Chapter 11
Expansion of Technology Utilization Through Tourism 4.0 in Slovenia

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ABSTRACT

With more and more people traveling worldwide (the number doubling in the last 20 years), tourist destinations are now more than ever trying to maintain and enhance their competitiveness in the global market. In this regard, novel business models combined with state-of-the-art technology can play a crucial role in not only satisfying the increasing tourism demand but also ensuring a sustainable growth to avoid the deteriorating effects on both the social and natural habitat. For these reasons, the Slovenian government included tourism as one of the priority areas for investment. Hence, the Tourism 4.0 initiative was launched to unite tourism stakeholders with high-tech companies and unify their scattered ideas, experiences, knowledge, and expertise. The ambition is to position Slovenia as a top destination for sustainable tourism with high economic value. This chapter introduces the basic concepts behind Tourism 4.0 and how it relates to technologies for an enhanced tourism experience.

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INTRODUCTION

Within this proposed book chapter, the authors present the largest government-funded research and development project in the field of Slovenian tourism, called Tourism 4.0 (T4.0) and launched in September 2018. The name itself originates from the fourth and ongoing industrial revolution known as Industry 4.0 (Vogel-Heuser & Hess, 2016), which is characterized by the cyber-physical systems (CPS) manufacturing, consisting of a heterogeneous data exchange (Lu Y., 2016). If Industry 4.0 aims to achieve higher added-value products and services though operational efficiency and the automation of the production process by utilizing the modern technologies, Tourism 4.0 is aimed at doing the same for the tourism sector.

The motivation behind the project is that, unfortunately, a gap between the tourism industry and the use of emerging technologies still exists. Some of the obstacles for a greater technology implementation are the lack of sufficient knowledge, tools and strategies. These issues are already being addressed within the context of Smart Tourism (Gretzel, Sigala, Xiang, & Koo, 2015), an initiative aimed at applying technological innovations to improving the efficiency and sustainability of the tourism sector, while at the same time enhancing the local residents' quality of life. There are three main components associated with Smart Tourism:

1. Smart Destination –a tourist destination where the state-of-the-art technology is integrated in the destination's own infrastructure. It applies the same principles of accessibility, efficiency, sustainability and quality of life as Smart Cities, only in this case they are extended to include tourists (in addition to local residents) (Buhalis & Amaranggana, 2013).
2. Smart Experience – the convergence of technology and tourism experience (Hunter, Chung, Gretzel, & Koo, 2015). One of the requirements is a technological platform for instant tourism-related information exchange between the stakeholders, thereby also creating a large amount of data in this process – known as Big Data (Buhalis & Amaranggana, 2015). Through this data, destinations can provide personalized services and products to tourists in order to enhance their tourism experience. In this context, the tourists themselves become active participants in the creation of their own experience by sharing the information about their preferences and past experiences.
3. Smart Business - a complex business ecosystem which includes a strong collaboration between the public and the private sector (Buhalis, 2000), defined by the digitalization of business activities and by the rapid responses to the changes in the market. As a result of the data sharing between all stakeholders, consumers are also included in the product/service creation process as an important source of knowledge for innovation (Foss, Laursen, & Pedersen, 2011).

Recognizing the potential of the Industry 4.0 technologies by merging them with the concept of Smart Tourism, the T4.0 project ambition is to create a benchmark for the transformation of today's Slovenian tourism industry into an innovation-driven economy for the benefit of all participants. The main goal is the establishment of a Collaborative Platform that will facilitate the exchanges between all of the stakeholders in the tourism ecosystem. The platform will also enable the collection, exchange and analysis of data for the needs of strategic activities such as marketing, resource allocation, energy consumption and tourist dispersion, all of which are aimed at improving the tourist experience and minimizing the negative impact on the local environment. To this aim, the project partners have a set of defined technologies for the improvement of business processes and activities in the tourism sector.

BACKGROUND

The first forms of tourism were known already in ancient Egypt, whereas the ancient Greeks and Romans devoted considerable attention to traveling for pleasure and even developed a concept associated with what we understand as vacations (Rabotić, 2014; Korstanje & Busby, 2010). Modern tourism, according to many historians (Zuelow, 2015), started to develop at the end of the eighteenth century and is recognized as one of the most important commercial activities today. It accounted for generating 10% of the total employment in 2018 and represented a share of 10.4% in the global economy GDP in 2018 (WTTC, 2018).

However, it has long been reported (Forster, 1964; Young, 1973; Pizam, 1978; Sunlu, 2003) that host locations can also experience several negative consequences, resulting in a degradation of both the natural and social environment. At the destination level, examples of such negative consequences include the following:

i.) Overconsumption of water, where in some countries the tourist sector represents more than 10% of the domestic water consumption (or as high as 40% in the case of Mauritius) (Gössling et al., 2012); and
ii) Skyrocketing of rental prices, like in the case of Barcelona, where the price of residential apartments can reach vacation apartments price level (Martín Martín, Guaita Martínez, & Salinas Fernández, 2018).

At the global level, tourism-related activities already account for 8% of the global greenhouse gas emissions (Lenzen, et al., 2018), representing a significant factor, associated with climate change. Similarly, the negative effects on the cultural heritage and its role in society have been associated with over-tourism and banalizing or "disnifying" tourism (Ashworth & Tunbridge, 1990), which have led to a 'multiplicity of standardized attractions that reduce the uniqueness of urban identities even while claims of uniqueness are more intense (Zukin, 1998).

At the same time, when properly implemented, tourism has the potential of driving positive social transformation (Tovar & Lockwood, 2008), bringing economic benefits (Frechtling, 2000) and resulting in sustainable development (McCool & Moisey, 2001). The latter is recognized by the United Nations Organisation in their recommendations on implementation of the 17 Sustainable Development Goals (SDGs) (World Tourism Organization and United Nations Development Programme, 2018). In this regard, the use of new technologies plays an important role in facilitating a more environmentally, socially, culturally and economically sustainable interaction between visitors, local communities, tourist landscapes and the cultural heritage, e.g. the so-called "intelligent entertainment" (Mencarelli & Pulh, 2012) and "edutainment" (Addis, 2005).

Before moving on to explain the main focus of this chapter and how new technologies can improve every stakeholder's experience in tourism, the authors present the characteristics of Slovenia as a destination with a great potential for improving its current state of tourism. Slovenia is a relatively small country with a population of around 2 million and covering an area of 20 273 km^2, located at the crossroads between the central and Southeastern Europe at the intersection of three globally recognizable regions (the Alps, the Mediterranean and the Pannonian plains). After gaining its independence from Yugoslavia in 1991, the country faced a sharp decline in tourism and lost almost 75% of foreign visitors (Sirse & Mihalic, 1999). However, in the last 20 years a number of measures were implemented in order to boost

Figure 1. A division of Slovenia into 4 macro destinations

the Slovenian tourism and make it internationally competitive. Among the actions taken is the establishment of a system of macro-destinations by the Slovenian Tourist Board, based on geographically defined units and with similar strategic elements (e.g. main products and services). These destinations, shown in Figure 1 are: the Alpine Slovenia, the Mediterranean Slovenia, the Thermal Pannonian Slovenia and Central Slovenia with the capital Ljubljana. Two more important drivers of Slovenia's tourist brand and its tourist offer are also the natural environment and the natural heritage (especially the outdoor activities, the natural sights and the rich gastronomy). The cultural heritage (comprising more than 30.000 immovable cultural heritage monuments), on the other hand, still presents immense opportunities for further interpretation.

As a result of past efforts, there are record numbers of tourist visitors today, going hand in hand with a notable global interest in Slovenia as a destination. In 2018, more than 5.9 million tourist arrivals and 15.6 million overnight stays were recorded in Slovenia. Most of the visitors come from abroad, with Germany, Italy, Austria, the Netherlands and Croatia topping the list. Visitors from these countries combined accounted for more than 30% of the total visitors (see Table 1). This represents an increase of 8% in arrivals and 10% of overnight stays, as compared to 2017, making this the fifth consecutive year of growth in tourist visits. In the same year, tourism accounted for 12.3% of the total gross domestic product and 12.8% of all employment (representing around 110 700 jobs). With this above-average growth continuing in 2019 (see Total Slovenia News, 2019), which is forecast to continue in the near future, the Slovenian tourism industry is becoming one of the most important economic sectors in the country.

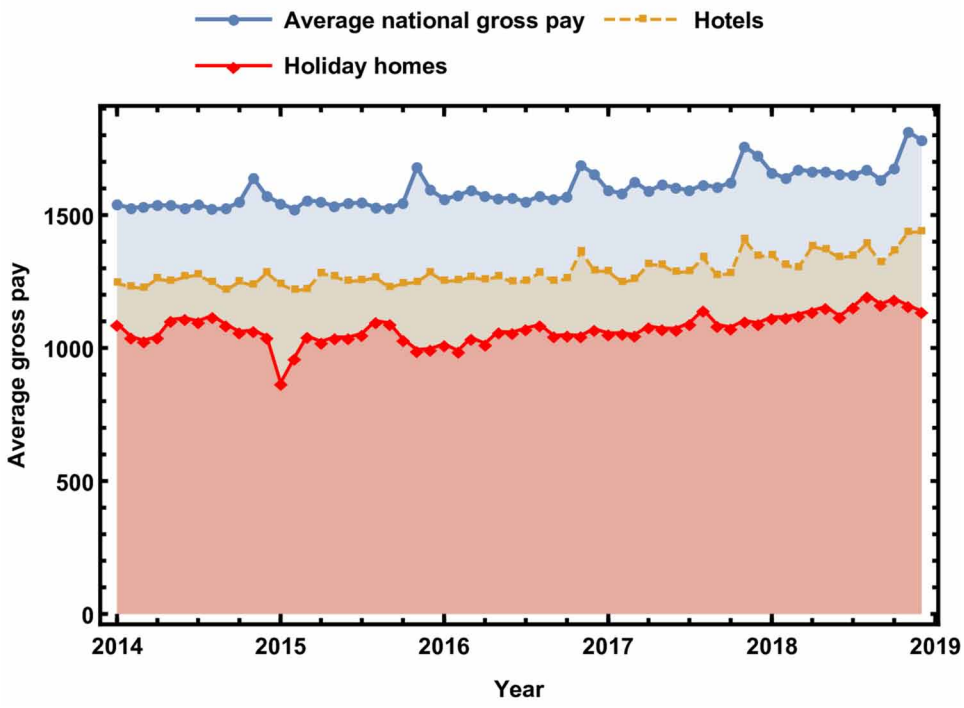
However, despite the aforementioned achievements, some pressing issues remain open, and continue to hinder further progress of tourism. Among the most visible are the shortage of workforce and the low wages. This is illustrated by Figure 2, depicting the average salary of hotel employees in the past 4 years. The pay in this sector accounts for only around 80% of the national average salary. When inspecting the employees in holiday homes, the situation is even worse - their average gross salary is below 70% of the national average salary. As a consequence, employers are experiencing great setbacks when looking for trained and competent staff, mainly due to the harsh working conditions and low salaries.

Table 1. Number of foreign tourist arrivals and overnight stays in 2018. The data is courtesy of the SURS—Statistical Office of the Republic of Slovenia

Country of origin	Tourist arrivals		Tourist overnight stays	
	Number	Percent of total	Number	Percent of total
Germany	506 081	8.6	1 362 214	8.7
Italy	598 825	10.1	1 334 059	8.5
Austria	381 709	6.5	1 011 135	6.5
Netherlands	185 257	3.1	612 710	3.9
Croatia	218 896	3.7	527 118	3.3
other countries	2534371	42.9	6 328 774	40.5

In order to tackle these issues, the partnership for Strategic Development and Innovative Partnership in Tourism (SRIPT) was launched by the Tourism and Hospitality Chamber of Slovenia with the objective to include tourism into the Slovenian Smart Specialization Strategy (S4) (published by the Government of the Republic of Slovenia, 2015). The Smart specialization focuses on areas with growth potential. It highlights the fields in which Slovenia has the critical mass of knowledge, capacities and competences to reach a recognizable position within the global markets, making such sectors investment priorities.

Figure 2. Comparison between the national average gross salary and salary of employees in hotels or similar accommodations and holiday homes or similar accommodations. Data courtesy of Statistical Office of Slovenia.



Among the key SRIPT performance indicators defined for the period until 2023 are the following:

1. Increasing the added value in tourism by 15%;
2. Increasing the revenue under the heading of export travel by 4-6% annually;
3. Improving the energy efficiency of tourist facilities by 20%.

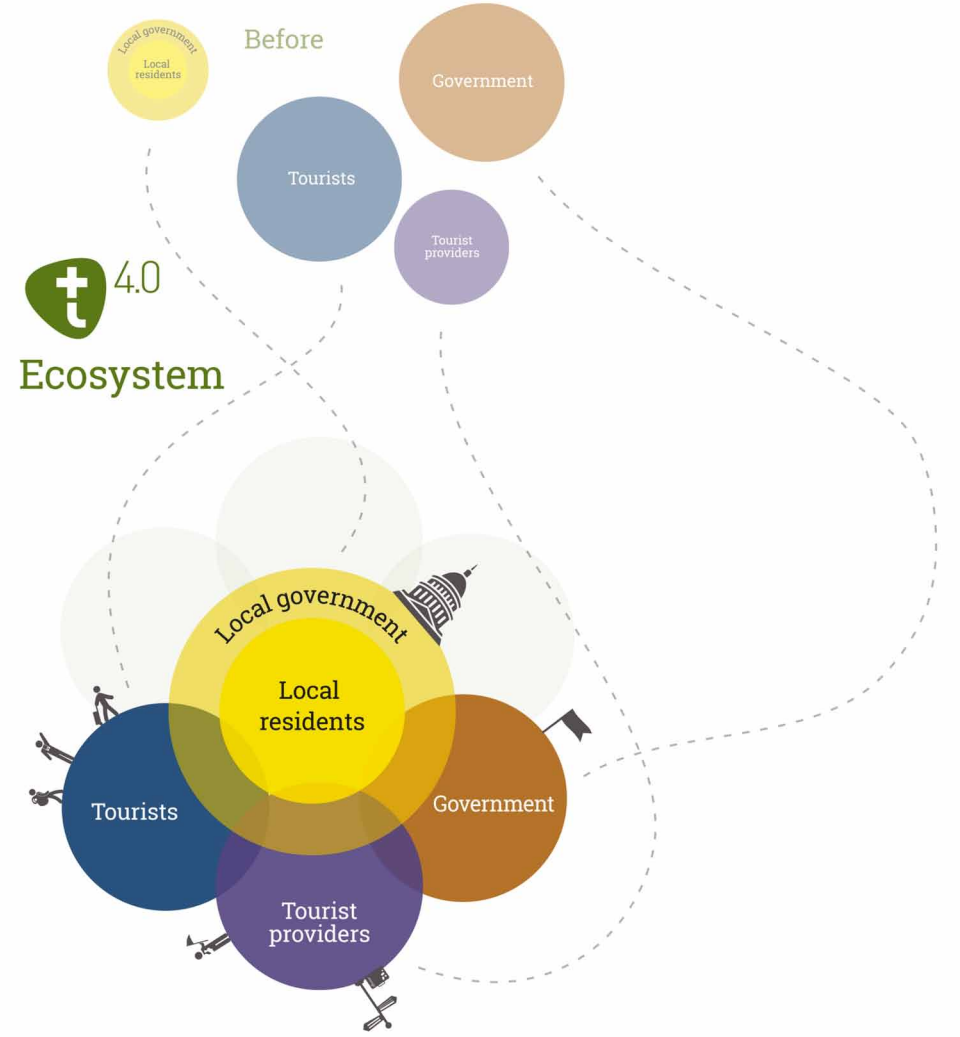
Tourism 4.0 follows the SRIPT goals, directly addressing two key priority fields: information-based marketing and technological solutions. The project initiative was launched by the high-tech company Arctur, which identified the lack of readiness to embrace the use of the key enabling technologies in the tourism sector, especially among small and medium enterprises. Consequently, the Partnership for Tourism 4.0 was established to strengthen the collaboration between various stakeholders willing to participate in the research and in the further development of tourism. The project brings together business companies, governance bodies and top researchers in tourism and IT technology. The evolving partnership already boasts a number of prominent members, such as the Slovenian Ministry of Economic Development and Technology as well as the Ministry of Public Administration, the Tourism and Hospitality Chamber of Slovenia, the Association of Towns and Municipalities of Slovenia, the University of Ljubljana, the University of Maribor, the University of Primorska and many other partners.

MAIN FOCUS OF THE CHAPTER

The primary goal of the project is to establish a collaborative ecosystem that is focused on merging both the physical and the digital space into a personalized experience. At the same time, it is also aimed at promoting sustainable and socially conscious aspects of tourism. For this reason, the Tourism 4.0 ecosystem is defined under the assumption of connecting all stakeholders, which includes the local community, the various levels of government, the tourist service providers and the tourists themselves, while at the same time promoting their collaboration (see Figure 3). The existing business activities and processes are being identified and analyzed within this collaboration in order to encourage more innovation in tourism and to foster strategic thinking.

Tourism 4.0 project can be roughly divided into two main phases, both of which are further explained in the following part. In the first phase, a basic study is being conducted on the current state of the Slovenian tourism, including on the level of technology use, in order to develop a theoretical model of the ideal tourism and to quantify the deviations from this model. At the same time, a technological research on selected innovative technologies is carried out that could help optimize business processes, improve the tourist experience and minimize the negative impacts of tourism. Based on the results obtained from the aforementioned research activities, a modern, technologically-supported Collaboration Platform for all stakeholders in tourism will be created. The platform will allow for communication, monitoring and analytically supported decision-making at the level of providers, consumers and destinations. The second phase includes demonstrative testing of the Collaboration Platform in a controlled real-environment along with the technological tools analyzed in the research.

Figure 3. Tourism 4.0 ecosystem of collaboration between all stakeholders in tourism



Basic Research Phase

Tourism and technological advancement have been inter-connected for a long time (Poon, 1993; Buhalis & Law, 2008). Among the major milestones in this process, one could note the introduction of the Computer Reservations Systems (CRSs) in the 1970s, the Global Distribution Systems (GDSs) in the 1980s and the spread of Internet in the 1990s. Because tourism is a part of the global economy today, tourist destinations have to be, now more than ever, innovative as regards the use of new business models and state-of-the-art technology. To achieve this, first and foremost, the adequate information on the state-of-the-art and future trends is necessary.

Through the basic research phase, the aim of the project is to develop and introduce a comprehensive ecosystem, based on the theoretical model named Tourism Impact Model (TIM). TIM encompasses a system of motivation and rewards for positive behavior, i.e. behavior with positive consequences on

the social, environmental and economic aspects of the tourism sector. The latter encompasses positive impacts on tourism as regards local inhabitants, tourists and other stakeholders. The model is based and sustained with the data gathered with the help of key enabling technologies, as known from the Industry 4.0. These technologies will be used initially to develop the tools that support the management of tourist flows in the context of the local tourist carrying capacity and will be consequently providing the instruments for potentially preventing the occurrence of over-tourism. In parallel, bibliographic research is being conducted on selected technologies for establishing their present and potential use in tourism.

This chapter section is dedicated to providing an explanation of both TIM and the technologies selected for a detailed study. The results will allow us to compare the ideal tourism ecosystem based on the literature review with the existing state of tourism and show us how the key enabling technologies could be used to manage the transition from the existing tourism ecosystem closer to an ideal one. The outcome will be presented in a research report, summarizing the results and suggesting a set of recommendations on how to improve the overall state of tourism. Also based on the above-mentioned research, the development of a prototype version of the Collaboration Platform will begin, encompassing steps from user environment design to generic technology development and technology integration.

Tourism Impact Model

The Tourism Impact Model (TIM) represents one of the tools of the T4.0 platform. It is designed to support the digital transformation of processes with the aim of understanding the respective micro location's existing state and future predictions according to the so-called strategic thinking 4.0, which is focused on raising sustainable tourism to its maximum possible potential level. The greatest value of TIM for users is the planned integration of the quick response mechanism. The model combines a study of the methodology of the carrying capacity with the technological components, including data from different sources, to provide recommendations for respective micro locations. These recommendations would be more in-depth than mere policies and adjusted according to the specific characteristics of each micro location, respectively, rather than staying general. The overall approach to the development of the TIM tool follows the stages described below.

The first stage is the identification and a critical review of the existing methodologies for measuring the carrying capacity at tourist destinations and of the models for the visitors' management. There are several tourist-carrying-capacity models, both applied and theoretical. For example, the maximum carrying capacity concept could be formalized by applying the Fisher and Krutilla model (Fisher & Krutilla, 1972) or the Canestrelli and Costa's model (Canestrelli & Costa, 1991). The selection and development of the most suitable method will take into account the local and regional specificities (i.e. macro destinations in Slovenian tourism) and the interconnection of indicators (e.g. for benchmarking), as well as their dynamics. Monitoring the indicators dynamics is important, since the carrying capacity is a category that sets the scale for measuring environmental stresses on one hand. The dynamic monitoring, on the other hand, makes it possible to assess the degree of tourism-related pressures within a given period and opens up space for timely action.

In the second stage, the methodology will be developed for measuring the tourist capacity of the various types of territory of stakeholders, respectively. An analysis of the strategic tourist flows and the niche tourist flows in each type of the stakeholders' territory is planned, in order to design the model for measuring the carrying capacity of destinations and to cater for the selection of the relevant digital tools for the data harvesting and analysis. There are a great number of potential indicators for monitor-

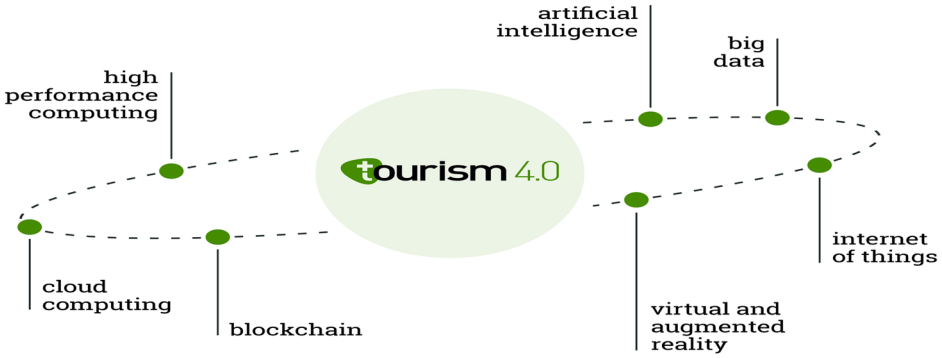
ing the carrying capacity, as well as for drafting recommendations for the macro and micro destinations (in the case of Slovenian municipalities) on how to properly collect and process the required data. When measuring the values of these indicators, we are primarily interested in two major aspects: what is the impact of tourism activities at a specific micro location and what are the degrees of collaboration between different stakeholders at the same micro location. Thematically, the identified indicators are categorized into six groups:

1. Economic indicators (growth, income, accommodation, employment, local crops and livestock products, real estate, seasonality);
2. Social indicators (impact on local communities, safety and health, adjustments for people with disabilities, cultural heritage, concentration of demand and supply, meeting the needs of tourists and local residents);
3. Environmental indicators (air quality, consumption of drinking water, disposal and treatment of waste water, waste management, traffic-related data such as transport-related pollution, energy consumption, environmental assessments);
4. Infrastructure indicators (cycling route network, charging stations for electric cars, road network congestion, public transportation, parking lot occupancy);
5. Political-civilian indicators (participation of local residents in local government decision making, NGO support, collaboration between neighboring locations);
6. Collaboration indicators (although interwoven in all other aspects above, a special focus and care is dedicated to the understanding and evaluation of the natural environment and to the level of collaboration between different stakeholder).

Through the selection of indicators, the project aims to determine the tourist carrying capacity in all of the indicator groups by applying the Multi-Attribute Decision Making (MADM) theory, using the open-source DEXi visualization and the analytical platform (Bohanec, 2008). The methodology of MADM DEXi is based on the decomposition of a large complex problem into sub problems, which are smaller, less complex and easier to solve than the overall problem. The situation is presented graphically by a hierarchical tree of attributes. Each alternative is evaluated by each attribute and subsequently formulated again by a single value. The aggregation of values (the utility function) is defined by a set of simple "if-then" rules, which are, compared to the linearly weighted sum, more suitable for expressing nonlinearities in decision knowledge and are easier to understand. The hierarchical tree of attributes presented as a set of decision rules (utility functions) that are defined by experts, represents the knowledge base.

The TIM will enable each respective location to determine, with the help of experts, the threshold values of its carrying capacity in terms of the basic indicators like air quality, water supply, waste disposal, tourist accommodation, traffic load, etc. In this way, the destination can obtain a detailed assessment of the status and a comparison to the referential and the regional average values. Each destination will be able to see what their advantages, opportunities and risks are. Depending on the availability of the data, the system will enable for real-time impact assessments, thus providing decision makers with a reliable foundation for strategic decision-making and adopting adequate measures in the processes of digitalization. The result in the form of visual representations will help them to grasp their level of preparedness and empower by providing the guidelines for further actions. Through the analysis of the data, provided from selected sources, TIM can also generate tailored reports for the respective destinations. Such reports can include the visualization in the form of a "traffic light", depicting in this way the existing state as

Figure 4. Key enabling technologies with the potential for use in the tourism sector



compared to the critical limit values. In such visual representations, areas that are below the predefined critical values are marked in green, whereas yellow indicates an approaching warning and red appears when the values are above the critical benchmark.

What the TIM strives to unlock is the innovation potential of the advanced technologies, originating in the Industry 4.0. TIM aims to do that with the goal of tackling the challenges of over-tourism and allowing for insights into the degree to which tourism in a respective location still has a positive impact on the ground. In contrast to other similar initiatives from all over the world, we are trying to achieve more sustainability in the tourism sector. This is encouraged by a bottom up approach, encouraging collaboration among all stakeholders in the tourism ecosystem, among the actors who are and always will be co-creating the tourist experience. The results of our activities help destinations, be it municipalities or any selected location of any size, to understand their limits and act strategically to create destinations that people want to visit and live in.

Technology Research

The technology research in the scope of Tourism 4.0 is a bibliographic study conducted on pre-defined technologies, such as blockchain, the internet of things, big data, high performance & cloud computing, artificial intelligence and virtual & augmented reality, as shown in Figure 4. It is aimed at gathering the required technical descriptions and identifying the (potential) uses in the tourism sector. Advanced technological solutions are of particular importance for a sustainable use of resources within the accommodation facilities and for the optimization of business processes, such as:

- the reduction of costs;
- offering higher quality services;
- the reduction of time spent on individual activities in the course of the business process.

In addition to being included in the recommendations for both tourism service providers and policy makers, these technologies will be integrated into the Collaborative Platform to provide a new cooperative system for all tourist stakeholders. The respective technologies and their use in tourism within the context of Tourism 4.0. are described below.

Blockchain Technology

The first blockchain was introduced by Satoshi Nakamoto in 2008 as the supporting technology for Bitcoin, a peer-to-peer electronic cash system (Nakamoto, 2008). While there is no universally valid definition of blockchain, one can provide the following definition based on the peer-reviewed literature (Seebacher & Schüritz, 2017): "*A blockchain is a distributed database, which is shared among and agreed upon a peer-to-peer network. It consists of a linked sequence of blocks, holding timestamped transactions that are secured by public-key cryptography and verified by the network community. Once an element is appended to the blockchain, it can not be altered, turning a blockchain into an immutable record of past activity*".

The blockchain technology presents a wide range of possibilities, and can be implemented into any service provided, thus gaining attention of many different industries. Tourism is among these, with a special interest pertaining to the areas of booking, reservation and payment systems (Önder & Treiblmaier, 2018). However, the real potential of this technology lies in building reliable, flexible and stable systems. Such systems tend to rely on a large number of transactions between the users, where any interaction between the users is considered a transaction, whichis not limited solely to financial transactions. Therefore, the most important factors to be considered when dealing with smart distributed systems are the transaction costs, the transaction times and the permeability of transactions.

The blockchain technology is an ideal match for systems and platforms that would profit from the fact that no single person or company can exercise control over them. As such, two specific use cases are being developed to be included into the Collaboration Platform later:

- *A Digital Passport* for tourists, where the blockchain technology can be utilized as a data storage solution. With the Digital Passport, tourists are able to build their own personal profile based on the shared information, preferences and interests, with the purpose of receiving recommendations for trips, activities or products. All of the user data or their hashes can be stored in a public or private blockchain. The main advantage of this is that no one owns or controls the database and the access to the data in this way. In a "traditional" system, if the database owner ceases to exist or decides that they are no longer interested in maintaining the database, other connected products can be left nonfunctional. In distributed systems, however, this kind of risk is averted, because a consortium owns the database, both legally and through a technical implementation of the blockchain technology. Blockchains can also be used to store information which users share through their profiles. The benefits include the fact that a clear and transparent system is put in place, which allows for backtracking of profile sharing and data access. Should any privacy issues occur, there is a record for every time a user has shared their data with an agent.
- *A Collaboration Impact Token*_(Peceny, Urbančič, Mokorel, Kuralt, & Ilijaš, 2019). The idea of the Collaboration Impact Token (CIT) is to provide a reward system for tourists. These tokens are a blockchain-based crypto currency, awarded to tourists as incentives for the behavior which is beneficial to the local community and to the environment. The emphasis is on sustainability, e.g. consuming less energy or using public transport. In turn, these tokens can be used for purchasing other tourist goods. Their most important feature is the assignment of a dynamic value, dependent on the location and a given time, i.e. a higher value at the touristic periphery or during low tourist season. The CIT will be stored in a digital personal user wallet, which can be integrated into Digital Passport.

Internet of Things

The IoT or Internet of Things represents all of the inter-connected devices that communicate with each other through the Internet. There can be more than one communication mode, ranging from the communication between devices and people to communicating among the devices themselves. A larger number of uniquely determined devices can be connected into the IoT, which, with the help of sensors, transmit the various data to the Internet, thus making it available for other users. The technology breakthrough in IoT (along with smart cities, Big Data, and Cloud computing) has contributed to designing the notion of smart tourism (Kaur & Kaur, 2016). The greatest impacts of the IoT technology are expected in the fields related to personalization (e.g. the use of tablet computers or smart TVs in hotel rooms for adjusting the room temperature, the television control, the lights, etc.), in accessing real-time data (e.g. notification of the change of flight directly to one's mobile device), in simplifying certain tasks, in easier management of customer relations, for improving the tourist experience or in simplifying maintenance tasks (e.g. instantaneous error notification) (Dave, 2018).

For Tourism 4.0, the IoT can present an effective tool to monitor and reduce the negative impacts of tourism, notably through installing the sensors for monitoring the energy and water consumption or the waste production. It can also offer an upgrade of the already existing services, such as virtual bulletin boards, by displaying context-sensitive ads in accordance with a generalized Digital Passport profile of tourists who are located near a respective location.

Big Data

Big data refers to a large amount of data that can be processed, analyzed and used to support decision-making (Hung, 2016). While there is no single definition of big data, the definitions usually include the characteristics, pertaining to data volume (the quantity of data), velocity (the rapid data collection and analysis) and variety (the various types of data from different sources). Big data has already proven useful for marketing purposes (Elgendy & Elragal, 2014; Xu, Frankwick, & Ramirez, 2016) and in the fields of the biomedical research and healthcare (Luo, Wu, Gopukumar, & Zhao, 2016; Raghupathi & Raghupathi, 2014). In tourism (Li, Xu, Tang, Wang, & Li, 2018), big data is being used, too, notably to study the tourist behavior (Miah, Vu, Gammack, & McGrath, 2017). Big data can be effectively used to facilitate exploring the popular tourism destinations (i.e. where to travel) (Lee, Cai, & Lee, 2014), the searching for effective travel routes (Kurashima, Iwata, Irie, & Fujimura, 2013; Lu, Wang, Yang, Pang, & Zhang, 2010; Okuyama & Yanai, 2013) and for identifying the best timeframe to visit a specific destination.

Tourists produce a huge amount of data on the global scale, which can provide valuable insights into their practices and attitudes. This data is collected and "owned" by a range of actors, public and private, for their own business and administrative purposes, such as billing. However, after the primary use this data often remains un-shared, thus limiting the potential for cross-analysis and business intelligence that could provide a boost for the tourism sector. With the appropriate data collection and analysis, complex Big Data analytics can be applied within the context of Tourism 4.0. This would allow for a deeper insight into the tourism sector, as compared to more traditional methods of surveys and interviews with focus groups. This in turn can encourage more sustainable strategies and business models in order to tackle the negative externalities presented by modern tourism, while at the same time improving the experience of both returning and new visitors. A special focus is put into developing a tool for monitoring and visualizing the tourist mobility patterns through various sources, such as reports of mobile phone activities, traffic counters and street cameras. By combining the (appropriately anonymized) mobility

data in tourism with other data available (i.e. accommodation capacities, resources available, population density, traffic pollution, etc.), trends in tourism throughout seasons can be monitored, in order to identify the destinations (both local and regional) where peaks are unsustainable, thus identifying the possible strategies for a diversification as well as new marketing approaches. Through this process, a diversification of the tourist flows can be promoted or a more effective distribution can be planned over time, to minimize the negative impacts of the existing peaks and – most importantly – to identify the areas for improvements and innovation.

High Performance Computing and Cloud Computing

A high-performance computing (HPC) system is a tool used to tackle problems that require substantial computing resources or a length of time and therefore cannot be processed using personal computers due to their limitations. Normally the HPC services are provided by supercomputers that can be accessed remotely, using the network. Traditionally, they have been used in scientific and engineering fields, which require large quantities of data to be processed, e.g. in weather forecasting, steel casting simulations and in aerodynamic research. Recent uses include projects in the artistic and creative industries, which are due to the rapid advances in the area of 3D technologies.

Cloud computing refers to the practice of using a network of remote servers hosted on the Internet to manage, store and process data, instead of using a local server or a personal computer. These services are broadly divided into three categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). The most relevant advantage of using cloud computing is the overall reduction of fixed costs and the possibility of shifting those costs into operative costs depending on the demand (Etro, 2009). This facilitates the market entry for smaller entities like SMEs, startups or public institutions, since it removes the need to purchase and maintain expensive equipment. Also, the expanded use of the Internet of Things has led to the production of large amounts of data that requires storage, processing and appropriate access, with cloud computing providing an appropriate dynamic and flexible support infrastructure.

Cloud computing offers many advantages over other distributed platforms, lately including HPC as a Service (HPCaaS), which aims to provide scalability of resources, cost-effectiveness and no-maintenance for end users (Sha, et al., 2019).

While certain case studies on the uses of HPC and Cloud computing in the tourism sector can be found, they are mostly limited to big players like Airbnb (AirbnbEng, 2010), Red Lion Hotels Corporation (AWS Case Study: Red Lion Hotels, 2019) and SETTOUR (AWS Case Study: SETTour, 2019). On the other hand, there are many examples of success stories of SMEs using HPC that have led to business benefits and could also be applied to tourism. For example:

- In the field of urban planning, building-performance was modelled in order to create more sustainable buildings (HPC-Cloud-based urban planning, 2019). Large simulations were performed quickly and effectively through Cloud-based HPC, which significantly decreased the operation time and substantially increased the number of buildings per simulation. The same principle can be applied when designing new or improving existing tourist accommodations.
- For predicting air quality, Cloud-based HPC services have been used to investigate the air-quality in large urban areas, cities and towns (HPC-Cloud-based prediction of air quality, 2019). Running simulations by using HPCaaS helps to increase the number of scenarios which can be simulated

realistically in a given time and to reduce the computational time needed for simulations. The outcomes of using this system include shorter times for simulations and cost reductions. In tourism, this can be used to monitor the increase in pollution, caused by tourism-related activities in near-real-time, and consequently to adapt appropriate reduction scenarios.

- HPCaaS has been used in environmental consulting for the design of industrial plants and public infrastructure by using simulations for modeling the emissions and water consumption, in order to estimate their impact on the environment (Cloud-based environmental modelling, 2019). Tourism encompasses the need for adequate infrastructure, and a similar method can be used to improve the planning of tourism-related facilities.

The whole Tourism 4.0 Collaborative Platform will be developed on an HPC infrastructure, consisting of the general computing infrastructure, the GPU core processors and a dedicated memory partition, coupled with a highly fault tolerant parallel storage. All this is available through Arctur, a leading HPCaaS provider in the region.

Artificial Intelligence

When discussing Artificial intelligence (AI), people often refer to the simulations of human intelligence processes by computer systems and other machines. These processes include, but are not limited to learning, reasoning and self-correction. AI has been applied to a number of different fields, including organic chemistry (Lindsay, Buchanan, Feigenbaum, & Lederberg, 1980), healthcare (Hanson & Marshall, 2001), photovoltaic (Mellit & Kalogirou, 2008), finance (Bahrammirzaee, 2010) and many others. Considerable attention has been given to the application of AI to tourism forecasting (Cho, 2003; Yu & Schwartz, 2006). It has been proven that the AI-based forecasting methods like the neural network model, the fuzzy time-series theory and the hybrid grey theory can surpass the traditional forecasting methods (Wang, 2004).

It can be concluded, therefore, that the use of forecasting with the help of AI in Tourism 4.0 lies in the ability to predict long- and short-term demands of tourists, in order to support decision-making regarding resource allocation, investment planning and economic policy directions.

Virtual and Augmented Reality

Virtual reality (VR) is a three-dimensional, interactive computer-generated environment that allows the user to experience both real and unreal events (Perry Hobson & Williams, 1995). There are three key elements that define a VR experience (Cruz-Neira, Sandin, DeFanti, Kenyon, & Hart, 1992; Williams & Hobson, 1995):

1. **Visualization Components:** These components include the 3D vision, the clarity and linearity of vision as well as the ability to look around a particular point, all of which is achievable by using a virtual reality headset.
2. **Immersion:** A key factor of a VR experience is the perception by the VR user of actually being present in a virtual world, i.e. their isolation from the real world. This is achievable through panoramic surroundings and the surrounding acoustics, by the reaction of images to the movements of the user and through physical representations of objects.

3. **Interactivity:** This is the control of participants over the experience. The combination of many kinetic effects helps to provide additional realism to the whole VR experience by tricking the human brain into believing the illusion.

Since the tourism sector is aiming to offer different types of experiences to guests, the VR is quickly gaining importance for the sector. Some of the immediate uses for VR in tourism are (Guttentag, 2010): in planning and management, in marketing, entertainment and education, as well as relating to accessibility and preservation of heritage.

Augmented reality (AR) is a visualization technique that superimposes computer-generated data (video, graphics, text and other multimedia formats) on real-world images that are captured by the camera (Kounavis, Kasimati, & Zamani, 2012). In this way the AR can provide an augmentation of a person's view of reality by enhancing the perception of the surroundings with the help of a computer or a mobile device. Thanks to smartphones, the AR technology has become available in one small portable device and accessible to an even wider public, including as a tool to improve the tourist experience. For example, by pointing the smartphone with an AR application towards a particular object or location, the user can see additional information on top of the real-world camera view (Yovcheva, Buhalis, & Gatzidis, 2012). Hence, the AR can assist tourists with important information regarding attractions, events or destinations.

For Tourism 4.0, VR & AR are particularly important in view of designing the innovative digital services that offer enriched touristic experience, like visiting locations with difficult accessibility or experiencing digital depictions of historic sites. Users would also be able to create their own personalized virtual excursions, contributing to the personalization of tourism in this way.

Experimental Testing Phase

The next phase of the Tourism 4.0 project is the T4.0 Living Lab Slovenia, which covers the setup of an experimental environment, enabling a demonstration of the technological tools described in the previous section and their potential for use in tourism. This project connects Slovenian tourism stakeholders and high-tech companies for the first time in history, in order to identify and unify the dispersed ideas, experiences, knowledge and expertise, along with linking them into a collaborative relationship. For the purpose of testing, validation and demonstration of product innovations, the T4.0 Living Lab Slovenia project will establish a testing ground near the town of Postojna, (see Figure 5), one of Slovenia's most important tourism destinations due to its long-standing history of cave tourism (Gunn, 2004; Šebela, 2019).

The goal of this phase of the project is to further develop and test the comprehensive business and innovative tools developed by Tourism 4.0 in a controlled environment. This will facilitate the tourist economy to reach higher levels of interaction between the guests and the providers of tourism services and products. The products and services presented in the Living Lab will enable tourists to have a completely new personalized experience, while companies will achieve greater business excellence and have better business outcomes, due to the fact that their tactical and strategic business decisions can now be empirically supported.

The partners of this project will develop innovative solutions in line with the recommendations provided through the preceding research phase. All users (tourists, tourism service providers and public institutions) will be able to get acquainted with several interconnected technological modules. This phase also provides an opportunity to test the Collaboration Platform with the support of the tools, developed by using the technologies stemming from Industry 4.0, the result of which will be implemented into the

Figure 5. The location of the T4.0 Living Lab Slovenia, near the town of Postojna

final market-ready business product. Following additional elements for the comprehensive ecosystem will also be developed:

- An interactive interface to facilitate communication between tourists and the tourism service providers, which will enable connectivity with all enabling tools, user applications and databases on the Collaboration Platform.
- Applicative solutions in five focus areas (the development of which will be carried out by providers of tourism services with the participation of partners, active in the technological field):
    1. Developing smart systems and services to optimize resource use. The project will explore and test technologies for reducing the consumption of energy in tourism facilities;
    2. Developing smart systems and services to improve the tourism experience;
    3. Additional enabling tools (implemented by technology partners);
    4. A digital tool for measuring and understanding the behavior of the guest in different contexts, which will be the basis for the development of new business decisions and solutions;
    5. A web-based tool, together with a reservation system for managing and integrating tourism offers in destinations, with the aim of achieving the best possible experience for the guest and raising business opportunities in the field of tourism. The latter leads to an increase in the value added of tourism, to more job opportunities in tourism and the rise of business opportunities in tourism.

The testing, the validation and the demonstration of the technology, the applications (the products and the services) and the Collaboration Platform itself will be carried out in an experimental center consisting of 20 high-tech demonstration units with a central space and the supporting infrastructure. During

the duration of the project, the authors expect to have a minimum of 1000 tourists and a minimum of 50 tourist stakeholders participating in this innovative environment.

Innovative Potential of the Project

The Collaboration Platform represents a completely new basis for the development of a comprehensive innovative environment in the field of tourism. For a successful implementation it should include knowledge about:

- The field of tourism, i.e. the definition of cooperative roles of the tourism providers, the tourist, the local community and the national government. Among other things, it needs to define the models of interaction, and define the tourist both as a co-creator and as a user of the new products in tourism. It should be defined what tourism providers and tourists can acquire using the latest technologies, without forgetting one of the most important topics - the safety of personal data.
- The field of ICT technologies, i.e. the definition and application of technological standards in the tourism ecosystem. This includes the development of integration platforms IoT, blockchain, data and text mining using artificial intelligence and others.

The central innovation of the T4.0 Living Lab Slovenia project is the establishment of a research environment, allowing for development and innovation, facilitating the direct interaction between tourists and other stakeholders. In this environment, the tourist appears in three roles: as a guest of a particular destination, as a temporary resident of the local environment and as an innovator contributing to the reduction of negative effects of tourism activities. In terms of the technological achievements, this environment consists of advanced applications that act as an interface between the tourism providers and the tourists. As mentioned above, these applications are the first tools of their kind in the world, with which tourists are able to communicate directly, interactively and safely with the tourism providers, in order to improve their user experience. Since it is crucial that an interactive cooperation is established, a transparent and trusted environment must be created, which will encourage the development of new tourism solutions using industry-wide enabling technologies for an enriched tourism offer.

Non-technological innovations are marked by the transformation of the tourism providers and tourists into groups of people that use modern digital technologies for new tourist experiences and practice sustainable behavior. This cooperation requires new business models and the rethinking of processes by tourism providers, as well as new forms of tourist behavior. The innovation for companies means a significant leap towards a more personalized offer for the tourist, improved practical uses of enabling technologies in order to increase the satisfaction of the tourists and of other stakeholders involved in tourist experiences, as well as to achieve better business results.

SOLUTIONS AND RECOMMENDATIONS

The results of the basic research are the assessment of the level of technology-use in the field of tourism and the preparation of a set of recommendations to tourist service providers, destination managers and public institutions, including the use of technology for the optimization of business processes and activities. These will be set out in the form of recommendations, made publicly available to tourist as-

sociations, the Chamber of Commerce and Industry of Slovenia and to the Association of Municipalities and Towns of Slovenia. The project proposed also results in an innovative tourist platform for the active collaboration of tourism stakeholders, with the tourism providers and the tourists as the key actors.

Through the experimental phase T4.0 Living Lab Slovenia, the project will also provide both a demonstrative and an educational environment for tourist workers, students, managers and policy makers, too. By piloting the tools provided within the Tourism 4.0 project it will be possible to leverage the tourist potential by promoting synergies in a range of tourism "niches" (including as regards heritage, cultural tourism, wine-related activities, city- and, rural tourism, to name but a few), while simultaneously being able to scale-up the cross-national and regional benefits of tourism. Overall, the testing phase will provide an opportunity to:

- Test, verify and expand the potentials of data collection for support to the tourism sector;
- Discuss and develop concrete analytical tools to be used by all stakeholders in the sector;
- Foster a greater involvement of the data owner and identify further business opportunities;
- Set the foundations for the incubation and financing of business ideas (SMEs-based) in the region.

With the project, the authors want to demonstrate the true value of the key enabling technologies of Industry 4.0 for the tourism sector, in terms of business excellence as well as in terms of sustainability. Their introduction in tourism is expected to lead to high quality monitoring of the business processes for empirically supported strategic planning, a higher level of responsible behavior from the tourists, increasing the level of personalization of tourist offers and to an overall increase in the value added of Slovenian tourism. The actions planned, the lessons learnt and the recommendations will also allow to upscale the benefit of this pilot initiative EU-wide, notably by advancing sustainable tourism innovations across Europe.

FUTURE RESEARCH DIRECTIONS

In the light of the predicted future increase in the tourist activity, it is essential that the tourism supply is constantly innovative and sustainable at the same time. The establishment of the Tourism 4.0 ecosystem could address both of these issues by providing an environment that stimulates all stakeholders to exercise more informed behavior. This innovative environment is independent of any geographic location and thus implementable worldwide. Currently, plans are underway to establish large international consortiums in the Alpine, the Danube and the Black Sea macro regions, where the tools developed through Tourism 4.0 will be implemented. Through the guidelines and recommendations provided, the results of the targeted analysis are to be translated into strategic guidelines and policies. However, the aim is beyond general, as the policy-specific guidance will be offered for a successful implementation and the use of tools to help manage specific destinations move towards sustainable development.

Last but not least, Tourism 4.0 puts a special emphasis on the use of the smart technology applications for the heritage sector and the cultural tourism in the form of digitisation (transforming the real-life cultural heritage into digital formats) and digitalisation (using new business processes for managing and presenting the digitised heritage). This is primarily aimed at developing new points of interest, as well as heritage-inspired digital branding, marketing and post-tourism creative narratives, and equally at the use in management, monitoring and citizen participation. Hence, the proposed chapter will discuss the

potential of Tourism 4.0 for the value chain – from "creation", production/publishing, dissemination/trade, exhibition/transmission, promotion, as well as use and re-use. It will include an overview of the technologies available and possible, the case studies and business models in the heritage sector, as well as an in-depth discussion of the required skill-sets for a successful implementation.

CONCLUSION

Through this book chapter, the project Tourism 4.0 is presented, which began in September 2018 and is still underway. Tourism 4.0 strives to continuously optimize the interaction between the tourist and the tourism providers, with the aim of responsibly and innovatively meeting their respective needs, while including the local population and government bodies into the tourism process. Although initially lunched in Slovenia, the project is already expanding across the national borders.

The authors introduce the two main phases of the project: the initial research and the experimental phase. In the research phase, the consortium partners aim at gaining an in-depth understanding of the present state in the Slovenian tourism with the aim of providing future improvements of tourist satisfaction levels, increasing the value added for service providers and minimizing the negative impacts of tourism on the local community. For this reason, a great effort is put into the study of emerging technologies. In this part, a definition of an ideal tourism ecosystem based on the stakeholder collaboration is being developed, accompanied by a description of the role of technology in reaching the desired goals. The experimental phase is dedicated to setting up a testing environment where the technologies can be implemented in a controlled real environment, in order to demonstrate the characteristics of sustainable and personalized tourism.

To conclude, the Tourism 4.0 project aims to unlock the innovation potential in the whole tourism industry by combining the tourism resources with the available technology, to leverage the existing local and distributed attempts, the ready-made solutions, the development proposals and the initiatives which are running at the levels of tourist destinations. The project not only intends to stimulate the exchange of best practices and solutions between the stakeholders in tourism, but more importantly, wishes to inspire innovation, sharing and collaboration between various entities, thus creating a unique innovation environment. Tourism 4.0 also understands that technological infrastructure and smart tourism solutions can only act as enablers towards more sustainable tourist communities and as such encourage the evolution towards symbiotic destinations.

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REFERENCES

Addis, M. (2005). New technologies and cultural consumption–edutainment is born! *European Journal of Marketing*, *39*(7/8), 729–736. doi:10.1108/03090560510601734

AirbnbEng. (2010, Nov. 15). *MySQL in the cloud at Airbnb*. Retrieved from https://medium.com/airbnb-engineering/mysql-in-the-cloud-at-airbnb-336e5666bc94#.llrxogduu

Ashworth, G. J., & Tunbridge, J. E. (1990). *The tourist-historic city Belhaven. AWS Case Study: Red Lion Hotels*. (2019, Aug. 13). Retrieved from https://aws.amazon.com/solutions/case-studies/red-lion/

AWS Case Study: SETTour. (2019, Aug. 13). Retrieved from https://aws.amazon.com/solutions/case-studies/settour/

Bahrammirzaee, A. (2010). A comparative survey of artificial intelligence applications in finance: Artificial neural networks, expert system and hybrid intelligent systems. *Neural Computing & Applications*, *19*(8), 1165–1195. doi:10.100700521-010-0362-z

Bitcoin Transaction Fees. (2019, June 15). Retrieved from https://bitcoinfees.info/

Bohanec, M. (2008). *DEXi: Program for Multi-Attribute Decision Making User's Manual*. Ljubljana, Slovenia: Institut Jozef Stefan.

Buhalis, D. (2000). Marketing the competitive destination of the future. *Tourism Management*, *21*(1), 97–116. doi:10.1016/S0261-5177(99)00095-3

Buhalis, D., & Amaranggana, A. (2013). Smart Tourism Destinations. In *Information and Communication Technologies in Tourism 2014* (pp. 553–564). Cham, Switzerland: Springer. doi:10.1007/978-3-319-03973-2_40

Buhalis, D., & Amaranggana, A. (2015). Smart Tourism Destinations Enhancing Tourism Experience Through Personalisation of Services. In *Information and communication technologies in tourism 2015* (pp. 377–389). Cham, Switzerland: Springer. doi:10.1007/978-3-319-14343-9_28

Buhalis, D., & Law, R. (2008). Progress in information technology and tourism management: 20 years on and 10 years after the Internet—The state of eTourism research. *Tourism Management*, *29*(4), 609–623. doi:10.1016/j.tourman.2008.01.005

Canestrelli, E., & Costa, P. (1991). Tourist carrying capacity: A fuzzy approach. *Annals of Tourism Research*, *18*(2), 295–311. doi:10.1016/0160-7383(91)90010-9

Cho, V. (2003). A comparison of three different approaches to tourist arrival forecasting. *Tourism Management*, *24*(3), 323–330. doi:10.1016/S0261-5177(02)00068-7

Cloud-based environmental modelling. (2019). Retrieved from FORTISSIMO: https://www.fortissimo-project.eu/experiments/514

Cruz-Neira, C., Sandin, D., DeFanti, T., Kenyon, R., & Hart, J. (1992). The CAVE: Audio visual experience automatic virtual environment. *Communications of the ACM*, *35*(6), 64–73. doi:10.1145/129888.129892

Dave, N. (2018). *digitaldoughnut*. Retrieved from https://www.digitaldoughnut.com/articles/2018/january/ways-in-which-iot-is-shaping-the-future-of-travel

Elgendy, N., & Elragal, A. (2014). Big data analytics: a literature review paper. *Industrial Conference on Data Mining* (pp. 214–227). Springer. 10.1007/978-3-319-08976-8_16

Etro, F. (2009). The economic impact of cloud computing on business creation, employment and output in Europe. *Review of Business and Economics*, *54*(2), 179–208.

Fisher, A., & Krutilla, J. (1972). Determination of optimal capacity of resource-based recreation facilities. *Natural Resources Journal*, *12*, 417.

Forster, J. (1964). The Sociological Consequences of Tourism. *International Journal of Comparative Sociology*, *5*(2), 217–227. doi:10.1177/002071526400500208

Foss, N. J., Laursen, K., & Pedersen, T. (2011). Linking Customer Interaction and Innovation: The Mediating Role of New Organizational Practices. *Organization Science*, *22*(4), 980–999. doi:10.1287/orsc.1100.0584

Frechtling, D. C. (2000). Assessing the Impacts of Travel and Tourism-Measuring Economic Benefits. *International Library of Critical Writings in Economics*, *121*, 9–27.

Gössling, S., Peeters, P., Hall, C., Ceron, J.-P., Dubois, G., Lehmann, L., & Scott, D. (2012). Tourism and water use: Supply, demand, and security. An international review. *Tourism Management*, *33*(1), 1–15. doi:10.1016/j.tourman.2011.03.015

Government of the Republic of Slovenia. (2015). *Slovenia's Smart Specialisation Strategy.* Retrieved from http://www.svrk.gov.si/fileadmin/svrk.gov.si/pageuploads/Dokumenti_za_objavo_na_vstopni_strani/S4_document_2015_ENG.pdf

Gretzel, U., Sigala, M., Xiang, Z., & Koo, C. (2015). Smart tourism: Foundations and developments. *Electronic Markets*, *25*(3), 179–188. doi:10.100712525-015-0196-8

Gunn, J. (2004). *Encyclopedia of caves and karst science*. Taylor & Francis. doi:10.4324/9780203483855

Guttentag, D. (2010). Virtual reality: Applications and implications for tourism. *Tourism Management*, *31*(5), 637–651. doi:10.1016/j.tourman.2009.07.003

Hanson, C. III, & Marshall, B. (2001). Artificial intelligence applications in the intensive care unit. *Critical Care Medicine*, *29*(2), 427–435. doi:10.1097/00003246-200102000-00038 PMID:11269246

HPC-Cloud-based prediction of air quality. (2019). Retrieved from https://www.fortissimo-project.eu/experiments/410

HPC-Cloud-based urban planning. (2019). Retrieved from https://www.fortissimo-project.eu/experiments/406

Hung, P. (2016). *Big data applications and use cases*. Berlin, Germany: Springer. doi:10.1007/978-3-319-30146-4

Hunter, W. C., Chung, N., Gretzel, U., & Koo, C. (2015). Constructivist research in smart tourism. *Asia Pacific Journal of Information Systems*, *25*(1), 105–120. doi:10.14329/apjis.2015.25.1.105

Kaur, K., & Kaur, R. (2016). Internet of things to promote tourism: An insight into smart tourism. *International Journal of Recent Trends in Engineering & Research*, *2*(4), 357–361.

Korstanje, M., & Busby, G. (2010). Understanding the bible as the roots of physical displacement: The origin of tourism. *Ereview of Tourism Research*, *8*(3).

Kounavis, C., Kasimati, A., & Zamani, E. (2012). Enhancing the tourism experience through mobile augmented reality: Challenges and prospects. *International Journal of Engineering Business Management*, *4*, 10. doi:10.5772/51644

Kurashima, T., Iwata, T., Irie, G., & Fujimura, K. (2013). Travel route recommendation using geotagged photos. *Knowledge and Information Systems*, *37*(1), 37–60. doi:10.100710115-012-0580-z

Lee, I., Cai, G., & Lee, K. (2014). Exploration of geo-tagged photos through data mining approaches. *xpert Systems with Applications, 41(2)*, 397-405.

Lenzen, M., Sun, Y.-Y., Faturay, F., Ting, Y.-P., Geschke, A., & Malik, A. (2018). The carbon footprint of global tourism. *Nature Climate Change*, *8*(6), 522–528. doi:10.103841558-018-0141-x

Li, J., Xu, L., Tang, L., Wang, S., & Li, L. (2018). Big data in tourism research: A literature review. *Tourism Management*, *68*, 301–323. doi:10.1016/j.tourman.2018.03.009

Lindsay, A., Downs, D., & Lunn, K. (2003). Business processes—Attempts to find a definition. *Information and Software Technology*, *45*(15), 1015–1019. doi:10.1016/S0950-5849(03)00129-0

Lindsay, R., Buchanan, B., Feigenbaum, E., & Lederberg, J. (1980). *Applications of artificial intelligence for organic chemistry*. McGraw-Hill.

Lu, X., Wang, C., Yang, J.-M., Pang, Y., & Zhang, L. (2010). Photo2trip: generating travel routes from geo-tagged photos for trip planning. *In Proceedings of the 18th ACM international conference on Multimedia* (pp. 143-152). Florence, Italy: ACM. 10.1145/1873951.1873972

Lu, Y. (2016). Industry 4.0: A survey on technologies, applications and open research issues. *Journal of Industrial Information Integration*, *6*, 1–10. doi:10.1016/j.jii.2017.04.005

Luo, J., Wu, M., Gopukumar, D., & Zhao, Y. (2016). Big data application in biomedical research and health care: a literature review. *Biomedical informatics insights, 8, BII-S31559.*

Martín Martín, J., Guaita Martínez, J., & Salinas Fernández, J. (2018). An Analysis of the Factors behind the Citizen's Attitude of Rejection towards Tourism in a Context of Overtourism and Economic Dependence on This Activity. *Sustainability*, *10*(8), 2851. doi:10.3390u10082851

McCool, S., & Moisey, R. (2001). *Tourism, recreation, and sustainability: Linking culture and the environment*. Wallingford, CT: Cabi. doi:10.1079/9780851995052.0001

Mellit, A., & Kalogirou, S. (2008). Artificial intelligence techniques for photovoltaic applications: A review. *Progress in Energy and Combustion Science*, *34*(5), 574–632. doi:10.1016/j.pecs.2008.01.001

Mencarelli, R., & Pulh, M. (2012). Museoparks and re-enchantment of the museum visits: An approach centred on visual ethnology. *Qualitative Market Research*, *15*(2), 148–164. doi:10.1108/13522751211215877

Miah, S., Vu, H., Gammack, J., & McGrath, M. (2017). A big data analytics method for tourist behaviour analysis. *Information & Management*, *54*(6), 771–785. doi:10.1016/j.im.2016.11.011

Nakamoto, S. (2008). *Bitcoin: A Peer-to-Peer Electronic Cash System (White Paper).* Retrieved from https://bitcoin.org/bitcoin.pdf

Okuyama, K., & Yanai, K. (2013). A Travel Planning System Based on Travel Trajectories Extracted from a Large Number of Geotagged Photos on the Web. In *The era of interactive media* (pp. 657–670). New York: Springer. doi:10.1007/978-1-4614-3501-3_54

Önder, I., & Treiblmaier, H. (2018). Blockchain and tourism: Three research propositions. *Annals of Tourism Research*, *72*(C), 180–182. doi:10.1016/j.annals.2018.03.005

Peceny, U., Urbančič, J., Mokorel, S., Kuralt, V., & Ilijaš, T. (2019). Tourism 4.0: Challenges in Marketing a Paradigm Shift. In Consumer Behavior and Marketing. IntechOpen.

Perry Hobson, J., & Williams, A. (1995). Virtual reality: A new horizon for the tourism industry. *Journal of Vacation Marketing*, *1*(2), 124–135. doi:10.1177/135676679500100202

Pizam, A. (1978). Tourism's impacts: The social costs to the destination community as perceived by its residents. *Journal of Travel Research*, *16*(4), 8–12. doi:10.1177/004728757801600402

Poon, A. (1993). *Tourism, technology and competitive strategies*. Wallingford, CT: CABI.

Rabotić, B. (2014). Special-purpose travel in ancient times: 'Tourism' before tourism? *Turističko poslovanje, (14)*, 5-17.

Raghupathi, W., & Raghupathi, V. (2014). Big data analytics in healthcare: promise and potential. *Health information science and systems, 2*(1), 3.

Šebela, S. (2019). Postojna—Planina Cave System, Slovenia. In Encyclopedia of caves (pp. 812-821). Academic Press.

Seebacher, S., & Schüritz, R. (2017). Blockchain technology as an enabler of service systems: A structured literature review. In *Proceedings 8th International Conference on Exploring Service Science, IESS 1.7* (pp. 12-23). Cham, Switzerland: Springer. 10.1007/978-3-319-56925-3_2

Sha, C., Zhang, J., An, L., Zhang, Y., Wang, Z., Ilijaš, T., . . . Ji, Q. (2019). Facilitating HPC Operation and Administration via Cloud. *Supercomputing Frontiers and Innovations, 6*(1).

Sirse, J., & Mihalic, T. (1999). Slovenian tourism and tourism policy: A case study, 54(3). *Tourism Review*, 34–47.

Sunlu, U. (2003). Environmental impacts of tourism. In *Proceedings Conference on the Relationships between Global Trades and Local Resources in the Mediterranean Region*, (pp. 263-270). Academic Press.

Total Slovenia News. (2019, July 31). Retrieved from https://www.total-slovenia-news.com/travel/4215-strong-first-half-for-slovenian-tourism-in-2019

Tovar, C., & Lockwood, M. (2008). Social impacts of tourism: An Australian regional case study. *International Journal of Tourism Research*, *10*(4), 365–378. doi:10.1002/jtr.667

Vogel-Heuser, B., & Hess, D. (2016). Guest editorial industry 4.0–prerequisites and visions. *IEEE Transactions on Automation Science and Engineering*, *13*(2), 411–413. doi:10.1109/TASE.2016.2523639

Wagar, J. A. (1964). The carrying capacity of wild lands for recreation. *Forest Science, 10*(suppl_2), a0001-24.

Wang, C.-H. (2004). Predicting tourism demand using fuzzy time series and hybrid grey theory. *Tourism Management*, *25*(3), 367–374.

Williams, P., & Hobson, J. (1995). Virtual reality and tourism: Fact or fantasy? *Tourism Management*, *16*(6), 423–427. doi:10.1016/0261-5177(95)00050-X

World Tourism Organization and United Nations Development Programme. (2018). *Tourism and the Sustainable Development Goals – Journey to 2030*. Madrid, Spain: UNWTO.

WTTC. (2018). Retrieved from World Travel & Tourism Council: https://www.wttc.org/-/media/files/reports/economic-impact-research/regions-2019/world2019.pdf

Xu, Z., Frankwick, G., & Ramirez, E. (2016). Effects of big data analytics and traditional marketing analytics on new product success: A knowledge fusion perspective. *Journal of Business Research*, *69*(5), 1562–1566. doi:10.1016/j.jbusres.2015.10.017

Young, G. (1973). *Tourism: Blessing or blight?*

Yovcheva, Z., Buhalis, D., & Gatzidis, C. (2012). Smartphone augmented reality applications for tourism. [ertr]. *Ereview of Tourism Research*, *10*(2), 63–66.

Yu, G., & Schwartz, Z. (2006). Forecasting short time-series tourism demand with artificial intelligence models. *Journal of Travel Research*, *45*(2), 194–203. doi:10.1177/0047287506291594

Zuelow, E. (2015). *A history of modern tourism*. London, UK: Macmillan International Higher Education.

Zukin, S. (1998). Urban lifestyles: Diversity and standardisation in spaces of consumption. *Urban Studies (Edinburgh, Scotland)*, *35*(5-6), 825–839. doi:10.1080/0042098984574

KEY TERMS AND DEFINITIONS

Artificial Intelligence: The ability of computers to imitate human intelligence and give the impression that the computer has learned human-like habits and patterns. This can be achieved through complex algorithms, machine learning technologies and behavioral patterns.

Augmented Reality: Technology that upgrades the image of the real world with additional computer-generated information or virtual effects, such as images and sounds.

Big Data: Volumes of data that are too large and too complex to be processed by traditional data-processing application software.

Blockchain: A chain of blocks containing data that is bundled together. This database is shared across a network of computers (so-called distributed ledger network). Each data block links to the previous block in the blockchain through a cryptographic hash of the previous block, a timestamp, and transaction data. The blockchain only allows data to be written, and once that data has been accepted by the network, it cannot be changed.

Cloud Computing: Cloud computing refers to the practice of using a network of remote servers, hosted on the Internet to manage, store and process data instead of using a local server or a personal computer.

HPC: A high-performance computing (HPC) system is a tool used to tackle problems that require more computing resources or time than they can obtain on the personal computers, available to the respective users to address them.

Industry 4.0: The name given to the fourth industrial revolution that includes the trend of automation and optimization of the manufacturing processes using smart autonomous systems.

Internet of Things: Internet of Things or IoT represents all connected devices that communicate with each other through the Internet.

Tourism 4.0: The trend of applying the tools and concepts of Industry 4.0 to the tourism sector, in order to create a personalized travelling experience and a more sustainable tourism.

Virtual Reality: Computer technology that uses realistic images, sounds and other sensory experiences, created with specific software in order to mimic a real or imaginary environment and to simulate the user's physical presence.