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Smart Tourism Destinations as Complex Adaptive Systems: a Theoretical Framework of Resilience and Sustainability

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Smart tourism destinations as complex adaptive systems: A theoretical framework of resilience and sustainability

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Abstract. The concepts of "resilience" and "sustainability" have often been associated with each other in a systems view. The health crisis has prompted theorists and practitioners to increase their efforts to identify the stressors and impact factors that disrupt systems, as well as the factors that can enhance resilience and sustainability. In this respect, this paper presents tourism destinations as complex adaptive systems (CAS), and aims to establish the link between the resilience and the sustainability of these systems in favor of developing their intelligence. Thus, a theoretical model is proposed, representing the functioning of smart tourist destinations (STDs) seen as CAS, in terms of sustainability and responses to critical functions. This paper presents some theoretical and managerial implications. On the one hand, it establishes the link between resilience and sustainability of a system, based on the models proposed by Ahi, P., & Searcy, C. (2013) and developed by Marchese, D et al. (2018), and presents intelligent tourism systems as CASs undergoing the same functioning. And on the other hand, this model can prove useful for managers and administrators of destinations who seek to increase its resilience and sustainability by focusing on improving enhancing factors and controlling all types of disturbances.

Keywords: Resilience . Sustainability . Complex Adaptive Systems (CAS) . Smart Tourism Destinations (STDs) . Stress and Impact factors .

1 Introduction

Tourism dependence is a reality for an ever-increasing number of cities, regions, and nations around the world [1]. However, tourism systems reveal many vulnerabilities to their internal and external environments [2]. The scope of these threats goes beyond the tourism sector and can affect a significant number of systems of all types. It is in this regard that there are ongoing efforts to ensure a future that offers both a high quality of life and resilience to the impacts of undesirable events. These efforts have led to an ever-increasing focus on sustainability and resilience [3]. In this sense, the development of smart tourism promises various benefits, including destination resilience and sustainability [4], and has become a mantra for many destinations around the world [5]. In fact, the Application Areas of Complex Adaptive Systems

provide an esteemed overview of the latest research on the strategies, applications, practice, and implications of complex adaptive systems to better understand the various critical systems that surround the social sciences in general, and the management domain of the tourism sector in particular.

This article then presents smart tourism destinations as complex adaptive systems and proposes a theoretical model that compares this resilient and sustainable system to a non-resilient and unsustainable one, while specifying the factors for enhancing this system and the desired outcomes. Therefore, this paper addresses the following issue: How can we theoretically model the functioning of resilient and sustainable smart tourism destinations? To answer this question, three derived questions should be considered:

- What is the relationship between resilience and sustainability of a complex adaptive system?
- To what extent are STDs seen as CAS?
- What are the stress and impact factors in STDs, and the factors enhancing their resilience and sustainability?

In this article, the first part of literature review will be dedicated to defining the resilience of a system, an ecosystem and, finally, a complex adaptive system (CAS). Explaining the relationship between resilience and sustainability by presenting each time one as a component of the other will follow. The second part of literature review that presents smart tourism destinations as CAS and emphasizes their resilience and sustainability for the creation of renewed competitive advantages will be presented. Next, we will shed light on the stressors and impact factors of STDs, as well as the factors promoting their resilience and sustainability. Finally, a representative theoretical model will be proposed in order to bring together the knowledge already mentioned above.

2 Literature review

2.1 The Resilience of Complex Adaptive Systems and its Link with Sustainability

The Resilience of an Eco/System

Resilience, according to [6], is the ability of a system to absorb different disturbances. It is, in fact, another way of looking at the strength of a coupled human-environment system [7]. Indeed, the term "resilience" is one of the most polysemous terms, given its multidisciplinary use in humanities and social sciences, medicine, ecology, and economics and management sciences. The popularity of the term in question comes from the fact that resilience, as the ability to bounce back, can be applied to any ecosystem [8] to describe its ability to return to the normal functioning after a major disturbance. Therefore, the term can be extended to the solutions that the international community seeks to overcome the various crises/stress and impact factors that may arise.

However, it should be noted that the notion of resilience is based on the idea that after a disturbance, the system is not marked by a simple return to equilibrium. It rather expresses a resistance behavior defined as the notion of "reactive resilience" that often reacts, unexpectedly, in a positive, creative way, thanks to multiple readjustments called "proactive resilience". This type of resilience stipulates that the occurrence of disturbances favors the renewal of the system. Indeed, in the case of complex systems such as social and territorial systems, the concept of proactive resilience is part of the paradigm of plural equilibria [9], in the sense that the system's behavior is dictated by several attractors. The notion of resilience, thus, implies that the system ensures its continuity not only by preserving an immutable equilibrium, or, by returning to the same state as before the disturbance, but also by integrating transformations into its

evolution. Accordingly, resilience is a concept that fits into the theoretical framework of systems far from equilibrium.

The Resilience of a Complex Adaptive System (CAS)

A complex adaptive system (CAS) is the set of special cases of a complex system capable of adapting to its environment through learning experiences. The term "CAS" was introduced by the Santa Fe Interdisciplinary Institute, notably by John H. Holland and Murray Gell-Mann in 1962. Indeed, the great difference between a complex system and a linear system is its predictability: in a linear model, such as chemical equations, we are able to predict its result. However, in a complex model, it is practically impossible to predict future results if we do not model all the relationships of the system. It is, therefore, not possible to describe the response of a complex system to a change due to the interdependence of all its stakeholders. Moreover, [10] state that the more complex a system is, the greater its fragility but also the greater its reservoir of structural change. In this regard, Scutarri and Corradini observe that resilience has evolved to be understood as a property of complex adaptive systems, "managing inevitable disturbances toward a desirable and unstable development path" (2018: 35).

The Relationship and Difference between Resilience and Sustainability

The concept of resilience has often been linked to the concept of sustainability, despite the differences in definition, tools, methodology, and application areas of the two concepts. For this reason, no single management framework can be proposed to meet the needs of all stakeholders. However, [11, 12] reviewed existing strategies for implementing the two concepts in the literature and categorized these strategies using three generalized frameworks that capture their common goals: (1) resilience as a component of sustainability, (2) sustainability as a component of resilience, and (3) resilience and sustainability as distinct goals. We have retained the first two assumptions in order to not only understand the relationship between the two concepts, but, to be able to present them in a common framework as well.

Resilience as a Component of Sustainability

Several scientific researchers have proposed quantitative methods that incorporate resilience as a component of sustainability [13, 14]. Indeed, this first view states that without resilience a system can only have fragile sustainability [15]. In addition, sustainability is seen as a system goal, and resilience is used as a tool to achieve these goals [16]. Furthermore, according to [17], the design process of a system must consider its vulnerabilities to disturbances to be considered sustainable. In this respect, Figure (1) illustrates how the resilience of a system can impact the sustainability of that system [12] and shows how a resilient system can become sustainable after recovering from a disturbance through the adaptive component of resilience.

Sustainability as a Component of Resilience

This view is used in several recent studies in the fields of supply chain management [11-18, 19], public policy [20], and business management [21]. In this context, the goal of resilience is to maintain critical functionality (including safety, profit ..) during and after disturbances. Thus, with increasing economic, environmental, and social well-being, this critical functionality illustrates sustainability as a component of resilience (Figure 2) . Indeed, a more sustainable system is better able to absorb, recover from, and adapt to economic, environmental, and social disturbances. Put differently, this view asserts that increasing the sustainability of a system makes that system more resilient, but increasing the resilience of a system does not necessarily make that system more sustainable.

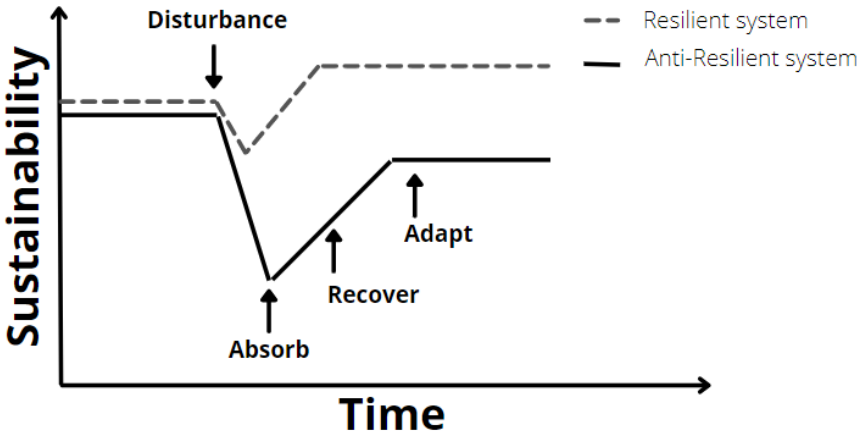

Fig. 1: Resilience as a component of sustainability adapted from [12]

An important difference between sustainability and resilience is the time scale of implementation. Sustainability efforts are often undertaken on longer time scales than resilience. The primary goal of sustainability is to create desirable conditions for future generations [22]. Therefore, the effects of sustainability policies may not directly influence current conditions, but they may have substantial effects on future conditions. Resilience, on the other hand, is understood in many situations as applying to more immediate time scales [23]. Policies that increase the resilience of a system will protect the system in the short term from potential disturbances. Common efforts exist across disciplines and framework styles to implement resilience and sustainability. These efforts include prioritizing sustainability and resilience goals [15, 24], capitalizing on synergies [3, 25], mitigating the negative impacts of conflict [26, 27] and communicating efforts to stakeholders [28].

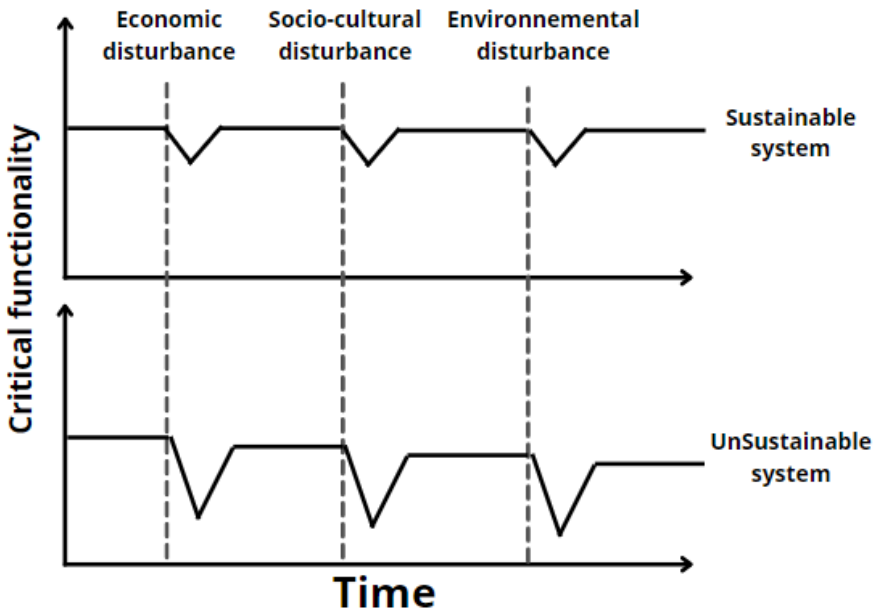

Fig. 2: Sustainability as a component of resilience adapted from [12]

2.2 The Resilience of Smart Tourism Destinations and their Sustainability

The concept of resilience reinterprets the way of thinking about the urban system and its disturbances. Applied to a city, it retains its definition of the capacity to absorb a disturbance and to recover its functions following this disturbance. Consequently, the operationality of the concept would involve the need to adapt the functioning of the urban system, as well as its components to potential disruptions, to rebuild the urban system, following a major disruption, or, to define crisis management methods by integrating the complexity of the city itself [29]. Thus, the concept of resilience applied to the city seems to find operational translations, particularly in terms of urban services, which also meet the objectives of sustainability.

Intelligent Tourism Systems seen as CAS: Resilience offering Renewed Competitive Advantages

Territorial systems can be described as CAS, in general, and tourism destinations, in particular. Indeed, the tourism literature of the last decades repeatedly describes tourism destinations as complex adaptive systems (CAS) [30-31, 32] and resulted in an evolutionary approach. This view of destinations is accentuated by the growing interest in "smart tourism" practices and "smart tourism destinations." Consequently, over the past three decades, e-tourism, as a field of scientific research, has evolved into a substantial body of knowledge focused on the development of information theory and technology, in relation to fundamental tourism issues [33]. Therefore, technology has become a major factor in building resilience in tourism [34, 35]. It is not surprising, then, that tourism academics and practitioners are investing considerable time and energy in research focused on resilience strategies that will ensure the longevity of tourism destinations in the face of crisis or adversity, as well as in relation to slow-moving change.

Indeed, in a context of social uncertainty and crisis, tourism development may be different from that observed in times of prosperity [36]. For this reason, evolutionary resilience efforts go beyond maintenance towards improving the system through continuous adaptation and transformation [32]. Put differently, evolutionary resilience thinking and action extends the scope of a system beyond resistance and recovery to trajectories of reorientation and renewal [37]. Accordingly, the pursuit of destination resilience at the system level as an overarching strategic direction not only contributes to destination survival [38, 39], but, by embedding resilience into the very fabric of the destination, it can help ensure system longevity through a pipeline of renewed competitive advantages [40]. Indeed, the scale and pace of change/disruption, the exposure and sensitivity of the system as a whole, or, just its component parts, and the ability of the system to mitigate and/or compensate for certain vulnerabilities are critical to a destination's survival [41-42, 43].

Stress and Impact Factors in Smart Tourism Destinations

Within and across tourism systems, destinations frequently face a combination of internal and external disturbances that take the form of slow-moving "stressors" or fast-moving "shocks" [43, 44]. External shocks experienced by tourism destinations include, for example, epidemics, terrorism, natural disasters, and large-scale transportation or construction infrastructure accidents. External stressors, on the other hand, include natural resource shortages, climate change, economic downturn, and environmental degradation [45]. As for technological advances, they can be considered external stressors that affect all destinations, but even more so smart destinations due to their increased reliance on technology [46]. These advancements can also be considered internal stressors when it comes to, for example, the dissemination of misinformation or even the slow rollout of a new destination

marketing strategy, especially when many stakeholders are involved. Really, this type of stressor can lead to a weakening of relationships, a decline in stakeholder performance, and a compromise in the overall quality of the tourism experience at the destination.

Factors for Reinforcing the Resilience of Smart Tourism Destinations

[47] describe three areas of capacity for tourism systems and the disruptions they face: 1) absorptive adaptation; 2) adaptive capacity; and, 3) transformation. [48] draws these findings together to propose a set of six key conditions toward building destination resilience: 1) variety and redundancy; 2) connectivity; 3) polycentric governance; 4) environmental sensitivity; 5) learning and reflexivity; and finally, 6) adaptive thinking and systems. Indeed, [48] notes that when operationalizing these constituent elements of resilience, destinations may encounter difficulties if their tourism system is "trapped" in one of the four specific traps : the rigidity trap, the lock-in trap, the poverty trap, and the isolation trap. These traps can foster a particular development trajectory that is not conducive to building resilience. By extension, [47] effectively analyzed the intersection between Hartman's [48] destination resilience conditions and smart tourism goals and objectives, and provided insights into how smart tourism infrastructure and governance can be used to support destination resilience. As a result, they proposed five pillars of smart destinations that support these six conditions and, thus, contribute to destination resilience, namely 1) sensing (sensing), 2) openness, 3) sharing, 4) governance, and 5) innovation [47].

Sustainability of STDs

In the field of tourism, efforts have focused on developing indicators for sustainable tourism destinations [49-50-51-52-53,54]. Vargas Sánchez's model [55] is the most well-known conceptual model of destination competitiveness in the tourism literature and has served as a starting point for much other research on the competitiveness of "sustainable" destinations. Today, the concept of smart tourism itself is based on the generalization of this notion, as a destination cannot be considered smart if it is not sustainable. Indeed, the development of tourism sustainability has positive effects, as before the environmental awareness of tourism demand, the perception of the destination (if it is presented as sustainable) generally tends to be better [56].

Sustainability of tourism destinations is one of the main current pillars of territories building tourism destinations and smart cities. This approach to the sustainable development of cities and towns, in addition to considering the environment as a fundamental aspect, also involves cultural and economic aspects as important roles in creating sustainable territories. Therefore, sustainable tourism is based on three main aspects when building up a smart environment: environment, socio-culture, and economy [57]. Indeed, destination sustainability indicators adopt the balance approach (economic, social and environmental sustainability) as the most visible position in public policy making and the dominant position in academic discourse [58]. Moreover, the tourism sector has an extraordinary capacity to link economic, social, and environmental aspects of sustainability. This is possible because tourism, as an economic activity, relies on intact environments, rich cultures, and welcoming communities. Therefore, technological tools enable the creation of jobs and income from cultural experiences [59]. That is, smart tourism destinations must respect the main pillars of sustainability: environment, economy, and socio-culture, establishing a perfect combination of the three parts through ICT and data analysis [59].

3 Research Methodology

This research was based on a literature review of several scientific articles related to: 1) resilience and sustainability, 2) smart tourism destination (STD) management 3) resilience and sustainability of STDs. The method adopted is a synthetic analytical method. In order to establish the link between resilience and sustainability, we based ourselves on the system representations proposed by [11] and developed by [12] as mentioned before. Subsequently, a connection between these systems and those of tourism destinations was noted and we retain therein the enhancing factors of smart tourism destinations proposed by [47], factors that can only be developed through the existence of a strong human/commercial dimension. Other enhancing factors relate to technological infrastructure and infostructure. All these elements seek, in the short term, to successfully integrate and optimize resources, in order to achieve desired outcomes in the long term; outcomes that represent the purpose of "smart tourism" practices according to several researchers.

4 Results

This diversified literature review has allowed us to conceptualize smart tourist destinations as complex adaptive systems and to situate this system in a graph according to time, critical functionality, and sustainability. We have seen that a non-resilient system, when it undergoes social, economic, or environmental disturbances, suffers a significant degradation in the course of the system depending on the strength of these critical functionalities. This system takes a long time to heal and ends up collapsing, therefore, it is an unsustainable system. However, a resilient system is characterized by its ability to bounce back, even to exceed its subsequent level, hence its sustainability. Thus, we can model these two systems in a single graph in order to compare them easily. However, a system can reach a good level of resilience if it is a system that adapts to its environment and is able to take advantage of its complexity. This is the case with all complex adaptive systems, such as the smart tourist destinations as already demonstrated.

In this respect, acting on the destinations, we synthesize the factors of enhancing the resilience that relate to the advanced technological infrastructure, such as the internet of things and sensors, artificial intelligence, machine learning, use of big data, and cloud computing. On the other hand, these factors also relate to the human and social dimensions and can be synthesized, according to [47], into openness, sharing, polycentric governance, innovation and sensing. Bringing intelligence into tourism destinations, therefore, means dynamically connecting stakeholders through a technological platform on which they can exchange information about their tourism activities in real-time [46, 57]. Moreover, we can say that the use of smart technology, and big data, in particular, allows the effective integration of resources, and consequently forms the interactive dimension of the smart tourism ecosystem [60]. This allows for better optimization of resources.

Finally, we were keen to model towards the end of the "time" abscissa the desired outcomes of smart tourism: first, this approach guarantees renewed competitive advantages, as the system manages to bounce back and opens up other possibilities during the resilience process. Secondly, the co-creation of value, since all social and economic actors are resource integrators, Moreover, operational resources are the fundamental source of competitive advantage [61]. Furthermore, the combination of tangible and intangible smart components within an adaptive complex system structure offers the possibility of sustainable competitive advantage and improved quality of life for residents and tourists in smart tourism destinations [4], hence, the

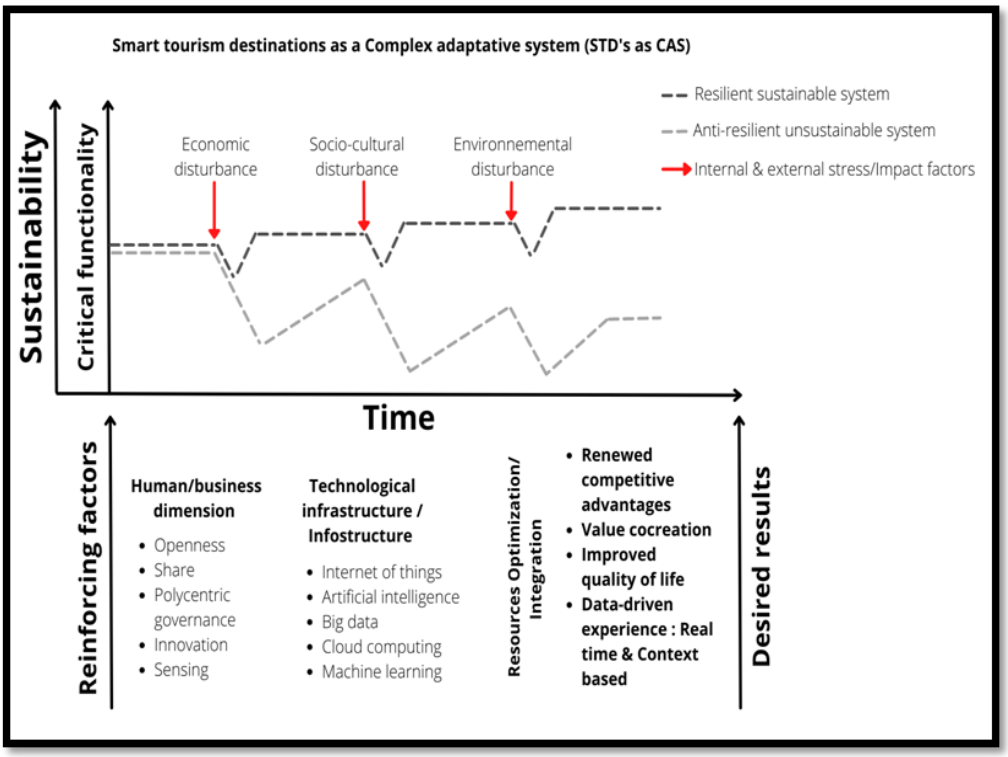

Fig 3: The functioning of smart tourism destinations as CAS for the development of Resilience and sustainability

third and final desired outcome, namely improved quality of life for residents and improved tourist experience. This experience is characterized by being real-time and context-based. Therefore, Figure (3) brings together all the aforementioned concepts along with their interrelations to reveal the functioning of smart tourism destinations as CAS for the development of resilience and sustainability into a single representation model.

5 Discussion

In discussing the resilience and sustainability of smart tourism systems, it is worth noting the link often made between the development of a city and that of a destination. It is known that by maintaining urban functions at an acceptable level of functioning, the resilient capabilities of urban systems contribute to the economic, social, and environmental aspirations of a sustainable city. More specifically, improving resilience may be the means to restore the balance between the three pillars of sustainable development when disruptions challenge the social, economic, or environmental functioning of the urban system, which is forced to adapt. Whether it is short-term or long-term, resilience combines issues at different spatial and temporal scales, through a systemic vision, and articulates the skills of all the city's actors. What applies to urban cities also applies to the destination, especially when it is a smart city or smart destination, where the qualification of smartness forces them to adopt the principles of resilience and sustainability. Thus, we model, on the one hand, a resilient and sustainable system as one that manages to absorb disturbances in a minimal time and manages to reorganize itself, so that it can be improved and become more efficient. We model by analogy, on the other hand, a non-resilient and non-sustainable system, which undergoes the same criticality of disturbances as the first

system, but which takes more time to absorb, recover and adapt, and which never returns to its previous level, until it crashes, hence, its non-sustainable character. The idea is that by adopting a simple definition of resilience, a concrete approach to improving urban sustainability, in general, and destination sustainability, in particular, is proposed.

At the same time, building resilience that leads us to sustainability requires reinforcing factors to be implemented over time. These factors can be divided, as seen before, into: 1) Human and business dimension. 2) Technological infrastructure and infostructure. The first dimension represents operant resources of the destination and includes the five pillars of smart destinations proposed by [47] that support resilience. The second dimension represents operand resources and groups together the set of smart technologies that support this resilience and contribute to sustainability. In fact, actors and objects effectively work collectively as a complex adaptive socio-technical system, with benefits arising from interdependencies within networked systems [62, 63]. Moreover, the co-creation of value in the smart destination is closely related to the complex ecosystem of actors involved [4] and the increasingly blurred roles of each actor in this ecosystem [46]. Indeed, in all tourism destinations in general, which are known to be highly complex and multifaceted service ecosystems [57], it is essential to consider the engagement of all actors to maximize interactions and opportunities for positive value co-creation [60, 64].

Indeed, technical networks are a fundamental basis for maintaining urban functions and are, therefore, the subject of operational methodological developments for the assessment and management of local governments. In addition, sustainable tourism development meets the current needs of visitors and host regions while protecting and enhancing opportunities for the future. By focusing on integral resource management and optimization, economic, social, and aesthetic demands can be met while respecting cultural integrity, essential ecological processes, biological diversity, and life support systems. In sum, tourism sustainability reinforces the STD (Smart Tourism Destination) model, as actions in this area are limited and sometimes associated with poor sustainability and a lack of the holistic management necessary for sustainable development to become a differentiator for the destination. We, then, have modeled the desired outcomes towards the end of the graph. These include the possibility of having renewed competitive advantages, being able to co-create value with the participation of all stakeholders, improving the quality of life of the destination's residents, as well as improving the experience in general. An experience marked by its contextual adaptation and real-time operability. It should be noted that the theoretical model proposed in this article is none other than a model of representation of the functioning of the intelligent tourism system as a complex adaptive system, undergoing disturbances and different crises, and characterized by its resilience and its sustainability. The dimensions presented in the model are those on which the vast majority of the scientific community agrees. However, the integration of resources is often presented as an interactive dimension according to the SD logic, and their optimization surfaces next. The desired results are also the synthesis of the various expectations of smart tourism.

6 Conclusion

The term resilience has been and continues to be widely debated across disciplines for several decades. It has received even more attention with the advent of the global health crisis. Indeed, the depth and complexity of the impact of COVID-19 requires both short-term response and long-term preparation to understand some of its far-reaching effects at the fundamental level. This health crisis is just one example of an

infinite number of disruptions that can arise and impact multiple sectors. Today, the quest for resilience is no longer a luxury, and all systems are under pressure to increase their resilience and, thus their sustainability. Each system, therefore, needs to detect the type of disturbances that can affect it, the factors that can enhance it, and the results it wishes to achieve.

This article has shed light on the tourism sector by presenting tourist destinations as complex adaptive systems, which can increase their resilience and sustainability by becoming more intelligent. The theoretical model proposed in this article presents the resilience enhancing factors of a destination according to several authors, factors that help the destination to move from a non-resilient and unsustainable system to a resilient and sustainable complex adaptive system. Comparing these two systems allows us to understand why non-resilient systems fail to achieve desired system outcomes. This paper presents some theoretical and managerial implications. On the one hand, it establishes the link between resilience and sustainability of a system, based on the models proposed by [11] and developed by [12], and presents smart tourism systems as CASs undergoing the same functioning. And on the other hand, this model may prove to be useful for managers and administrators of destinations that seek to grow its resilience and sustainability by focusing on improving the enhancement factors and controlling all types of disturbances. In fact, by drawing conclusions from a wide range of applications, this analysis provides critical insights for the joint implementation of sustainability and resilience that can more effectively and efficiently guide both action and management. However, this article was based on extensive theoretical research and only brings together pre-established knowledge. It then lacks empirical testing in order to be validated. We hope this will contribute to future efforts to minimize conflicts and maximize synergies between sustainability and resilience.

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