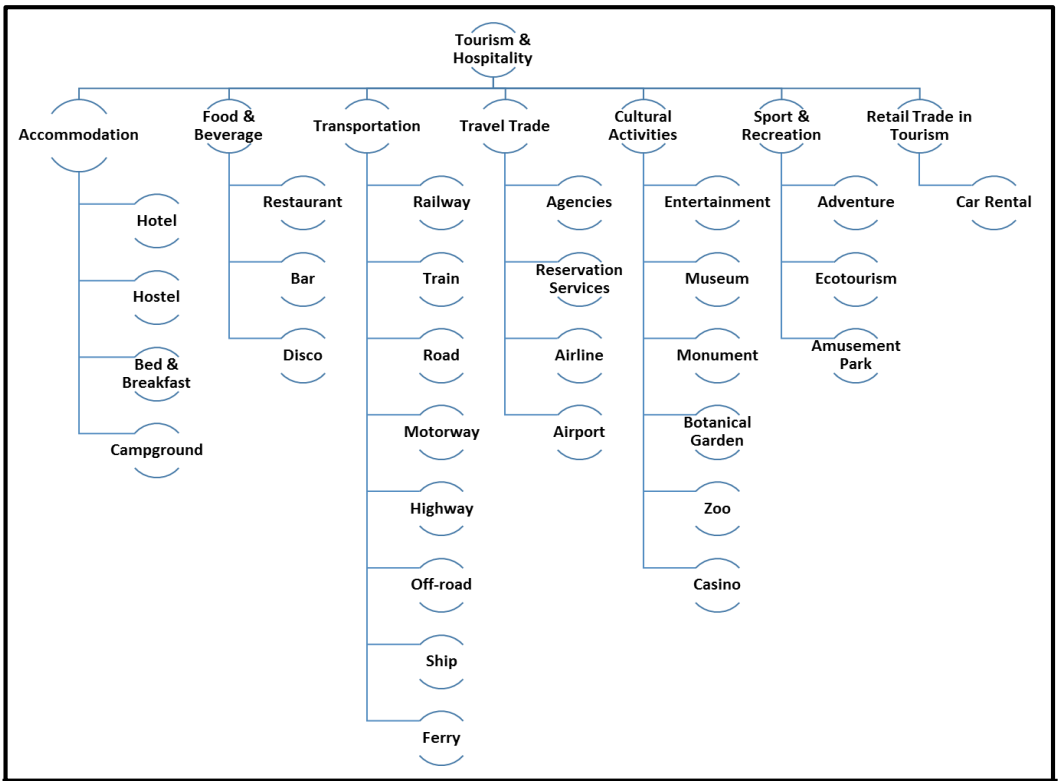


Figure 3.1 - Main Active Sectors and Sub-Sectors in Tourism Inspired from ISIC Rev.4

The search was conducted in the above mentioned database by selecting the publications that contained any of the keywords in Figure 3.1. and simultaneously the term "System Dynamics". The Boolean operators "OR" and "AND" were also used in our search. Hence, the keywords used in the systematic literature review are as follows:

(*"Tourism" OR "Hospitality" OR "Accommodation" OR "Hotel" OR "Hostel" OR "Bed & Breakfast" OR "Campground" OR "Food and Beverage" OR "Restaurant" OR "Bar" OR "Disco" OR "Transport*" OR "Railway" OR "Train" OR "Road" OR "Motorway" OR "Highway" OR "Off-road" OR "Ship" OR "Ferry" OR "Travel Agencies" OR "Reservation Service" OR " Airport" OR "Airline" OR "Cultural Activity" OR "Entertainment" OR "Museum" OR "Monument" OR "Botanical Garden" OR "Zoo" OR "Casino" OR "Sport and Recreation" OR "Adventure" OR "Ecotourism" OR "Amusement Park" OR "Car Rental"*) *AND* (*"System Dynamics"*).

In this study our focus is on the papers published in peer reviewed journals from 1961 to 2014. Therefore, for conducting the search using the above mentioned keywords, only "articles" were selected in the document type tab in the Web of Science bibliographic database. In order to include all the desirable papers for our study and exclude the unwanted papers it is necessary to define the exclusion criteria. All the selected papers that met the criteria below were excluded from further analysis.

- All papers published in non-peer review journals, books and book chapters, master and PhD theses;
- Papers published in other languages than English;
- Conference papers;
- Different subjects than tourism industry and its related sectors;
- Papers referring to dynamic systems but not using the System Dynamics method;
- Review articles on related topics;

- Papers published in predatory publications (Beall 2014).

3.2.3. Checking the Titles and Abstracts

By using the above keywords and restricting our analysis to "articles", our search resulted in 531 papers (Figure 3.2). Then, titles and abstracts were read carefully to check the papers which were related to the research objective (using System Dynamics in Tourism).

If the title had any indication for being excluded it would be omitted straightaway, but if there was any doubt in the title the abstract would be checked and read completely. Afterwards, if the abstract was vague, the article would be included for further check. Applying this procedure resulted in the exclusion of 486 papers. The number of selected papers which fully met the requirements were 45. The list of these papers was then approved by the supervisors. Hence, after checking titles and abstract we ended up with only 8.5% of the initial sample.

3.2.4. Obtaining Full Texts and Data Extraction

By having an agreement on the selected papers we moved forward with our sample. The remaining articles were downloaded and read thoroughly. After assessing and extracting the details of each paper, while applying the exclusion criteria, the final sample of 25 papers was obtained for further analysis. In order to summarize the information retrieved, and to compare different publications, a table was elaborated, presented in Annex 1, with the following categories: Authors, General Objective, Country, Software, Method (Qualitative/Quantitative), Objective of using System Dynamics, and Sector. Figure 3.2 presents a flowchart showing the process of obtaining the final sample of papers.

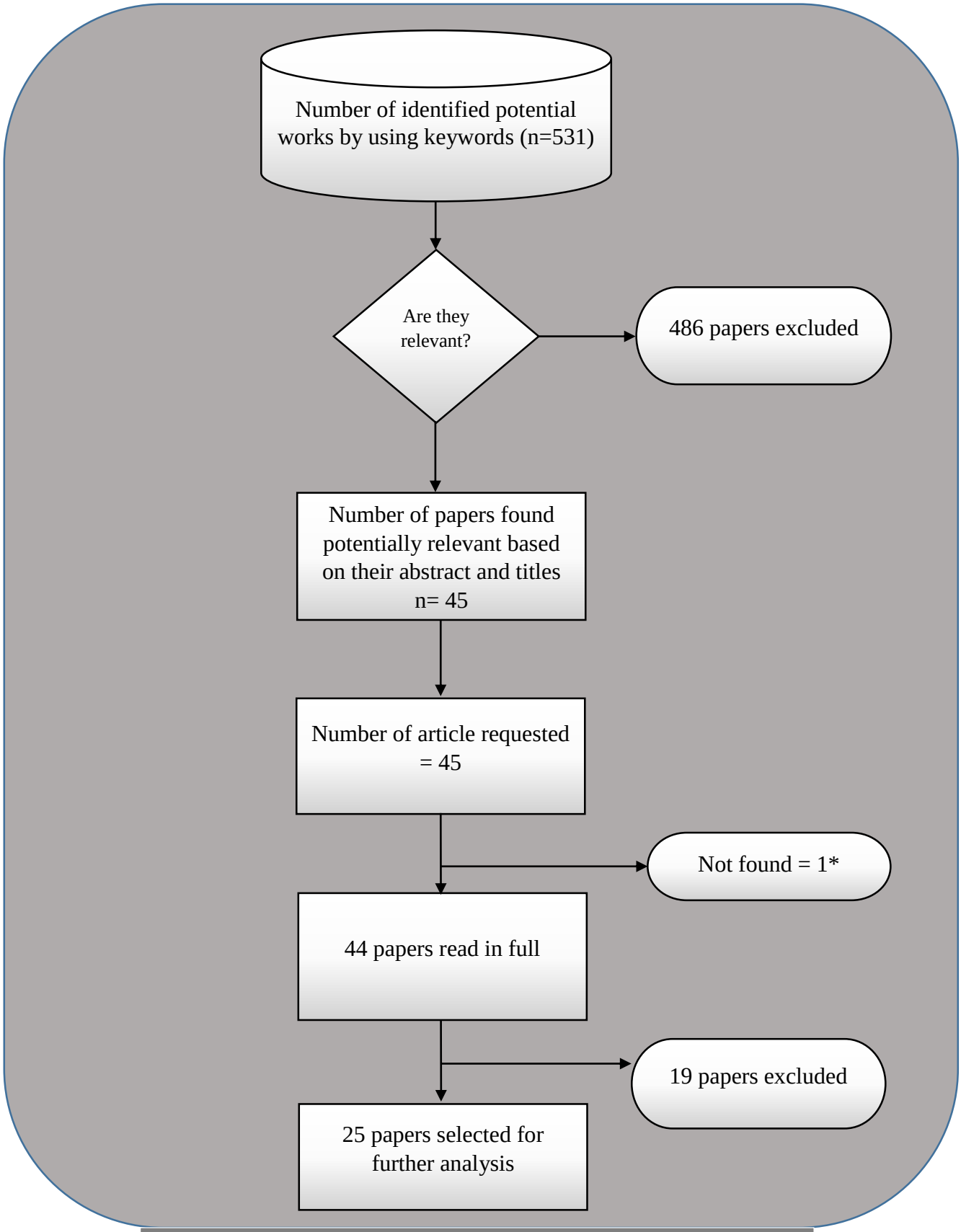


Figure 3.2 – Flowchart of Paper Selection Process

*The paper by Luo et al. (2015) could not be found in all the databases available at the University of Algarve

4. Results

After assessing the papers in detail, the results show that only 25 of the papers published in international journals and indexed in the web of science bibliographic database discuss the use of the System Dynamics method in the field of tourism. Moreover, we found that only six out of the 25 selected papers were published in tourism journals. Likewise, only four papers were published in the "System Dynamics Review", the most well-known journal in the area of System Dynamics. The remainder 15 papers were published in journals of other scientific fields. For instance, Journal of Computer Information Systems (Chen 2004) and Journal of Environmental Modelling & Software (Walker et al. 1998). Regarding the modeling method, 68% of the selected papers use both the qualitative and quantitative approach, 16% use only qualitative modeling and the same proportion use only quantitative modeling.

The systematic literature review's data extraction table (Annex 1) provided us with a useful overview about the selected papers. In the following sub-sections, publications by year, the geographic location where the tourism system was analyzed and the distribution of publications by sector are presented.

4.1. Publication by Year

Figure 4.1 shows the publishing frequency of the selected articles from 1990 to 2014. It indicates that recently there has been an increase in the use of System Dynamics in tourism.

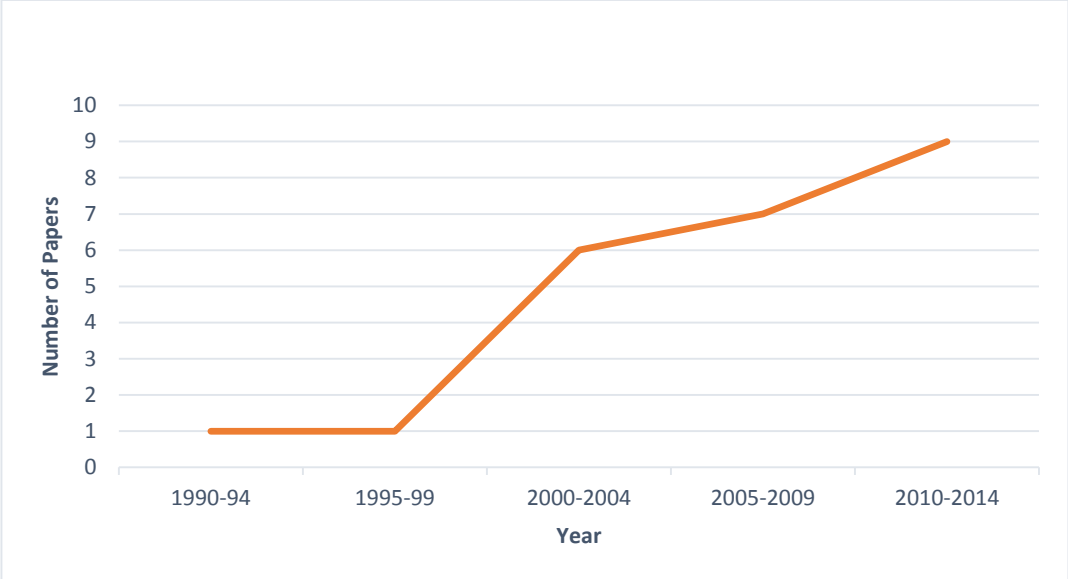
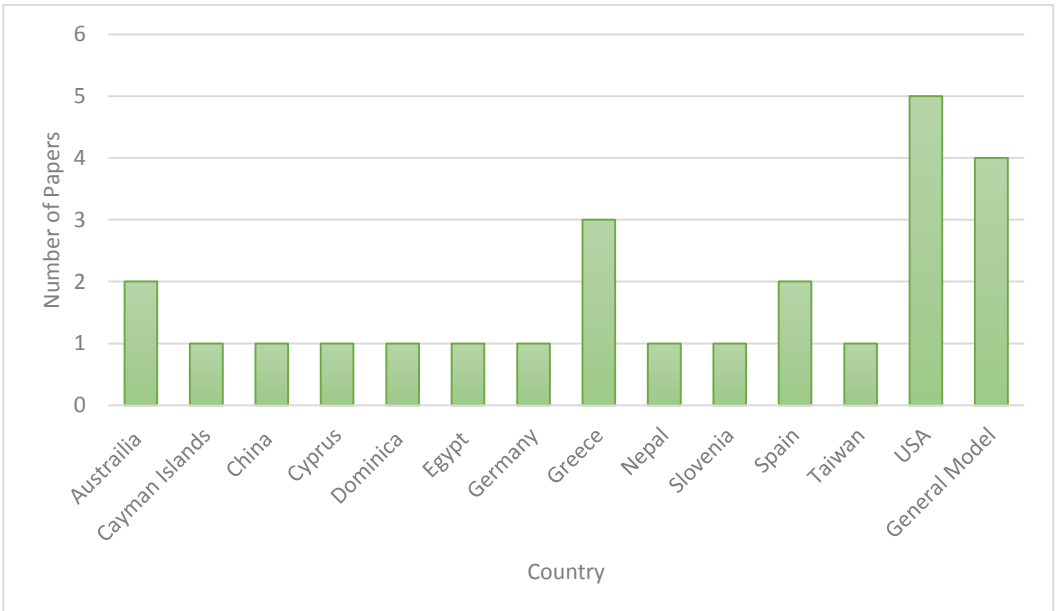


Figure 4.1 – Publication by Year

4.2. Geographic Location of the Analyzed Tourism System

Figure 4.2 shows the geographic location of the tourism systems analyzed by means of the System Dynamics approach. The four countries which received more attention are USA, Greece, Australia and Spain. It should be noted that four papers (16%), instead of concentrating on analyzing a tourism system in a specific location, focused on a general model.



4.1. Figure 4.2 - Geographic Location of the Analyzed Tourism System

4.3. Distribution of Publications by Sector

As we can see in Figure 4.3, Sport & Recreation and the Transportation sectors by having 36% and 32 % respectively, received more attention in comparison to other sectors. Sport & Recreation is composed of various sub-sectors, such as ecotourism which offers a wide range of activities to tourists. Authors have concentrated on different areas, for instance, sustainable golf tourism (Woodside 2009), wildlife tourism management (Semeniuk et al. 2010) and national parks (Panzeri et al. 2013). Moreover, since the transportation sector plays a vital role in the tourism supply chain and interacts with different industries, this sector have received a considerable attention. For instance, many authors have focused on the airline industry (Liehr et al. 2001; Agusdinata & de Klein 2002; Peterson et al. 2007; Pierson & Sterman 2013).

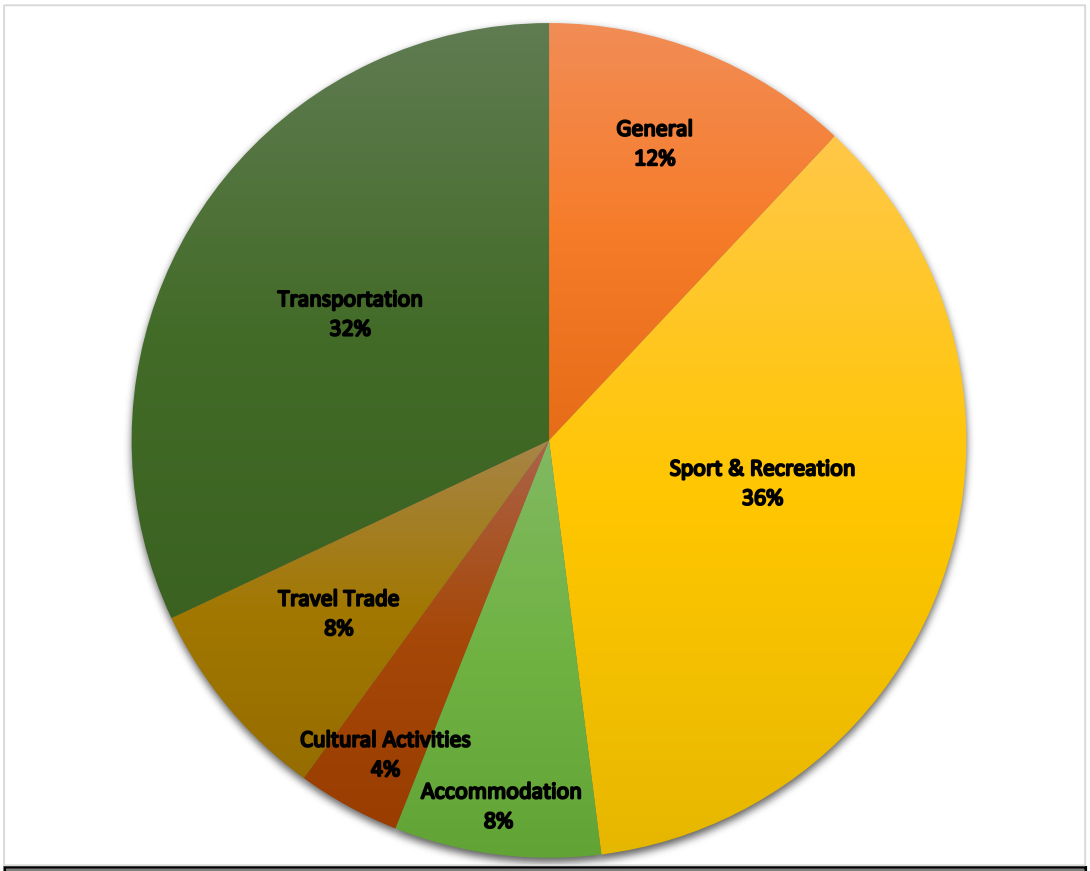


Figure 4.3 - Distribution of publications by sector

5. Discussion

The main objective of the selected publications is using the System Dynamics method to analyze and discuss tourism and its related systems. However, due to the variety of tourism industry's sectors and sub-sectors, the focus of the papers have varied from specific subjects to broader ones. For instance, public participation in environmental planning (Stave 2002) is an example of applying System Dynamics to a particular subject. On the other hand, the tourism future simulator (Walker et al. 1998) tries to give a broader look to the use of this method in tourism.

The following discussion reports on what has been done regarding the application of System Dynamics in tourism, with an emphasis on the dynamic modeling process stages. This discussion is structured in order to scrutinize different aspects of System Dynamics application in tourism. In this way we aim to understand how complex problems are defined in tourism and what kind of dynamic characteristics have been identified to conceptualize the tourism system. Moreover, the different systems' behavior were checked based on tests and defined scenarios.

5.1. Defining Complex Problems in Tourism

Walker (1998) argues that the driving forces of tourism are shaping the industry and learning about them can help us to gain some overview for the future. Tourism consists of a myriad of sub-systems or related industries and all these systems are interconnected and working at the same time.

The majority of the identified papers were focused on specific sectors or sub-sectors of the tourism industry. For instance, some papers worked on the transportation sector and specifically on the airline industry or airport's terminal (Liehr et al. 2001; Agusdinata & de Klein 2002; Peterson et al. 2007; Manataki & Zografos 2009; Manataki & Zografos 2010; Pierson & Sterman 2013).

The transportation sector is one of the most influential sectors in tourism, as such, many authors have worked on its related topics. In the airline industry, for instance, due to the cyclicality of this business a change in the market can cause a great impact on earnings

(Liehr et al. 2001; Pierson & Sterman 2013). Since airports contain several stakeholders and operators, a small malfunction in any part of their sub-systems will lead to a series of problems which contribute to passengers' dissatisfaction (Manataki & Zografos 2009; Manataki & Zografos 2010). The blast wave of a security accident can cause a downfall in commercial aviation industries and the related supply chains (Peterson et al. 2007). Moreover, the importance of internationalization in this industry was emphasized, showing that it can also bring fluctuations to the tourism market (Agusdinata & de Klein 2002).

Tourists are constantly using city transport and highways and have a direct impact on them. The presence of tourist has consequences on traffic, delays, construction and maintenance. Meanwhile, climate change has drawn a serious attention to CO2 emissions associated to tourism (Egilmez & Tatari 2012; Trappey et al. 2012; Guzman et al. 2013).

There are different active sectors in the tourism industry which have their own specific impacts. According to Georgantzas (2003) tourism impacts on society, environment and economy can be controversial. The destructive impacts of tourists on environment and destinations on the one hand, and expectation of tourists, on the other hand, are important factors and issues which have mutual interactions (van den Bergh & Nijkamp 1994; Semeniuk et al. 2010). Authors have emphasized on the importance of managing these areas and all the related activities. Land use, urban development and hydrological changes are problems that due to their high negative impacts should be observed and controlled in destinations (Fernández et al. 2005; Woodside 2009). Impacts of visitors in destinations whose local people are already dependent on natural resources can be problematic (Chen 2004; Patterson et al. 2004; Panzeri et al. 2013).

Heritage sites due to their sensitivity and importance require a specific attention from authorities and governments. These sites attract many tourists every day and have major influence on regional economies and people's welfare. It is important to have a management plan for such areas in order to control all the interactions and businesses (Xu & Dai 2012). Stave (2002) explains about the influential role of stakeholders' opinion in decision making for environmental policy and strategic planning. Moreover, the impact of unsustainable tourism can be very destructive. Flooding a mass of uneducated tourists to a sensitive destination can have a lot of consequences. Thus, in order to preserve the

resources, a framework for sustainable tourism development is required (Xing & Dangerfield 2010).

5.2. System Conceptualization & Model Formulation

In the 25 selected papers, a consensus can be found among authors on the complexity of the tourism industry and its related sectors. The aim of system conceptualization is to explain the key variables and their interactions with each other to get a better understanding of the model. The authors tried to explain the dynamic characteristics of their models and structure their feedback loops. According to Walker (1998) and Lazanski and Kljajić (2006) the tourism industry is composed by a large number of sectors with different economic, social and environmental dimension. Each of these sectors can be a complex system by itself and therefore they should be managed simultaneously.

Island destinations can be considered as complex systems. In order to reach sustainable development in these destinations, tourism is being used to enhance their economies by improving supply chains (van den Bergh & Nijkamp 1994; Georgantzas 2003; Xing & Dangerfield 2010)

Egilmez & Tatari (2012) stress that all the industries and services are dependent on transportation. This sector deals with a huge amount of interactions at the same time, therefore it plays a significant role in the supply chain. In the airline industry some authors mention how delays in the lead time of the aircraft manufacturer and problems in understanding over-capacity can cause oscillation in the market (Liehr et al. 2001; Pierson & Sterman 2013). Moreover, regarding the airline industry, the market is sensitive to different changes, such as security issues or airline companies merger, which cause problems in demand or revenue management (Agusdinata & de Klein 2002; Peterson et al. 2007). Manataki & Zografos (2009; 2010) regarding airports assert on how they are dealing with a large scale of supply system which consists of several independent stakeholders and sections.

Furthermore, tourists have influence on the intricate engineering system of destinations and the complexity of city transport systems and highways. Understanding this complexity is necessary in order to build a low carbon policy structure, reach sustainable

transportation, and reduce delays and cost of maintenance (Egilmez & Tatari 2012; Law et al. 2012; Trappey et al. 2012; Guzman et al. 2013).

The Sport & Recreation sector is characterized by complex mutual relationships between the ecological systems and human factors. Tourism, natural resources, climate change, local communities, and recreational activities are all interdependent (Stave 2002; Chen 2004; Patterson et al. 2004; Schianetz et al. 2009; Woodside 2009; Semeniuk et al. 2010; Panzeri et al. 2013). Xu and Dai (2012) bring a similar explaniation about the historical monuments and destinations which interact with a complex environment, consisting of businesses and stakeholders in their surroundings. Some authors have also understood destinations as being similar to organizations, bringing up the concept of "learning tourism destination", according to which individual development of an element of the system will lead to development of the whole system (Schianetz et al. 2007; Schianetz et al. 2009).

By using the dynamic characteristics of a system, a feedback loop can be structured which represents the dynamic interactions in each system. These models are being used as facilitators for better understanding the complexity of the system. In the transportation sector, feedback loops are used for different reasons such as demonstrating the way airports are clustered by showing interaction among every section (Manataki & Zografos 2009; Manataki & Zografos 2010). These models are being used to show the social, environmental and economic backlashes of exogenous and endogenous factors on different aspects of tourism. For instance, feedback loops are useful to model airline earnings, passenger security costs, carbon dioxide emission, visitation rates, GDP, global tourism market, learning tourism destinations (LTD) and how iterative the airline business could be (Fernández et al. 2005; Peterson et al. 2007; Schianetz et al. 2007; Law et al. 2012; Pierson & Sterman 2013).

5.3. Analysis of Tourism Model Behavior

A very crucial reason to build a model of a system and evaluating it is to find the impacts derived from environmental, economic and social approaches toward the system. This can be done by using the reference model which will help to test and simulate the behavior of the system. In general, the reference model test is conducted to show the model's

capabilities and interactions among the elements of a system. Xu and Dai (2012) explain that running their reference model provides a tool to gain a better perspective toward relations among sectors.

Some of the selected papers have focused on similar factors and impacts, such as the CO2 emission indicator. By running some tests, the results derived from reference models showed the necessity of using different controlling policies (Law et al. 2012; Trappey et al. 2012). Moreover, in the work of Trappey et al. (2012) the scenario of business as usual did not contribute to the implementation of a green transportation system.

Due to the unique properties of each sector a reference model is built to check the behavior of the system. For instance, Manataki and Zografos (2009; 2010) used a reference model in order to assist in demonstrating the complicated operational environment of airport terminals. According to Liehr et al. (2001), in the airline industry, the simulation of a reference model shows that fluctuations in the market are independent from developing demands for flights. In the case of public participation in environmental decision making, Stave (2002) shows that there would be an additional cost for transportation improvement.

5.4. Policy Implication

Policy analysis is conducted to evaluate different assumptions and scenarios in the system. By increasing a rate or manipulating some elements in a system, it is possible to assess its behavior under different circumstances and check its performance on specific scenarios.

In some papers, by using different scenarios, policy analysis was conducted and the outcomes were found useful. In some cases, such as heritage conservation or sustainable urban transport framework, a scenario of strict policy implementation was defined. The results showed that such policies will not pay off in the expected way (Xing & Dangerfield 2010; Xu & Dai 2012).

In case of Sporades islands, van den Bergh and Nijkamp (1994) use two limitations for designing scenarios. The first limitation is the high dependency of the Sporades islands' economy on tourism. The second one is the sensitive condition of environmental conservation which is influenced by the economy and human activities. After considering the designing constraints, scenarios were formed based on social, economic and environmental patterns. The outcomes of this study showed the ability of System Dynamics for giving an insight over the long run. Moreover, scenarios indicated that tourism growth will reduce unemployment and enhance the economy. For realizing such an outcome, it is necessary to implement some restrictive policies in order to reduce the negative impacts on the environment.

Georgantzas (2003) suggested four scenarios for hotel value chain in Cyprus to check the changes in bed capacity, value chain parameters, tourism growth, and price seasonality. In bed capacity and value chain scenarios, the impact of the bullwhip effect on the tourism market can be seen more on suppliers than hotels. In the tourism growth scenario, building hotels in Cyprus is prone to any changes in the market and any fluctuation can lead to significant negative impacts. In price seasonality, the last scenario, reducing the tourism seasonality can contribute to increasing hotels' profit. The results show that Cyprus' hotel value chain is unstable due to its specific structure. Building several scenarios can be helpful for hotel managers to prepare themselves for any further changes.

Schianetz et al. (2007; 2009), in the topic of "learning tourism destinations", defined some key scenarios to gain a new vision about what can affect the development of a destination in the long run. These scenarios indicate that involving stakeholders, holding workshops for them and using the potential of system thinking for building a shared vision helped to learn more about their mental models regarding the destination. Stave (2002), in addressing "public participation for decision making" developed four scenarios and concluded that maximizing vehicle occupancy would be the best option. In Stave's (2002) study, System Dynamics provided two kinds of benefits: a good structure for education, and also a great tool for technical analysis of the process.

In heritage sites, Xu and Dai (2012) investigated the implementation of the following four scenarios: resident house, tourism, second home and sustainable policy. In this

study, sustainable policy turned out to be the best solution. Controlling the use of residential houses for tourism and using the generated income to restore the monuments leads to a sustainable preservation. Semeniuk et al. (2010), addressing wildlife tourism management, proposed scenarios in order to find the negative impacts of tourism on wildlife. The results indicate that the presence of tourists will decrease the life expectancy of stingrays. In this study, System Dynamics shows the need of a good management plan to prevent the negative impacts on wildlife health and tourists' experience.

In the process of reaching a green economy, Law et al. (2012) used different environmental, social and economic scenarios. These scenarios showed the ability of System Dynamics in assessing future impacts of tourism indicators such as destination revenue, hotel occupancy level and greenhouse gases emissions on reducing energy consumption. Egilmez and Tatari (2012), addressing highways sustainability, used scenarios to find the best policies for lowering and controlling the level of CO2 emissions. Moreover, System Dynamics simulations show that to reach sustainability it is necessary to use collaborative policy making.

5.5.Model Use or Implementation

Models were made and used for different purposes such as being implemented in a sector or destination, in order to improve the general understanding of a system. In the selected papers, seven cases were implemented to destinations or sectors. Manataki and Zografos (2009; 2010) published an assessment for terminal performance for Athens international airport. Trappey et al. (2012) worked on a model of low carbon island in Taiwan. Fernández et al. (2005) implemented a model in which aquatic birds are bio indicators of trophic changes and ecosystem deterioration in the Mar Menor Lagoon. This model was used for a watershed management plan. A System Dynamics model was used to check public participation in environmental decisions in Las Vegas (USA) by Stave (2002). The project of managing cycles of the airline market was conducted for the Lufthansa Company in Germany by Liehr (2001). Van den Bergh and Nijkamp (1994) worked on a case study of economic development and natural environment in Greece. The model indicate that regional development may lead to environmental unsustainability.

6. Conclusion

In this systematic literature review, we explored the literature on the application of System Dynamics to the tourism industry. This helped us to gain a better perspective about the use of this method in the tourism industry. This review disclosed useful information about the concentration of publications on each sector and opened a new outlook about the possible applications of System Dynamics to tourism.

Several other approaches exist to model the complex structure of industries such as geographic information systems (GIS), and agent based models (ABM). Nevertheless, the evidence and results of this study show that System Dynamics has been used to capture the complex interactions of the different systems in the tourism industry.

A set of 25 papers were selected and reviewed. All the assessed papers showed the relevance of using the System Dynamics method in the tourism industry and its related sectors. This study aimed to identify the tourism complex problems in different sectors. Furthermore, it investigated the ways in which a system is structured and what kind of behaviors come out of simulations. Moreover, we determined what scenarios have been designed and what the likely outcomes of implementing such policies would be.

According to the results of this systematic literature review, a new viewpoint can be gained regarding the use of the System Dynamics method to tourism. The following conclusions can be drawn from the results of this study:

- Despite the large number of industrial application of System Dynamics we found only 25 papers discussing the application of this modeling method in the tourism industry.
- Most of the investigated papers focus on related industries which are in interaction with the tourism industry. It can be said that there is a lack of a fundamental work on the concept of tourism system by using this method. Apart from Walker (1998) and Chen (2004) there are no other relevant studies implicitly working on this topic.
- Among selected publication, the main concentration was on the transportation sector and its related sub-sectors such as highways and airlines. Likewise, some

authors have focused on the related topics of sports & recreation, such as ecotourism and golf tourism. There is just one paper on the accommodation sector (Georgantzas 2003). No study was found in the food and beverage sector.

- In a tourism destination, if a modeler is dealing with local communities or different groups of stakeholders, using qualitative models helps to explain the relations among the elements in an understandable way.

Although in this study we found literature on the tourism sector and sub-sectors, the main problems and issues that tourism is dealing with are yet to be analyzed by using System Dynamics method. The majority of papers have focused on the sectors that independently can be considered as a complex industry such as transportation. Nonetheless, for future work, System Dynamics has the potential for analyzing tourism systems in particular or in general. The most important and necessary work is to concentrate more on different concepts of tourism by applying a holistic approach to this industry. For instance, some issues that could be analyzed include the long run impact of mass tourism on tourism hotspots or the balancing role of particular tourism activities as a complementary tool to reach sustainability. More specifically, System Dynamics can be used for modeling and strategic planning of natural resources. Another possible application is to model the interactions of tourism destinations with focuses such as tourist behavior and satisfaction level, security issues and the impacts of tourists on a specific environment. Moreover, research needs to be done on different sectors and sub-sectors of the tourism industry in which no study or just a few exist (e.g. accommodation, food & beverage, cultural activities).

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Annex 1.

Annex Table						
Authors	General Objective	Country	Software	Qualitative/Quantitative	Objective of using System Dynamics	Sector
Agusdinata and Klein (2002)	Analyzing the power and importance of airline alliances	General Model	Vensim	Qualitative	Showing the capability of System Dynamics in capturing the complexity of airline alliances	Transportation
Van den Bergh and Nijkamp(1994)	Modeling a sustainable development plan to explore the problems between economic and environmental aspect	Greece	–	Both	Using System Dynamics to integrate the economic and environmental aspect of tourism as one	Sport & Recreation
Chen (2004)	Assessing the impacts of tourism on environmental conservation	USA	Powersim	Qualitative	Using System Dynamics to build a decision support system for natural resource management	Sport & Recreation

Annex Table (Cntd.)						
Authors	General Objective	Country	Software	Qualitative/Quantitative	Objective of using System Synamics	Sector
Egilmez and Tatari (2012)	Modeling the sustainable transportation in supply chain of products	USA	Vensim	Both	Using System dynamics to give a holistic approach to sustainable transportation for low carbon emission	Transportation
Fernandez (2005)	Modeling the watershed socio-economic and ecological factors of Mar do Menor	Spain	Vensim	Both	Using System Dynamics to estimate all relevant factors which affect nutrient load in the wetland	Agricultural Sector
Georgantzas (2003)	Modeling of tourism value chain in Cyprus	Cyprus	iThink	Quantitative	Using System Dynamics as strong tool for modeling the island's hotel value chain	Accommodation
Guzman et al. (2013)	Making a decision support system to optimize and facilitate the way to achieve sustainable transportation in cities	Spain	Vensim	Both	Using System Dynamics for helping the process of structuring a travel behavior	Transportation

Annex Table (Cntd.)						
Authors	General Objective	Country	Software	Qualitative/Quantitative	Objective of using System Dynamics	Sector
Law et al.(2012)	Planning strategies for tourism destinations to play a role in decarbonization	Egypt	Powersim	Both	Using System Dynamics for moving toward green economy	Accommodation
Lazanski and Kljajic (2006)	Using causal loop model for modeling Slovene tourism market development	Slovenia	Powersim	Both	Modeling a complex system by using cause and effect relations	General model
Liehr et al. (2001)	Modeling the market cycle of airlines and planning alternative strategies	Germany		Both	Using System Dynamics as a complementary tools for statistical approach to model behavior of the market	Transportation
Manataki and Zografos (2009)	Modeling a terminal system which is accurate and adaptive	Greece	STELLA	Quantitative	Using System Dynamics to model a powerful framework for terminal performance	Travel Trade

Annex Table (Cntd.)						
Authors	General Objective	Country	Software	Qualitative/Quantitative	Objective of using System Dynamics	Sector
Manataki and Zografos (2010)	Developing a decision support system for airports terminal strategic planning	Greece	STELLA	Quantitative	Giving a holistic approach by using the ability of System Dynamics	Travel Trade
Panzeri et al. (2013)	Developing a systematic view for conservation and poverty reduction based on porters	Nepal	_	Both	Using System Dynamics to assess the impacts of tourism activities	Sport & Recreation
Patterson et al. (2010)	Modeling different aspect of tourism to analyze the development in islands	Dominica	STELLA	Quantitative	Using System dynamics to make a framework to analyze the impacts of different policy implementation over time	Sport & Recreation
Peterson et al. (2007)	Modeling a new security policies in airline industry	USA	_	Both	Giving a holistic approach for long term planning	Transportation
Piersona and Sterman (2013)	Exploring different aspects of airline cyclical earning	USA	Vensim	Both	Showing the complexity of airline system using System Dynamics	Transportation

Annex Table (Cntd.)						
Authors	General Objective	Country	Software	Qualitative/Quantitative	Objective of using System Dynamics	Sector
Semeniuk et al. (2010)	Modeling for sustainable wildlife tourism management	Cayman Islands	STELLA	Both	Using System Dynamics to compare different policy implementation on ecological and social component of the system	Sport & Recreation
Schianetz et al. (2004)	Assessing approaches in learning tourism destinations management	Australia	Vensim	Both	Analyzing the potential of using System Dynamics in learning tourism destinations	Sport & Recreation
Schianetza et al. (2007)	Making a collaborative approach to move toward a sustainable destination	General Model	–	Qualitative	Proposing System Dynamics as a power tool in promoting learning tourism destination	Destination
Stave (2002)	Enhancing mutual communications for environmental decision making	USA	Vensim	Both	Solving and facilitating the problem of communication with the public	Transportation

Annex Table (Cntd.)						
Authors	General Objective	Country	Software	Qualitative/Quantitative	Objective of using System Dynamics	Sector
Trappey et al. (2012)	Building a benchmarking platform for low carbon communities	Taiwan	_		Modeling a low carbon destination containing a complex set of factors	Transportation
Walker et al. (1998)	Assessing the impacts of nature based tourism on a region and it stakeholders	Australia	Vensim	Both	Building a strong model which can be adaptive to different sectors	Sport & Recreation
Woodside(2009)	Reaching sustainable golf tourism through partnership	General Model	STELLA	Qualitative	Showing how this method can lead to increasing the quality of life	Sport & Recreation
Xing and Dangerfield (2010)	Assessing the benefits of using system dynamics to understand the ways to reach sustainability	General Model	Vensim	Both	Analyzing impacts of tourism activities on an islands destination	General model
Xu and Dai (2011)	Structuring a model of cultural heritage destination	China	Vensim	Both	Using System Dynamics to gain long term perspective toward complex systems in heritage sites	Cultural Activities