Universidade de Aveiro Departamento de Economia, Gestão, Engenharia Industrial e Turismo
Ano 2019

PEDRO MIGUEL BELEZA TEIXEIRA

THE ROLE OF THE FOURTH INDUSTRIAL REVOLUTION IN ACCESSIBLE TOURISM: STUDY AND CONCEPTUALIZATION OF A WEB APPLICATION

O PAPEL DA QUARTA REVOLUÇÃO INDUSTRIAL NO TURISMO ACESSÍVEL: ESTUDO E CONCEPTUALIZAÇÃO DE UMA APLICAÇÃO WEB

Universidade de Aveiro
Ano 2019
Departamento de Economia, Gestão, Engenharia Industrial e Turismo

PEDRO MIGUEL BELEZA TEIXEIRA

THE ROLE OF THE FOURTH INDUSTRIAL REVOLUTION IN ACCESSIBLE TOURISM: STUDY AND CONCEPTUALIZATION OF A WEB APPLICATION

O PAPEL DA QUARTA REVOLUÇÃO INDUSTRIAL NO TURISMO ACESSÍVEL: ESTUDO E CONCEPTUALIZAÇÃO DE UMA APLICAÇÃO WEB

Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Engenharia e Gestão Industrial realizada sob a orientação científica da Doutora Leonor da Conceição Teixeira, Professora Auxiliar do Departamento de Economia, Gestão, Engenharia Industrial e Turismo e coorientação da Doutora Maria Celeste de Aguiar Eusébio, Professora Auxiliar do Departamento de Economia, Gestão, Engenharia Industrial e Turismo.

This work was developed in the scope of the research project ACTION - POCI-01-0145-FEDER-030376 - , funded by FEDER, through COMPETE2020 - Programa Operacional Competitividade e Internacionalização (POCI), and by national funds (OE), through FCT/MCTES

Dedico este trabalho aos meus pais, irmão e avós

o júri / the jury

Presidente	Prof. Doutora Helena Maria Pereira Pinto Dourado e Alvelos Professora Auxiliar no Departamento de Economia, Gestão, Engenharia Industrial e Turismo - Universidade de Aveiro
Arguente	Prof. Doutor José Manuel Matos Moreira Professor Auxiliar no Departamento de Eletrónica, Telecomunicações e Informática - Universidade de Aveiro
Orientador	Prof. Doutora Leonor da Conceição Teixeira Professora Auxiliar no Departamento de Economia, Gestão, Engenharia Industrial e Turismo - Universidade de Aveiro

Agradecimentos/ Acknowledgements

Agradeço à minha família, principalmente ao meu irmão e aos meus pais por me motivarem sempre a dar o meu melhor e serem sempre o meu maior apoio.

O mais sincero e profundo agradecimento à minha Orientadora Professora Leonor da Conceição Teixeira e Coorientadora Professora Maria Celeste de Aguiar Eusébio, pelos conselhos e orientações de grande conhecimento científico, que guiaram este trabalho desde a sua conceção até a sua conclusão.

palavras-chave Turismo acessível, Indústria 4.0, TICs, Turismo 4.0, Aplicação Web

resumo

O mundo encontra-se hoje no início da quarta revolução industrial, responsável pela promoção de uma nova era caracterizada pela digitalização. Apesar desta revolução ter surgido no setor industrial, com o conceito de Indústria 4.0, a sua aplicação é muito mais vasta, existindo outros sectores que podem igualmente beneficiar desta nova era tecnológica. O setor dos serviços, nomeadamente o Turismo, é um exemplo disso, e o conceito de Turismo 4.0 é o resultado do impacto da quarta revolução industrial nesse setor. Um desafio interessante que esta nova era tecnológica traz para o turismo é o da inclusão social, promovendo o turismo para todos. De facto, o mercado do turismo acessível, apesar de ter imenso potencial, tem sido relegado no contexto dos negócios. Por outro lado, o potencial tecnológico associado a esta nova revolução industrial sugere uma grande capacidade na promoção do turismo acessível, na medida em que podem facilitar as condições de acesso ao turismo, por parte de pessoas com algum tipo de incapacidade e ou necessidade especial.

O presente trabalho visa conduzir um estudo na área do turismo acessível, por forma compreender os principais requisitos deste tipo de mercado e, consequentemente, conceptualizar uma aplicação Web, com o propósito de promover a acessibilidade no turismo, funcionando como um mediador de informação entre os principais stakeholders. Para a obtenção dos requisitos do sistema foi feita: i) uma revisão da literatura; ii) um estudo que avalia a acessibilidade dos websites dos hotéis da zona centro de Portugal, e, ainda iii) um estudo com base em análise de conteúdo de algumas plataformas potencialmente concorrentes. Os resultados são apresentados na forma de uma matriz de triangulação, onde é possível identificar a fonte dos requisitos identificados, sendo posteriormente utilizados para conceptualizar a solução proposta com recurso à notação UML.

Pretende-se com este trabalho demonstrar o potencial e o efeito que as tecnologias existentes na era designada por quarta revolução industrial podem ter na sociedade, nomeadamente na promoção de um turismo para todos.

keywords Accessible Tourism, Industry 4.0, ICTs, Tourism 4.0, Web application

abstract

The world is experiencing the beginning of the fourth Industrial Revolution, responsible for implementing a new digitalization era. This revolution originated in manufacturing, with industry 4.0 bringing a new reality to organizations. However, the scope of this new technological revolution is vast, and other sectors can benefit from the new digital era. In the Services Industry, tourism is an example of that, as Tourism 4.0 is the result of the impact of the fourth industrial revolution in this sector.

Tourism 4.0 is the result of the impact of the fourth industrial revolution in tourism. An interesting challenge that this technological era brings to tourism is the social inclusion of people with disabilities. The accessible tourism market reveals huge potential, but despite this, this market is still largely ignored. Several technologies that promoted the fourth industrial revolution present capabilities to promote accessible tourism by improving tourism's access conditions to people with disabilities.

The present work developed a study in accessible tourism, understanding the main requirements for this market, and conceptualizing a Web application, for promoting accessibility in tourism. This Web application work as a mediator between the principal stakeholders. To gather requirements for the system, a triangulation matrix was elaborated using three methodological approaches: i) Literature Review; ii) website accessibility analysis of hotels located in the central region of Portugal; and iii) content analysis of some concurrent platforms. The requirements triangulation matrix allowed the identification of what requirements are crucial for the system success, which were used to conceptualize the solution with UML notation.

This work intends to demonstrate the technological impacts of the fourth industrial revolution on society, especially on the promotion of a more accessible tourism.

Content

Table of Contents

List of Figures

List of Tables

List of Acronyms

AR	Augmented Reality
CPS	Cyber-physical system
GDP	Gross Domestic Product
GPS	Global Position System
ICT	Information and Communication Technology
IoT	Internet of Things
NFC	Near field Communication
PwD	People with Disabilities
RFID	Radio Frequency Identification
UML	Unified Modelling Language
UN	United Nations
UNWTO	United Nations World Tourism Organization
VR	Virtual Reality
W3C	World Wide Web Consortium
WCAG	Web Content Accessibility Guidelines
WTTC	World Travel and Tourism Council

CHAPTER I

Introduction

I.1 Significance and Contextualization of the Study

In today's world, there is an ongoing technological revolution that may ultimately change humankind. The fourth industrial revolution is evolving at high speed and will lead to a deeply connected world. A significant change in the way society works and communicates is happening at the moment, and it is having impacts in several manufacturing and services industries. This new industrial revolution results from a new paradigm called Industry 4.0 (Schwab, 2016:10). The drivers of this revolution came from innovations in different technologies, that are taking the world to a new digitalization era. This era will ultimately change society as a whole. Thus, it is of most importance to take advantage of the opportunities this revolution presents and embrace change, though for example, greater social inclusion (Schwab, 2016: 85).

One sector that is being most affected by the new digital era is undoubtedly tourism (Ivanović, Milojica, & Roblek, 2017). United Nations World Tourism Organization (UNWTO) has defined tourism as: "a diverse industry, which is a central economic driver for socio-economic development in many areas/destinations throughout the world" (UNWTO, 2009:1). Tourism is one of the economic activities that more income generates worldwide, often having a vital role in the economy of the countries. World travel and tourism council (WTTC) estimated that the total contribution of Travel and Tourism to global Gross Domestic Product (GDP) in 2017 was 10,4% and predicted that in 2018, it would increase to 11,7% (WTTC, 2018). With the emergence of new technologies, the way to practice tourism has radically changed. Nowadays, flights and hotels can be booked via the internet with a single click. With a new revolution in technology, no doubt that the tourism sector will change again, making it essential to study what impacts the latest emerging technologies will have in this sector.

This new industrial revolution will bring not only benefits but also challenges for tourism. A big challenge is how it can contribute to the social inclusion of people with disabilities (PwD) in tourism industry. Tourism is an activity that enriches people in many dimensions. However, it is difficult for disabled tourists to travel without any constraint. Often people with reduced motor/cognitive skills come up unable to travel due to various factors such as transport and accommodation.

It is estimated that over a billion people (about 15% of the world's population) live with some form of disability (World Health Organization, 2011). Moreover, although nowadays, tourism is one of the most important economic activities for global GDP and total employment generated (Turner, 2017), there are still several groups of our society that face many travel constraints, mainly PwD. The contribution of tourism to a more inclusive community involves developing strategies that promote the accessibility in tourism destinations, conceding the opportunities to PwD, to also enjoy tourism activities. Accessible tourism is crucial to the social inclusion of PwD. To accomplish this objective, it is essential to encourage the active involvement of all stakeholders of the tourism system in the co-creation of accessible and adapted tourism products.

The study of the connection between accessible tourism and industry 4.0 led to the arrival of a new paradigm on tourism: Tourism 4.0. This dissertation offers insight into this very modern literature concept, that is Tourism 4.0. With a careful exploration of this new concept and its relationship with accessible tourism, it was possible to overcome the gap in the literature on how the fourth industrial revolution is transforming accessible tourism.

Information and access to it are seen as crucial factors for accessible tourism. With the emergence of new technological platforms promoting the fourth industrial revolution, information systems became crucial in many sectors (Haddara & Elragal, 2015). Information is still an essential factor, and Web platforms are rising, due to the digital era, which makes the creation of Web information systems essential in this new technological age. According to Alter (1992: 7), Information systems can be defined, from an organizational viewpoint as "a combination of procedures, information, people and information technologies, organized for achieving the goals of an organization". When these systems support management and communication on the internet, they can be conceptualized as web-based information systems (Yi & Hwang, 2003).

The use of information systems can be primarily responsible for facilitating access conditions, for people that have any disability. This type of system allows easy access to a range of tourism activities to PwD, contributing to better tourism experiences, and delivering more value to customers, which are the main goals in service science. Web application can be a crucial aspect for the integration the fourth industrial revolution and tourism. Since new digital activities increase, the amount of data also increases exponentially, making effective treatment of data a significant activity. These systems can provide data treatment and improve information management, by helping to distinguish what information is essential and which one is not relevant. The need for a Web application is clear, but despite this, currently, there is an evident lack of Web platforms promoting accessible tourism.

To align technologies and accessible tourism, another main objective of the study is also to conceptualize a Web application, designated in this work as *AccessTour@WebApp.* This application will work similar to a Web based information system to support information management in the context of accessible tourism.

The *AccessTour@WebApp* should work as a mediator between offer and supply and should be both accessible and smart. The accessible part is visible by the way the system is presented, and the smart part represents what the system allows users to do. The success of Web systems depends on how well it fits the user needs (Irestig & Timpka, 2008). Therefore, it is imperative to realize what are the most important aspects and requirements, regarding usability and the main reasons that prevent disabled tourists from traveling. So that, the conceptualized system can work as a technological solution and overcome accessibility constraints, in tourism. The literature reveals that research in this field is currently very limited.

Moreover, few studies use an integrative perspective of all the stakeholders that should be involved in the co-creation of tourism experiences for the accessible market (demand and supply agents). Therefore, this study also intends to overcome this gap, analyzing how the tourism industry could better attract and serve customers with special needs. This project aims to provide both theoretical and practical contributions to promoting accessible tourism, considering the needs and desires of all the stakeholders involved. This dissertation aims to promote accessible tourism in the by introducing an idea of the intended Web application, aligning concepts of the fourth industrial revolution and accessible tourism.

Summarizing, the major challenge of this thesis is to understand the roles of technologies in tourism and develop a Web-application for accessible tourism. This will allow to disseminate information, stimulate communication among all actors involved in the co-creation of tourism experiences and, simultaneously, create knowledge that could be used to produce personalized tourism products. It is, therefore, a project whose development will contribute significantly for the promotion of tourism practice of PwD and the elderly, which have some functional limitations that cause difficulties in acquiring tourism products. The *AccessTour@WebApp* will be dynamic and should contribute to eliminating travel constraints that this market faces. With the conceptualization of the system, this thesis seeks precisely to show how new technologies can help improving accessible tourism.

This thesis can be seen as a bridge that connects the fourth industrial revolution and the world of tourism. The new digitalization era primarily focuses on improving connectivity, thus making information still a critical factor. There are new technologies, developing connectivity and with the ability to carry the concept of Smart Tourism even further and at the same time, contribute to more accessible tourism. Web applications, like the one conceptualized with this work, illustrates how the new digital is revolutionizing accessible, and improve accessibility through information and connectivity.

I.2 Research Problem and Purpose of the Study

To comprehend the role of the fourth industrial revolution on accessible tourism, it is necessary to understand the impact that technologies promoting the fourth industrial revolution have on the tourism sector, and how these can contribute to developing accessible tourism for all. Several issues arise associated with the industrial revolution and can be easily interconnected in more accessible tourism platforms. Beyond understanding how industry 4.0 is helping accessible tourism, the study has the purpose of recoiling the requirements for building a Web application for accessible tourism. The potential requirements for the Web application will offer significant gains on the development of Web platforms for accessible tourism.

I.2.1 Research Questions

This dissertation attempts to generate an overview of the impact of the fourth industrial revolution, Industry 4.0, and digitalization in the tourism industry and understand the importance of developing more accessible tourism. For answering this question, one research question was formulated.

Q1: What is the impact of the fourth industrial revolution in tourism, and how can it contribute to the development of a more accessible tourism?

The dissertation also aims at the identification of requirements to a proposal of a Web application for accessible tourism. The objective is to conceptualize the system by identifying potential user requirements and present a primary concept of it. Therefore, it is fundamental to study possible ideas and understand how a Web application for accessible tourism should be conceptualized and what are users' main requirements, when using this type of platforms. A second research question was then elaborated.

Q2: What are the main requirements for the construction of a Web application, for accessible tourism, and how should the system be conceptualized?

I.3 Research and Methodology

This study has both theoretical and empirical parts. Due to the nature of the first research question, the qualitative research method was selected to compare academic findings and elaborate the answer to the problem. This thesis represents an exploratory study as it tries to understand and gain insight into the impact of the fourth industrial revolution and digitalization in accessible tourism. As the current literature in this topic is scarce, the approach of the study includes data collection, that is used to explore the phenomena and to identify central themes and patterns. The theoretical part of the research focuses on describing main literature topics. Industry 4.0, Information and communication technologies (ICTs), Smart tourism, accessible tourism, and tourism 4.0 provide the necessary theoretical background to develop the empirical study. This academic background was essential to answer the first research question, but also vital for the second research question. The identified literature gap, presented in the form of the first research question, was overcome with the alliance of theoretical concepts and the study of practical examples in literature. The literature review was gathered through a carefully selected, peer-reviewed, and widely referred articles from Scopus and EBSCO databases. Due to the novelty of the topic of the fourth industrial revolution combined with tourism, the theoretical background also incorporates business articles, and special reports by renowned institutions, companies, and research centers.

For answering the second research question and identify requirements for the construction of the *AccessTour@WebApp*, three methodological approaches were used: i) Literature Review; ii) website accessibility analysis of hotels located in the central region of Portugal; and iii) concurrent platforms' content analysis. The first research method is the theoretical background of the thesis. Alongside the analyze of literature topics, requirements for conceptualizing the Web application could be retrieved. The second research method was a practical study, which examined the accessibility in hotels websites, using two automated tools. The third research method was a second practical study, based on the analysis of Web platforms, similar to the Web application that is intended to be conceptualized. A more in-depth look at the methodology used in each study is explained when the studies are presented. The presentation of the requirements was executed with a triangulation matrix. The triangulation enables a look across the results of all used methods, and decide which ones are more crucial to the system (Teixeira, Ferreira, & Santos, 2012).

The identified user requirements are divided into two types: functional requirements and non-functional, that include accessibility requirements. Functional requirements can be defined as what the system can do, while non-functional requirements are defined as requirements that describe how the functional requirements should be executed (Zhou, Hyvonen, & Louise, 2004). In the case of PwD, non-functional requirements can include accessibility requirements.

Functional requirements provide the responses and actions to specific inputs and conditions of the system (Shahid & Tasneem, 2017), these were obtained with the help of literature review (scientific papers) and the analysis of content in concurrent platforms. Non-functional requirements are related to functionalities intended with the software like usability, flexibility, accessibility, and efficiency and were obtained based on literature review; the analysis of the website accessibility of a specific tourism supplier group (hotels); and content analysis of concurrent platforms. These types of requirements are the biggest responsible for providing content accessibility on the platform. After all the user requirements were presented, a conceptualized model of the Web application was elaborated in UML (Unified Modeling Language). The model was illustrated using the use-cases and class diagrams, with *Visual Paradigm* software.

I.4 Structure of the Study

The **first chapter** familiarizes the reader with the research topics, the main concepts of the study, and the overall setting of this thesis. It offers a description of the research problem and the purpose of the study. The chapter closes with the research questions and research methods used.

The second chapter presents in-depth and careful research on main literature topics. These topics compose the theoretical background of the thesis. The main objective of the section was to make an exploratory approach about the role of technologies and the fourth industrial revolution in accessible tourism. The literature review also contemplated the importance of Web accessibility. The chapter is divided into four sub-chapters.

Accessible tourism is the first analyzed concept. It was verified that this topic has been gaining international importance, across tourism researchers. Also, the market for this type of tourism is very diverse, and demand is increasing, revealing lots of potential for the future. Unfortunately, there are still many constraints for disabled tourists, that complicate access to tourism products.

The second key topic is related to the study of the impact of technologies in tourism. Technological impact on daily life is evident as new ICTs are rising and changing the way society communicates (Schwab, 2016: 12-13). Once the literature review of ICTs was finished, a theoretical study was elaborated. This research study focused fundamentally in discover practical examples of how technologies can make tourism more accessible. With the help of the specially selected articles, some technologies improving accessible tourism were identified.

Industry 4.0 and the rising of the fourth industrial revolution were also crucial to this research. A historical perspective is bestowed to recognize the different technological implications in the world. Then, technological and value drivers of this new digital era were identified. The role of ICTs in tourism leads to the concept of smart tourism. The topic of smart tourism is associated with essential topics, also responsible for elevating tourism industry.

The second sub-chapter closes with the presentation of a widely new concept in literature: Tourism 4.0. Tourism 4.0 can be perceived as the impact of the fourth industrial revolution on tourism and has particular importance to accessible tourism. To answer the first research question and surpass the identified literature gap, Tourism 4.0 was aligned with accessible tourism, and a new concept was created: Accessible@Tourism 4.0.

The importance of Web accessibility was also approached in the chapter of literature review (chapter 2). Since one of the main goals is the conceptualization of a Web system for accessible tourism, it is imperative to understand basic concepts associated with Web accessibility.

Alongside studying the impact of the fourth industrial revolution in tourism, some ideas of user requirements for the WIBS were retrieved. It was verified that technology and accessible tourism are linked with each other, as "Integration of technology make life easier, especially for disabled people" (Altinay et al., 2016: 95). Chapter two ends by presenting some requirements retrieved from the theoretical background.

The **third chapter** presents two practical studies used to identify the requirements for developing the *AccessTour@WebApp, and the conceptualized result*. The chapter is divided into three sub-chapters.

The first sub-chapter presents a study about the website accessibility of hotels located in the central region of Portugal. Some theoretical background on the importance of information is presented alongside research methodology, data gathering, and the methods used for data analysis. A sample of 344 websites was analyzed based on Web Content Accessibility Guidelines (WCAG) 2.0, using automatic web diagnostic tools (AccessMonitor and TAW). This analysis was performed considering the A, AA, and AAA conformance level of WCAG. This first study intends to identify accessibility requirements, mainly related to the way software presents the content, which makes information online access to all people, independently of their needs and functional limitations.

The second practical study is the content analysis of some similar Web platforms, to the Web application for accessible tourism. Six platforms that promote accessible tourism and a system that aims at improving healthy aging conditions were analyzed. The main functionalities of every system were transformed into important requirements, mainly related to content functionalities, crucial for the efficiency of a Web application that promotes accessible tourism.

After recoiling requirements form three different sources, all the retrieved user requirements for the Web application are presented. A Triangulation Matrix was used to explore the findings of the requirements obtained by the three executed methods (Literature Review; website accessibility analysis of hotels located in the central region of Portugal; and content analysis of some similar platforms). The chapter ends by presenting models for the *AccessTour@WebApp*, built in UML notation.

Chapter four discusses the main findings, possible limitations of this study, and recommends future researches in order to increase the knowledge in this area.

CHAPTER II

Theoretical Background

II.1 Accessible Tourism

Article 7 of the UNWTO Global Code of Ethics for Tourism introduced the “Right to Tourism". The article establishes that "family, youth, student and senior tourism and tourism for PwD, should be encouraged and facilitated” (World Tourism Organization, 2001: 5). Tourism is a right of citizenship and therefore, tourism institutions need to be inclusive for PwD and seniors, as they are an essential part of the accessible tourism market (Darcy & Dickson, 2009). People with access requirements represent challenges and opportunities for the tourism industry (Buhalis & Darcy, 2011: 40).

II.1.1 Disabilities and Health Care

Over a billion people (about 15% of the world's population) live with some form of disability (World Health Organization, 2011). In the United States, The American Community Survey estimates that in 2016, 12,8% of the population suffered from some type of disability (Kraus, Lauer, Coleman, & Houtenville, 2018). In the European Union, the number of people with access requirements is almost 127.5 million people (Buhalis & Michopoulou, 2011). In Portugal alone, the estimated percentage of the population requiring accessibility is about 30,3% (Buhalis & Michopoulou, 2011; Darcy & Dickson, 2009). The current tendency is for this number to increase even more. The fact that the population is aging may also be a risk factor since many health problems like diabetes, cardiovascular diseases, and mental illness are directly related to aging implications (Buhalis & Darcy, 2011: 5).

Banal views of disability highlight only wheelchair users and other groups such as blind people and deaf people, but this notion is a clear misunderstood. Disability is an experience resulting from the interaction of health conditions, personal factors, and environmental factors that varies greatly (World Health Organization, 2011). It is indispensable to address the problem of exclusion of PwD, in order to achieve a more inclusive society. The Convention of the UN for people with disabilities indicates on the preamble the necessity of understanding disability as an “evolving concept, that results from the interaction between persons with impairments and attitudinal and environmental barriers that hinders their full and effective participation in society on an equal basis with others” (United Nations, 2006: 1). Disabled and impaired people are capable of living independently, but for that to happen, there must be a compromise from society and the governments to provide these people, the best conditions possible. Disabled people must be seen as alter-capable without any type of prejudice to society (Portales, 2015). This group of people doesn't want to be treated differently; they just need to be provided with the right conditions to live their lives independently. In this context, it is essential to distinguish between disability and impairment. An impairment is “any loss or abnormality of a psychological, physiological or anatomical structure or function” (World Health Organisation, 1993: 27). A disability is “ any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being” (World Health Organisation, 1993: 143). In order to be genuinely inclusive, accessible tourism should incorporate these two concepts.

II.1.2 Accessibility and Tourism

Accessibility is a quality concept that may be interpreted differently from person to person (Persson, Åhman, Yngling, & Gulliksen, 2015). Some people think of accessibility as directly serving some of their needs, while others think of it in a more general way. *The Convention on the Rights of People with Disabilities* on article 9, states that accessibility is "to enable persons with disabilities to live their life independently and participate in all aspects of life" (United Nations, 2006: 9). Accessibility in tourism includes granting access to " the physical environment, to transportation, to information and communications, including information and communications technologies and systems, and to other facilities and services open or provided to the public, both in urban and in rural areas." (United Nations, 2006: 9). Also, article 30 implements the right to "participate in cultural life, recreation, leisure, and sport" (United Nations, 2006: 22). This convention supported the Manila Declaration on World Tourism signed in September 1980, where tourism was recognized as a fundamental right (UNWTO, 1980).

Although many international entities have agreed with the establishment of tourism rights for disabled people (United Nations, 2006; World Tourism Organization, 2001), sometimes legislation alone is not enough. It does not guarantee the end of discrimination against disabled people and the satisfaction of their needs (Zajadacz, 2014). This is a big problem in the tourism industry. A study in Australian has shown that even though tourism websites respect the legislation for disabling tourists, they are classified as not accessible (Shi, 2006). Tourism is a prominent national source of revenue in several nations, especially considering countries with ancient historical and cultural tradition, as for instance, European Countries like Portugal (Milicchio & Prosperi, 2016). Related to this, there is a problem with historical attractions, that don't have the same law requisites as new attractions sites. Historical touristic centers should take into consideration these analyzed factors in order to provide social inclusion to disabled tourists. The tourism industry plays a significant role in national and urban economies (Emrouzeh, Dewar, Fleet, & Bourgeois, 2017). The way cities present their services is crucial for accessible tourism. If transportation networks like metro and bus don't have access facilities, how can disabled tourists visit main attractions? And how can disabled tourists be provided with tourist experiences in restaurants and museums? In this case, technology and the right planning may be the answer.

In fact, accessible tourism englobes a lot of other concepts. In *Accessible Tourism: Concepts and Issues*, two known authors in this area, Buhalis and Darcy defined Accessible Tourism as : "a form of tourism that involves collaborative processes between stakeholders that enables people with access requirements, including mobility, vision, hearing and cognitive dimensions of access, to function independently and with equity and dignity through the delivery of universally designed tourism products, services, and environments." (Buhalis & Darcy, 2011: 10-11). One of the essential foundations of Accessible tourism is seeking to integrate people with impairments and disabilities in travel and leisure activities (Milicchio & Prosperi, 2016).

II.1.3 The Accessible Tourism market

The accessible tourism market includes people with special needs to access tourism activities. PwD is one of the most important segments of this market. Disabled tourists are rising, making the accessibility market, a market with tremendous potential. It is estimated that by 2020, around 25% of travel and leisure spending will come from PwD (Bekiaris et al., 2018). Demand in this market is increasing, which makes it a very attractive one. But, despite all the potential, accessibility market is mostly ignored (Buhalis & Michopoulou, 2011).

The accessible travel industry can encourage visitors, particularly individuals who have some type of incapacity or specific needs, to travel in the ideal conditions. It creates new business opportunities for entities that operate in the tourism area, reducing seasonality since PwD find travel out of season more opportune (Ribeiro, Silva, Barbosa, Silva, & Metrôlho, 2018). Non-seasonal tourism improves revenues and the use of infrastructure throughout the year, making destinations better and, above all, creating jobs. It should be noted that this type of tourism is not a niche market, but it can be responsible for improving products and services associated with accessibility. Also, tourism organizations can increase their market potential and improve their image by increasing the accessibility level of their tourism offerings (Alén, Domínguez, & Losada, 2018).

II.1.3.1 Segments of the market

The accessibility market is not homogenous (Buhalis & Michopoulou, 2011). Different types of disabilities have different demands and requirements (Figueiredo, Kastenholz & Eusébio, 2012). Therefore, it is critical to divide the market into segments with similar needs and wants in order to create customized offerings and suitable products (Buhalis & Michopoulou, 2011). Segmentation can be seen as the key to competitive advantage (McKercher, 2008), and the accessible market is no exception. The article 1 of the UN convention, establishes that: "Persons with disabilities include those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others." (United Nations, 2006: 4).

This market includes persons with disabilities, such as: i) mobility; ii) blind or vision impaired; iii) deaf or hearing impaired; iv) speech; v) cognitive (mental health/intellectually/learning) and vi) hidden (Buhalis & Darcy, 2011: 38). Other important segments include people with temporary disabilities such as people with crutches during a temporary period, the elderly, people carrying luggage, small children or people who are big or small in size, people with allergies and also Elderly/Seniors/Boomers. In table 1, some of these segments are described and characterized (Blocksidge, 2003; UNWTO, 2017; DEO, 2005; Disabled People's Association, 2015; Buhalis & Darcy, 2011:38; Michopoulou & Buhalis, 2013).

In accessible market segmentation, one should consider the differences among segments concerning travel behavior, motivations, interests, and needs that derived from the various types of disabilities (Kastenholz, Eusébio, Figueiredo, & Lima, 2012). On an important note, according to Shi (2006), disabilities affecting peoples' use of Web include: visual, hearing, cognitive and neurotically impairments, and some mobility disabilities.

Table 1- Segments of the accessible tourism market

Disability/Impairment	Characterization of each segment
Mobility Impairment	Mobility impairments indicate physical mobility restrictions, such as reach, stretch, dexterity, and locomotion. The capacity to move, coordinate body actions, or perform physical activities can be significantly limited, impaired, or delayed.
Blind/Visual Impairment	Fully or partially reduced functioning in one eye's or both eyes' ability to detect and/or process images. Caused by a wide range of biological or environmental factors, loss of vision typically arises in young people from a genetic/ biological condition or injury to part/s of the eye. Color blindness is also a visual impairment
Deaf/Hearing Impairment	The term for partial loss of hearing within a range from slight to severe.
Speech impairment	A speech disorder is an impairment related to the articulation of speech, sounds, fluency, and/or voice.
Cognitive (mental health/intellectually/learning)	**Mental disability:** Refers to any illness or disorder of the mind that: has significant psychological or behavioral implications. It is associated with painful or distressing symptoms and impairs an individual's level of functioning in certain areas of life. **Intellectually impaired**: A person with an intellectual disability has intellectual functioning significantly below average. In addition, he or she has limitations in adaptive behavior which affects his or her self-help, living, or social skills. **Learning disability**: a general term for any one of a group of conditions that includes, for example, autism and dyslexia.
Hidden impairments	Hidden impairments incorporate a wide range of illnesses that require special attention, but sometimes is not apparent or it is not seen at all times. These health problems might result in limited strength, vitality, attention deficit disorders, or hyperactivity disorders. Examples of hidden impairments are diabetes, epilepsy, heart problems, blood pressure, or circulation problems.
Elderly/Seniors/Boomers	Elderly people refer to old adults, who may suffer from some kind of disability due to age problems. They have a substantial impact on the accessible tourism market. A strong and positive correlation between aging and disability is verified in the literature. Senior tourism is directly related to accessible tourism because disability is often associated with the elderly. This target population also has specific interests that have been analyzed in several studies.

Source: Adopted from (Buhalis & Darcy, 2011: 34)

II.1.4 Travel Barriers for Disabled Tourists

Accessible tourism is gaining more exposure in recent times, but there are still many obstacles that need to be conquered. Tourists, especially the ones with disabilities, face some significant barriers that influence negatively tourism experiences and the opportunity of PwD to carry out tourism activities and have new experiences. Almost half of all disabled tourists would travel more frequently if there were more barrier-free offers (Franz Pühretmair, 2004). Sometimes, these obstacles are so challenging to conquer that prevent people with impairments from traveling (Popiel, 2016), making these problems a big issue. These obstacles create "roadblocks" to tourism, threatening the quality of life and independence, during tourism practices. Smart tourism understands the need for information and physical accessibility the tourism, but barriers to access are complex and not reducible to the physical environment and information constructs (Buhalis & Darcy, 2011:50).

As society is evolving, more attention is given to social problems. Lately, some efforts have been made to eliminate these barriers, especially considering new legislation. A few decades ago, legislation could be considered as one of the barriers to accessible tourism (Smith, 1987). But with recent developments on accessibility for PwD (United Nations, 2006, 2016; World Health Organization, 2011), regulations have played an important role in reducing discrimination against PwD (World Tourism Organization, 1991).

Recently various regulations have be published in order to make more accessible different kinds of tourism products (e.g., accommodation, food and beverage, tourism attractions, transports, travel agents and tour operators) (Gnoth, 2002). However, despite the existence of these regulations, frequently the tourism products offered are not accessible. Some barriers might affect more one type of impairment, but they are all relevant, so they must be identified in order to implement measures to minimize or eliminate these barriers on tourism.

In the literature, the barriers that PwD face to access tourism activities are frequently examined. These barriers are usually related to intrinsic (internal) or environment (external) factors (Smith, 1987). Several authors characterized different internal and external barriers (Avis, Card, & Cole, 2005; Snyman, 2002; Buhalis & Darcy, 2011: 50; Figueiredo et al., 2012; Smith, 1987, Popiel 2016). In table 2 different kinds of barriers, included in these two categorized groups are identified.

Table 2- Barriers to participation in tourism

Barriers to Accessible Tourism	
Intrinsic (Internal) Barriers	Lack of Information/ Knowledge
	Health problems
	Lack of Social Skills
	Physical/phycological dependency
Environmental (External) Barriers	Attitudinal
	Architectural
	Ecological
	Financial/Economic
	Transportation
	Communication

Source: Adopted from (Smith, 1987)

II.1.4.1 Intrinsic Barriers

Obstacles that are associated with each participant's own physical, psychological, or cognitive functions (state of consciousness) are intrinsic barriers (Smith, 1987). This is related to internal factors such as the capacity that people have to carry out tourism activities. After studying the different segments of the accessible market, it is possible to comprehend that different disabilities give origin to different barriers. Obstacles for deaf people are very different from the obstacles that visually impaired people face. Intrinsic barriers include: i) lack of Information; ii) health problems; (iii) lack of social skills and (iv) physical/phycological dependency.

A. Lack of information/ knowledge

The main problem, preventing people with different types of disabilities from traveling is mainly related to the shortage of information (Stumbo & Pegg, 2005). If there is a lack of information is impossible for PwD to be sure that all the requirements that they need to carry out a tourism trip

will be fulfilled. Pre-planning is crucial to ensure that special needs are met, exhaustive information for reaching the destination, returning home, moving around at the destination and for checking the availability of accessible accommodation, attractions are of utmost relevance (Buhalis & Darcy, 2011: 56). Other types of the required information are, for example, related to appropriate signage of accessibility, adapted recreational activities, security, and monitoring during the implementation of recreational activities (Figueiredo et al., 2012).

Currently, not only travel agencies are responsible for disseminating information. A lot of data exists in new internet platforms like web-systems and social media. This type of platform is now the preferable mean of communication (Wang, Wu, Yuan, Xiong, & Liu, 2017; Altinay et al., 2016), so their capacity cannot be underestimated. Lack of information about the accessibility level of tourism services and products is a big obstacle because it hinders answering basic questions related to tourism activity, like how to travel and what to explore. Information is undoubted, the foundation for accessible tourism, and because of that, the role of technology is crucial.

B. Health problems

Health problems affect the living conditions of many people with disabilities and people without disabilities, and sometimes they can be severe obstacles while traveling. A survey conducted to study senior tourism in Israel concluded that deterioration of health is related to a decreasing number of vacation days taken (Fleischer & Pizam, 2002). Well-being is vital for everyone and must be one of the main cautions when traveling. Of course, health problems cannot be a reason to deny tourism to a person, but prudence is advised. Impairments can cause severe chronicle pains that need special treatments. Pain may be a significant impediment to tourism (Meade, Dyer, Browne, & Frank, 1995; Smith, 1987).

C. Lack of social skills

The lack of social skills is a big problem among PwD (Abbott & McConkey, 2006). This leads to social ineffectiveness, which is prejudicial to tourism. Difficulties in integrating leisure activities are the leading causes of social exclusion. The lack of confidence to interact with others, prevents many tourists from traveling, so an inclusive environment to all is essential.

All stakeholders, involved in the tourism industry, must make sure that tourism activities welcome everyone, thus making sure PwD can participate in all activities, eliminating the constraints related to social skills. Generally, the lack of social skills affects mainly people with learning/intellectual disabilities (Gresham, Sugai, & Horner, 2001). Virtual reality, a technology gaining relevance with Industry 4.0, can help improve social skills among people with intellectual disabilities (Standen & Brown, 2005).

D. Physical / psychological dependency

Disabled people struggle every day to live an independent life, but sometimes impairments are so severe that assistance is required (Kittay, 2011). When psychological/physical dependency occurs, personal growth and self-development are gravelly affected (Smith, 1987). Dependency is also a big issue in tourism, because It may difficult the access to tourism activities of Ped without a companion.

When a person depends on another, the capacity to be part of leisure activities decreases, given that is very difficult to carry out tourism trips. In order to ensure accessible tourism, assistive requirements must be safeguarded. Assistive technologies can be a step forward in assuring that PwD have more independent life (European Parliamentary Research Service, 2018).

II.1.4.2 Environmental Barriers

Environmental barriers are imposed upon disabled tourists by social or physical conditions (Smith, 1987). These factors are mainly external to a person. They are related to the environment that surrounds the tourist. What exists in that environment, and the way is displayed to the tourist influences the concept of accessibility in a tourism experience. External factors are more likely to be addressed by stakeholders because they are directly or indirectly responsible for assuring that external constraints are eliminated. Environmental Barriers consist of: i) attitudinal; ii) architectural; iii) ecological; iv) financial/economic; and v) related to transports.

A. Attitudinal

Attitudes that people have related to PwD can difficult their access to tourism activities. Unfortunately, negative attitudes are still presented in society as it represents a significant barrier to tourism participation (Buhalis & Darcy, 2011: 55). Despite legislation, disabled people still suffer some types of discrimination (Dovidio, Pagotto, & Hebl, 2011). Negative behavior of non-disable people towards people with impairments have prejudicial impacts in many aspects, so it is society's duty to be more inclusive. The same happens in tourism, since if a person doesn't feel welcome when arriving a destination, the will to join tourism activities will probably disappear.

Mentalities are not easy to be changed, and wrong attitudes towards PwD include prejudice, ignorance, fear, insensitivity, bigotry, stereotyping, misconception, discrimination, dislike, insecurity, discomfort, tension, and intolerance (Snyman, 2002). Other forms of these barriers are the paternalistic attitudes that may arise from pity or from a nondisabled person's desire to demonstrate positive feelings toward PwD (Smith, 1987). There is a need to fight against pre-conceived ideas and stigmas against people with impairment. Obstacles related to attitudes create barriers in the physical environment that can only be reduced or eliminated through a profound change in attitudes (Buhalis & Darcy, 2011: 55). The attitudes toward these group of people are a gigantic obstacle to accessible tourism, and many times an attitude adjustment in society is much needed. Societies which must be able to realize the prudence of including barrier-free design in tourism environments (Snyman, 2002).

B. Architectural

Architectural barriers are "manmade obstacles (including the absence of adaptations) in the physical environment" (Smith, 1987: 382). If a tourism destination has attractions that are physically inaccessible, that constitutes a significant barrier for people with mobility and visual impairments. Attractions are the elements of a tourism destination that stimulate the purpose of a journey and visit (Snyman, 2002), and if they are no equipped with the right equipment for disables, it originates a substantial problem. Some examples include restaurants, museums, and hotels. In the case of these buildings, it is essential to have ramps, elevators and appropriate bathrooms for people in wheelchairs. Hotels should provide special rooms with appropriate equipment that allow the receptiveness of impaired people. This type of obstacles is the main cause of external physical barriers and can be eliminated with the help of proper planning. Some examples include accessibility of the public toilets, accessibility of tourism attractions, specific parking, existence of adapted or suitable accommodation, availability of equipment for PwD and by providing easy access to stores (Figueiredo et al., 2012).

Architectural barriers are not only focused on physical accessibility. When visiting some attractions like museums and staying at some hotels blind, deaf and cognitive impaired people have also encountered some difficulties, that also are cause for poor leisure experiences (Haworth &

Williams, 2012; Tantawy, Kim, & Pyo, 2005). Architectural obstacles should be pointed out as primary opposites to accessible tourism as they are also caused by the dreadful distribution of information and poor planning. The main responsible, for eliminating these obstructs are architects, engineers, builders, and anyone that participates in the design and management of the built environment (Snyman, 2002).

C. Ecological

When traveling to some destinations, nature can provide us with some adversities. Obstacles presented to us by nature are denominated ecological barriers (Smith, 1987). Ecological barriers to tourism development analyzed are i) the existing legislatively established standards regulating recreational pressure on them; ii)the resilience of ecosystems to tourism-related anthropogenic impacts, and iii) the present status of natural ecosystems under recreational pressure (Evstropyeva, Zabortseva, & Korytny, 2018). The ecological impacts that some types of tourism have in some regions create some ecological unsustainability, which can cause accessibility related problems (Münster & Münster, 2012). On the other hand, the natural landscape can provide significant challenges for tourism, especially for disabled people, as natural conditions such as hills, sand, mountains, trees, wind, snow, extreme cold, and extreme heat and rain can make accessibility quite difficult for mobility impaired people. Nature and tourism can work as barriers against each other, and in both cases, careful planning is advised.

D. Financial/economic

In a survey realized by Popiel (2016), 56% of the respondents stated that the most significant impediment to tourism practices is an economic barrier. Usually, traveling for disabled people is more expensive, because of eventual special needs. When traveling, specialized transportation can be costlier due to taxes relative to transport assistive devices. Most cheap options for accommodations like hostels are not ready to display options to disable people. This creates the necessity to adopt more expensive options like hotels. A complex dilemma is created since most of the times, disabled often have a worse position on the labor market, and on the other side, the touristic services adjusted to their needs are usually more expensive (Popiel, 2016).

E. Transportation

Transportation is essential in tourism and can be considered one of the main obstacles for disabled people. Availability of accessible transports to all citizens is essential if they want to participate fully in society (Snyman, 2002). For new transit riders, especially those with cognitive disabilities, it is challenging to execute a trip without personal assistance (Barbeau, Georggi, & Winters, 2010). Transport is present in many aspects when taking a tourism trip. Access to transport embraces two main components: arriving and leaving the destination and traveling (Buhalis & Darcy, 2011: 51). It all starts with the transport to the desired destination, and many times it is necessary to experience many leisure activities like going on trips and exploration of famous sites. The main types of means of transportation in tourism industries are air, sea, railway, automobile (Mammadov, 2012).

In the case of airplanes, they are the main mean of transportation to visit faraway places. In recent times, legislation has been more favorable to people with disabilities travel by air. Still, some problems arise like finding the way across the airport. Fortunately, several new technologies have been helping people with different impairments travel by plane (Darvishy, Hutter, Früh, Horvath, & Berner, 2008; Bosch & Gharaveis, 2017).

In the sea travel area, cruises are very popular amongst older adults. Proper care, when boarding and landing are necessary to ensure security and accessibility. Also, as cruise ships also work as

accommodations, the same accessible principles described in hotels should be followed like accessible bathrooms, the presence of elevators and guides in sign and braille language.

Trains and buses are critical in tourism as they are necessary means to visit big cities. These two types of transportation should be corrected optimized for welcome disabled people, with correct access equipment. Other critical aspects with these types of transportation are routes and timetables available only in print formats, graphics messages on signs, monitors, or maps displayed in transit terminals, on transit vehicles, and inside transit vehicles and bus stop locations that are not clearly marked (Snyman, 2002). Some technological advances have permitted to ease the process of navigation when using public transportations by utilizing mobile applications capabilities (Barbeau et al., 2010; Ribeiro et al., 2018), but most of them are still only prototypes. Transportation is a business much related to information, considered as the base for the tourism industry. To sum up, accessible transportation might very well be decisive for accessible tourism.

F. Communication

The United Nations' *Convention on the Rights of People with Disabilities* states that Communication includes "languages, display of text, braille, tactile communication, large print, accessible multimedia as well as written, audio, plain-language, human-reader and augmentative and alternative modes, means and formats of communication, including accessible information and communication technology" (United Nations, 2006: 4). Communication alongside with information is crucial for accessible tourism development.

The importance of the communication process in tourism was described as: "A consistent theme running through the literature on culture shock is communication difficulties. This nearly always involves language difficulties, as the tourist or sojourner is able to speak (or write or read) little or nothing of the host culture's language. It has been argued that these difficulties arise as a function of cross-cultural and cross-national differences in social skills" (Furnham, 1984: 49). This is especially verified on the case of tourists with hearing, seeing and speaking impairments. Various means of communication, such as the ones sated in the UN convention, must be safeguarded, in order to eliminate communication obstacles.

II.1.5 Eliminating Constraints to Accessibility

The barriers studied are clear obstacles to accessible tourism, as they are inequality factors in tourism for people with impairments. However, some of the categorized barriers can also have negative impacts on non-disabled tourists (Buhalis & Darcy, 2011: 57). An inaccessible transportation network or monuments with adverse access conditions can negatively influence tourism c experience of all visitors independently of their needs or functional limitations. All barriers should be taken seriously, as solutions must focus on achieving the ultimate goal of eliminating social injustice for PwD (Daruwalla & Darcy, 2005). For instance, it can be perceived that shortfall of information and obstacles that originate physical inaccessibility are the main problems.

Technological solutions and a more universal design arise as possible solutions to eliminate these obstructions to the tourism industry. Accessible design and information provision improve the accessibility and usability for PwD, but they also make tourism more approachable for a broader range of the population (Pühretmair, 2004). If correct information is displayed to tourists, correct planning is possible, helping eliminate all other obstacles, inclusive providing solutions for physical accessibility. Information is undoubtedly the pillar of accessible tourism.

II.1.5.1 Information in Accessible Tourism

In tourism, planning by people with impairments needs more detailed information, focusing on the respects to their individual/special requirements. Higher accessibility requirements demand more detailed and more specialized information. However, as verified by Waschke (2004), the supply of specific information becomes scarcer for those with higher accessibility requirements. As figure 1 demonstrates, the gap between the demand and supply of accessibility information is increasingly big, giving origin to the problem of information. By analyzing this problem, it can be noticed that the higher the requirement (demand) for information, the lower supply (information displayed) becomes. The difficulty of providing information according to the needs may lead to avoid the practice of holidays or seek alternative leisure solutions (Waschke, 2004). As a consequence, the tourism industry fails to appeal to this group of clients, ignoring possible business opportunities and wasting this considerable market potential (Buhalis, Eichhorn, Michopoulou, & Miller, 2005).

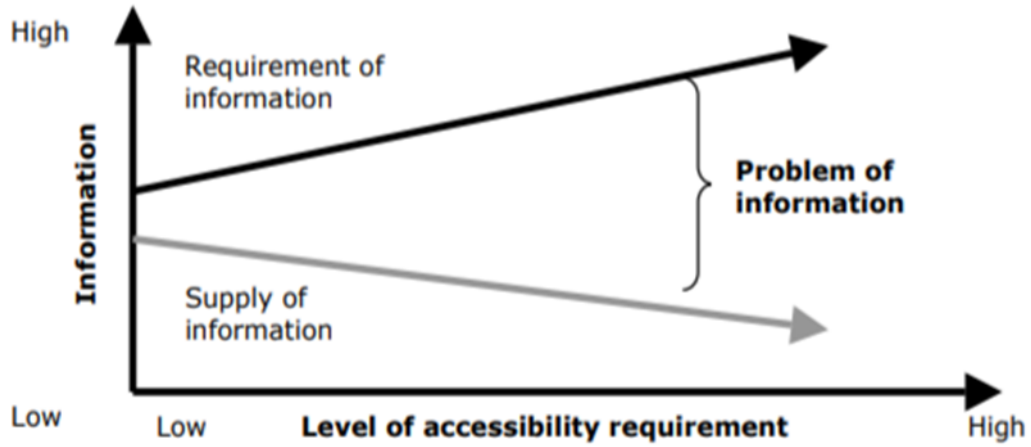

Figure 1- The problem of information in Accessible Tourism

Source: Waschke, (2004)

Access to information is critical for PwD but also is crucial for visitors without disabilities. The possibility to receive information about different features at the tourism destination is a key quality criterion that influences every tourist decision-making and booking processes (Buhalis et al., 2005). Information is remarked as essential to create and design informational strategies and accomplish successful tourism practices.

The quality of this information is an equally critical criterion. Inconsistent or contradictory advertising leads to disabled people being disappointed and frustrated to find that in reality, the facilities do not match the descriptions provided (Michopoulou & Buhalis, 2013). The accuracy and quality of information are therefore very fundamental since more complaints can lower loyalty and overall satisfaction (Lee, Jeon, & Kim, 2011). Travelers, by definition, are away from home and out of their comfort zone, which adds to the unknown risks, that may appear. Wrong information can have a terrible impact on tourism experiences, failing in delivering value and leading to unsatisfied costumers. As technologies in tourism are rising, they should focus on delivering the right information to disabled tourists. The problem of information in accessible tourism illustrates the need for accessible information systems. These systems can be conceptualized, precisely with the goal to eliminate information problems in accessible tourism, by displaying accurate and quality information.

II.1.5.2 Universal Design

Universal design is an approach to design thinking, that has a vital role in the area of designing for accessibility. When designing different products and services in the accessible tourism area, it must be ensured that they are user-friendly and not an obstacle. Careful planning and design of the different touristic products, services, and activities are beneficial to eliminate accessibility constraints. More inclusive and accessible design is crucial for the tourism industry. In order to accomplish this goal, it is required that interrelated policy areas, such as regional, environmental and social policy work together (Buhalis & Darcy, 2011: 58).

In the UN *Convention on the Rights of Persons with Disabilities* , Universal design is defined as "the design of products, environments, programs, and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (United Nations, 2006: 4). One of the most frequently cited concepts of Universal design is the seven principles elaborated at the *Center for Universal Design*, in North Carolina State University (Connell, Jones, Mace, Mueller, Mullick, Ostroff, Sanford, Steinfeld, Story, & Vanderheiden, 1997). The seven principles are the following:

> ***PRINCIPLE ONE: Equitable Use***
> *The design is useful and marketable to people with diverse abilities.*
> ***PRINCIPLE TWO: Flexibility in Use***
> *The design accommodates a wide range of individual preferences and abilities.*
> ***PRINCIPLE THREE: Simple and Intuitive Use***
> *The design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.*
> ***PRINCIPLE FOUR: Perceptible Information***
> *The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.*
> ***PRINCIPLE FIVE: Tolerance for Error***
> *The design minimizes hazards and the adverse consequences of accidental or unintended actions.*
> ***PRINCIPLE SIX: Low Physical Effort***
> *The design can be used efficiently and comfortably and with a minimum of fatigue.*
> ***PRINCIPLE SEVEN: Size and Space for Approach and Use***
> *Appropriate size and space are provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.*
>
>

Universal design is a concept of designing products and environments for the needs of people, despite their age, ability, or status in life (Persson et al., 2015). Accessibility is the main problem addressed by this type of design as is sometimes adaptable and sometimes generational but always accessible (Story, 1998). When universal design principles are applied, products and services meet the needs of potential users with a wide variety of characteristics (Burgstahler, 2001).

In Universal design, products, services, and the entire environment should be designed in a way that they are useable for the broadest user-group (Pühretmair & Wöß, 2008). The different principles can be considered as the answer to these difficulties since it has the potential to remove obstacles created by technology and faced by disadvantaged groups and individuals (Klironomos, Antona, Basdekis, & Stephanidis, 2006)**,** improving touristic experiences developed by technologies.

By following the principles of this design method, tourism can become accessible to all. Technologies are a great help to tourism, but if the inclusive design is infused among tourism products and services, some gaps, disparities, and inequalities can be surpassed, especially related to physical barriers. The goal of these design methods is to provide effective and usable opportunities for all potential users, regardless of the many challenges to users (Persson et al., 2015). Design methods can be applied by different stakeholders in numerous products and services in different sectors like attractions, traveling, web-systems, excursions, and transportation. Universal design and accessible designing parameters can also be very useful during the construction of Web applications.

II.2 The Role of Technologies on Accessible Tourism in the Fourth Industrial Revolution Context

II.2.1 Information and Communication Technologies (ICTs)

ICT innovation was vital for the launch of the fourth industrial revolution, as they were responsible for technological growth in many industries (Sedlar et al., 2018). ICTs are the leading technologies in assuring the progress of the digitalization era, making these technologies the backbone of the new industrial revolution. *Cambridge* dictionary defines ICT as: “the use of computers and other electronic equipment and systems to collect, store, use, and send data electronically” ("ICT", 2019). The emergence of ICTs played a significant contribution in the third industrial revolution and now the evolution verified in these technologies is having a similar impact in shaping industries and society. The term ICT can, within this perspective be described as “devices, networking components, applications and systems (technologies) that combined allow people and organizations (i.e., businesses, nonprofit agencies, governments, and enterprises) to interact in the digital world” (Rouse, 2014). As a consequence of global digitalization, most of the times, data needs digital platforms to become information. ICT are presented in very different forms and are responsible for assuring that information and knowledge are spread throughout the emission and transmission of digital data. Some common examples of ICTS include computers and mobile technologies like smartphones.

TechTarget is an American company that offers data-driven marketing services to business-to-business technology resellers (TechTarget, 2014). This company presented an idea of the components of ICT (figure 2). The list of existent technologies is very long, so the purpose of the figure is to illustrate that ICTs are composed of components that allow connection and iteration between people, organizations and the digital world.

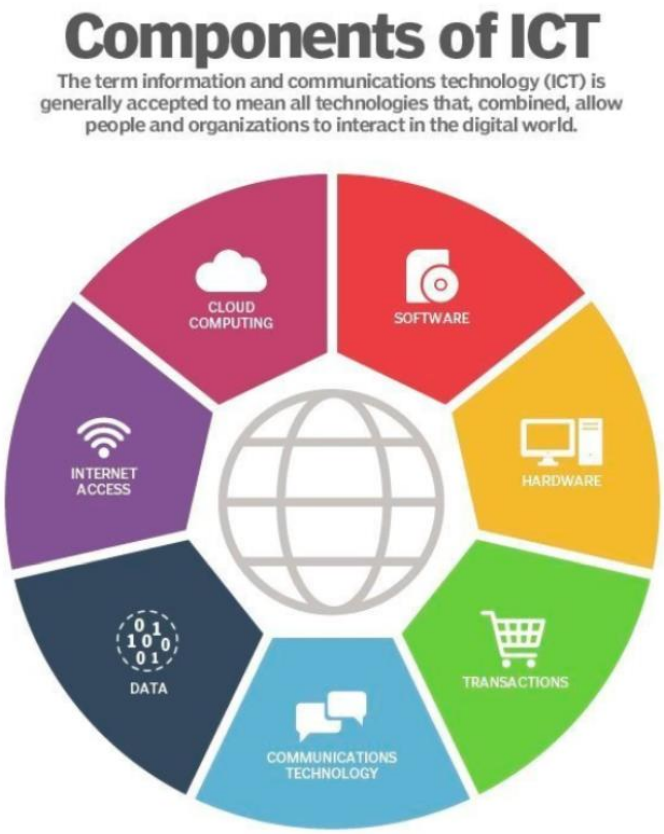

Figure 2- Components of ICTs

Source: Adopted from (TechTarget, 2014)

Society changed and ICTs are a response to these changes. ICT have drastically changed how people work, communicate, learn and live. In this new era promoted by the fourth industrial revolution, technologies are inserted into everyone's' daily life.

II.2.1.1 ICTs in Service Industry

A service can be described as "the application of competencies for the benefit of the consumer" (Vargo & Lusch, 2004: 14). In the services industry, the main goal is to create value for clients.

The transformation of services with ICT tools is starting to be visible. Traditional boundaries are going down between products and services, as firms are turning to services in pursuit of value (Paper et al., 2011). Manufacturing and services are no longer seen as two different realities.

The industry is experiencing Servitization in many sectors (Baines et al., 2017). Today, it is very common that associated with a product, companies also provide services to customers. The use of ICTs improves the efficiency of business operations by adding value and reducing waste. ICTs have enabled new kinds of product-service systems to emerge, with important role in a more efficient material use (Heiskanen, Halme, Jalas, Kärnä, & Lovio, 2001) . One example of product-service systems is electronic commerce.

Services also play a significant role in the fourth industrial revolution. The competitive environments established due to the digital era are making firms pursue value in ICT-enabled services (Paper et al., 2011). Many firms have their new technological systems offered by other companies linked with ICTs. This clearly demonstrates how services and ICTs are deeply connected to this new industrial age.

Paper et al. (2011) demonstrated throughout a service spectrum (table 3), how services are being transformed with ICTs.

Table 3- Service Spectrum

Irreducible Services	Hybrid Services	Automated Services
Humans deliver services. The services are usually created at the same time, and at the same place they are delivered	Services are delivered by humans and electronic tools. ICTs are used to promote human capabilities. This combination can be referred to as a two-part system.	Services are delivered by ICTs or other technologies. Services have been codified, digitalized, and made available with the help of electronic tools.

Source: Adopted from (Paper et al., 2011)

Irreducible services are evolving into automated services, in which humans don't interact. These new automated services are responsible for eliminating potential errors and deliver the best experience possible, creating value for the customer and satisfying their needs. This new type of offer can be designated as smart services.

ICTs play a central role in modern economies, and quantitative assessments of longer-term economic growth prospects will depend heavily on the contribution of ICTs to productivity change in the next years (Byrne & Corrado, 2017). Service providers can use ICT services to enhance traditional business models by increasing their efficiency.

As the fourth industrial revolution settles in society, dynamic interactions among people will increase (Jurčić et al., 2018). This will affect much in how services can provide value. Industries can no longer deny the impact of these new technologies, so it is imperative to adopt them in order to deliver more value for clients. With this new digital era, most service providers will have to change business strategies by offering smart services.

Smart services are a result of applying ICTs to service industries. Marquardt (2017), conducted a literature review and identified 5 characteristics that define a smart service: connection between the physical and the digital world; upgrade of value creation and economic efficiency; extension of products and services with a digital level; transformation of the product into a part of service; change from product centered to customer-centered business models. Smart services must not be seen only as an add on, as they are a consequence of new technologies and are revolutionizing service industry by delivering value to customers, the main goal in service science. Peoples' everyday lives are profoundly connected with the services offering sectors. Understanding the application of new technologies in services is crucial to estimate the impact of Industry 4.0 in society. Some examples of services industries currently applying ICTs in daily activities are: telecommunications (Clayton et al., 2005), education (Majumdar, 2015), health sector (Hanseth & Bygstad, 2015) , public sector (Jansen, 2012), transportation (Agarwal & Alam, 2018; Ahmad, Kaiwartya, Cao, Puturs, & Khalid, 2018), music industry (Rogers & Spavriero, 2011; Tran, 2011),

financial sector (Asongu & Nwachukwu, 2017), agriculture (Food and Agriculture Organisation (FAO), 2017) and, tourism.

II.2.1.2 ICTs and Tourism

Now that the application of ICTs in services industries was explained, the focus will be on how ICTs are applied in a particular service sector: tourism. When ICTs are connected with this sector, new concepts like smart cities, smart tourism destination, and smart tourism tools emerged.
ICTs have a crucial role in the competition of tourism organizations and destinations. It "empowers consumers to identify, customize and purchase tourism products and supports the globalization of the industry by providing tools for developing, managing and distributing offerings worldwide" (Buhalis & O'Connor, 2005: 7).

With the evolution verified across the ICTs, a new reality for tourism is going to appear. The entire process of creating, managing and promoting tourism objects is radically changing. Increasingly the impacts of ICTs are becoming more evident, as networking, dynamic interfaces with consumers and partners and the ability to re-develop the tourism product proactively and reactively are critical for the competitiveness of tourism organizations (Buhalis & Law, 2008). ICTs are essential for tourism, as they contribute to improving the sector and make the connection between the fourth industrial revolution and tourism possible.

II.2.1.3 ICTs in Accessible Tourism

A study was conducted to identify examples of technologies helping PwD in the tourism industry. The selected research articles are related to the use of technologies in tourism and were first obtained with research on different platforms, using the key-terms "accessible tourism" and "technologies". The study analyzed a total of 23 articles. The main focus was to identify the main technologies and understand their contribution to accessible tourism. This theoretical study also aims to demonstrate the importance that information systems can have in accessible tourism.

Table 4 illustrates the elaborated theoretical study. The table presents the different articles and identifies the author of the study, the technology analyzed, the segment of the accessible tourism market in which was focused on the study and the key findings of each article, reflecting about the importance of technologies in accessible tourism.

Table 4- How technology can improve accessible tourism

Author(s)	The segment of the accessible market analyzed	ICT and other technologies analyzed	Key Findings
Buhalis and Michopoulou, (2011)	All impairments, namely mobility, visual, hearing, speech, mental/intellectual, hidden impairment and the elderly population	Recommendation to use systems that employ intelligent agents and artificial intelligence, Wireless applications, and hand-held devices	Technology can be the enabler of destinations and tourism suppliers to address the information needs of the disabled/aging population traveler market. This is because the Internet provides an excellent opportunity to expand the detail provided with figures, photographs, videos, and user-generated content. Through the available technology, disabled travelers can be informed of relevant information based on their current location.
Darcy, (2011)	All impairments, namely mobility, visual, hearing, speech, mental/intellectual, hidden impairment and elders	Accommodation Assessment Template (a model used as a case example)	Strategic knowledge management of accessible accommodation information provides a way forward for the tourism industry and destination-management systems to begin to develop responses for accessible tourism. The model highlights the features related to accessible rooms and bathrooms.
Eichhorn, Miller, Michopoulou, and Buhalis, (2008)	All impairments, namely mobility, visual, hearing, speech, mental/intellectual, hidden impairment and elders	Information Schemes (model)	Distribution of Information and Communication Strategies: The failure to disseminate and promote access information in mainstream channels and the inability to make full use of tools through information technology results in an inappropriate distribution and communication strategy for people with special needs.
Michopoulou and Buhalis, (2013)	Physical disabilities	Tourism information systems (TIS) (model)	TIS must successfully satisfy the disabled users' requirements, providing all the necessary information to plan a trip. Ensure personalization and interoperability is also crucial when developing these systems.
Pühretmair and Wöß, (2008)	All impairments, namely mobility, visual, hearing, speech, mental/intellectual, hidden impairment and elders	Web-Services (webpages of tourism objects and information portals) (model)	Webpages, tourism and information portals can integrate the accessibility information, making accessibility information available for a broader target group. Adding evaluation criteria in web-systems can help disable tourists understand if a tourism object is accessible.
Rumetshofer and Woss, (2005)	All impairments, namely mobility, visual, hearing, speech, mental/intellectual, hidden impairment and elders	Web-based tourism information system (how to build a model)	The essential components of information that should be in the system are information about users (user profile), tourism information (medium profile) and information about tourism objects, allowing adaptation and personalization A tourism information system must be capable of adapting, according to the users' needs.
Sevilla, Herrera, Martínez, and Alcantud, (2007)	People with cognitive deficits	Web-based information system	Simplified browse pages and simplified selection pages can be applied to tourism webpages, like the case of acquiring tickets through the internet (steps with pictures can enable easy dissemination of information)

Continues in the next page

Author(s)	The segment of the accessible market analyzed	ICT and other technologies analyzed	Key Findings
Shi, (2006)	Disabilities affecting peoples' use of the web. Include visual hearing, speech, cognitive and neuroglial impairments, and some mobility disabilities.	Web-services (webpages of tourism objects and information portals)	Websites in the Queensland region of Australia have accessibility problems, although all the VICs are accredited by the statutory authority of the Queensland Government (the simple fact that it according to the law does not make a web-page accessible). Web-services like webpages must be created according to the World Wide Web Consortium guidelines
Teixeira et al., (2017)	Older Adults (cognitive)	Medical Assistant, a mobile app that helps control medication.	This app was created with the goal of assisting elderly people in taking medicines. The reminders that in this case, are for taking pills can become reminders for other touristic activities. Mobile apps that work as reminders of daily activities can be important for accessible tourism.
Wang, Wu, Yuan, Xiong, and Liu, (2017)	Vision, Hearing, Speaking, Physical, Mental, Intellectual, Multiple, and other disability categories	Social media (communication technology, participatory technology, mobile technology)	Platforms such as WeChat, QQ, WhatsApp, Facebook, Instagram (**social media**) can be utilized as information services, because these platforms accommodate a wide range of users and feature a more humanized research and development design; moreover, they are at a mature stage of development.
Fall et al., (2018)	Upper-body disabilities (individuals with arm amputations, congenital absence of upper limbs, etc.)	Assistive technologies	This paper describes a multimodal body-machine interface (BoMI). This technology helps individuals with upper-limb disabilities using advanced assistive technologies, such as robotic arms. The studied technology represents a revolutionary step for people with upper-body disabilities. By helping tourist's executer numerous tasks, this technology can improve accessible tourism, and provide experiences to the users, that would be impossible without aid. Making it possible to interact in a museum or participate in workshops in a hotel are examples of the impact that assistive technologies can have.
Milicchio and Prosperi, (2016)	Deaf People	Mobile apps	The app was a success by collaborating with public entities, involving both representatives of the Deaf community and archeological experts were. They were able to create a product with high usability, released for free in the apple and Google app stores. The App provides aid in visiting, but also enhance the experience by improving the orientation and perception.
Vila, González, and Darcy, (2018)	Not specified	Official tourism websites	The main weaknesses of the websites analyzed were the navigable, compatible, adaptability and text alternatives. Destination marketing organizations can be regarded as destination managers, as their websites are one of their central communication and marketing tools.
Liu, Sokhn, Calvé, and Schegg, (2016)	Not specified	Tourism databases	Structured data can be interlinked and become a useful tool. Enabling computers to identify potential conflicts and interdependencies in tourism services and allows automatic discovery and access to useful and real-time information for PwD.
Darvishy et al., (2008)	Passengers with visual disabilities	Mobile app	Technology can help blind people find their way throughout the airport but also provide them with information about delays and other important factors that influence traveling.

Continues in the next page

Author(s)	The segment of the accessible market analyzed	ICT and other technologies analyzed	Key Findings
Bosch and Gharaveis, (2017)	Older adults who may be experiencing visual and cognitive decline as part of the normal aging process or illness.	Mobile apps, RFID, Virtual Environments are proposed as strategies to improve wayfinding.	Smartphone-based systems using iBeacons that deliver real-time information to travelers as they walk by specific points. RFID tags were placed at critical points of decision, such as intersections. Virtual Environments offer a way to provide exploration and learning about environments with fewer constraints than real-world environments.
Barbeau, Georggi, and Winters, (2010)	Transit riders, with cognitive disabilities	TAD (travel assistant device) (still a prototype)	Bus travel rides is a crucial factor in tourism. For example, many excursions are made by bus. The TAD is a tool designed to help people with cognitive disabilities top travel by bus. The system is connected to the GPS system of mobile phones allowing information of both locations and time of arrival.
Radosav, Karuovic, Markoski, and Ivankovic, (2011)	Health conditions which influence access to web pages	Web-system	Accessibility of web pages means that PwD can perceive, understand and browse contents, add their own content and use the interaction with other users. Web pages should have the function to work in black and white, so colorblind people can easily access the content.
Emrouzeh et al., (2017)	Different segments	Mobile applications	Apps help in Navigation/ Social (sharing, collaborating and communicating) /Mobile Marketing /Security/Emergencies (health monitoring, and weather alerts)/Transactional (transaction of some sorts for tickets, reservations, and shopping)/Entertainment (games, movies, e-readers, etc.)/Information
Ribeiro et al., (2018)	Mobility Impairments, Hearing impairments, Visual Impairments Allergies and food intolerance Elderly People	Mobile applications	ICTs are the key to overcome several limitations of the target group, by helping disabled tourists access relevant information and by presenting that information appropriately, taking into consideration their interests, disabilities, and limitations. Targeting the specific needs of tourists, providing them with appropriate and tailored information.
Zajadacz, (2014)	Deaf people	Information Systems (what sources deaf tourists use ?)	Deaf people most often sought information on possibilities to organize tourism online Tourism Information portals should not only offer standard content presented in sign language, but they should also make it possible to ask questions and receive answers in sign language.
Altinay et al., (2016)	Orthopedically disabled people	Social media (communication technology, participatory technology, mobile technology)	Social media can contribute to more accessible tourism, allowing disabled people to share information and gain more knowledge about tourism objects and accessibility conditions. Social media might be the key to promote accessible tourism in this new digital era.
Haworth and Williams, (2012)	Cognitive and Learning disabilities	QR Codes	Social media can contribute to more accessible tourism, allowing disabled people to share information and gain more knowledge about tourism objects and accessibility conditions. Stakeholders can easily reach out to this significant portion of the tourism market, with these platforms. Social media might be the key to promote accessible tourism in this new digital era.

The study proves that technology has a significant role in promoting accessible tourism. ICTs have the spotlight, but other technologies can also help in spreading information or improve accessible conditions for tourism practices. Web-systems are one of the most identified information sources, in this regard. They are capable of providing a shared knowledge base to address every kind of disability. Different disabilities give origin to different information requirements, so specific services need to be provided.

ICTs are also very useful in other cases like navigation. PwD often have troubles with transportation, as location technology can be fundamental to build accessible geographic databases, helping accessible navigation. Mobile apps are other good examples since they can provide proactivity mechanisms and collaborative features. New information technologies that focus not just on divulgation of information, but also in making sure everything is connected, which in the case of accessible tourism has significant value. Despite that significant importance and influence of ICTs in tourism, they are not the only technologies that can be inserted in the accessible tourism market. Assistive technologies can have a significant role in assisting, for example, people with mobility impairments visiting attractions like museums. Adaptive technologies can also be applied to means of transportation like trains and buses.

Finally, an important aspect visible across many of the articles is that an accessible Web touristic platform beneficiates not only disabled tourists but also non-disabled people. This demonstrates the importance of the development of these platforms to promote the tourism sector. Many of the identified literature topics focused on information systems based on the Web for developing accessible conditions in tourism. These platforms are an excellent source to share and provide information, the main issue in accessible tourism. In conclusion remark, the study also proved that tourism changed due to the rising of new technologies.

II.2.2 The fourth Industrial Revolution – Industry 4.0

Increasing digitalization is changing the everyday lives of people, markets, business models and value chains. Nowadays, companies face various challenges like new corporate strategies, new requirements for the training of personnel, new demands for cybersecurity and radical changes in business processes across all company levels, justifying solutions based on new information and communications technologies. In fact, emergent ICTs provide the opportunity for companies to build new customer relationships, to invent new business models, and to increase their competitiveness (Parida, Sjödin, & Reim, 2019).

The phenomenon of Industry 4.0, first mentioned in 2011 in Germany (Bundesministerium für Wirtschaft und Energie, 2016) launched the fourth industrial revolution, which is based on a set of concepts enhanced by new technologies. *McKinsey & Company*, an American management consulting company, studied Industry 4.0 as digitalization of the manufacturing sector which originates from four disruptive technology groups: i) connectivity, data, and computing power; ii) analytics and intelligence; iii) human-machine interaction, and iv) digital-to-physical conversion.

In 2016, McKinsey conducted a survey in which 300 experts from Japan, USA, and Germany where questioned about their expectations and progress regarding Industry 4.0. The majority is positive about Industry 4.0. Most of the companies are confident that their competitiveness will increase or remain the same. Nevertheless, they are somewhat restrained in making investments related to Industry 4.0.

Most of the literature review studies made on this topic rely on the definition provided by Bundesministerium für Wirtschaft und Energie (2016), that defines Industry 4.0 as a "the intelligent networking of machines and processes for industry with the help of information and communication technology". The foundation of the fourth industrial revolution is the availability of all relevant real-time information (Crandall, 2018), which was made possible by focusing on the networking of equipment and processes in the industry through the use of ICT to form an intelligent value chain (Schlüter, Hetterscheid, & Henke, 2017).

II.2.3.1 Historical Perspective

Since the first Industrial Revolution, subsequent revolutions have resulted in manufacturing. From water and steam-powered machines to electrical and digital automated production, which makes the manufacturing process more automatic and sustainable. Throughout history, machines became more efficient and persistent (Vaidya, Ambad, & Bhosle, 2018).

There are 4 revolutions altogether (figure 3). The first revolution is based on the use of steam engines. The second revolution is based on the application of electrical energy, which allowed mass production. The use of electronics and information technology, which is known as automation marks the third revolution. The phenomenon of Industry 4.0 was originated in 2011 in Germany and promoted the fourth industrial revolution.

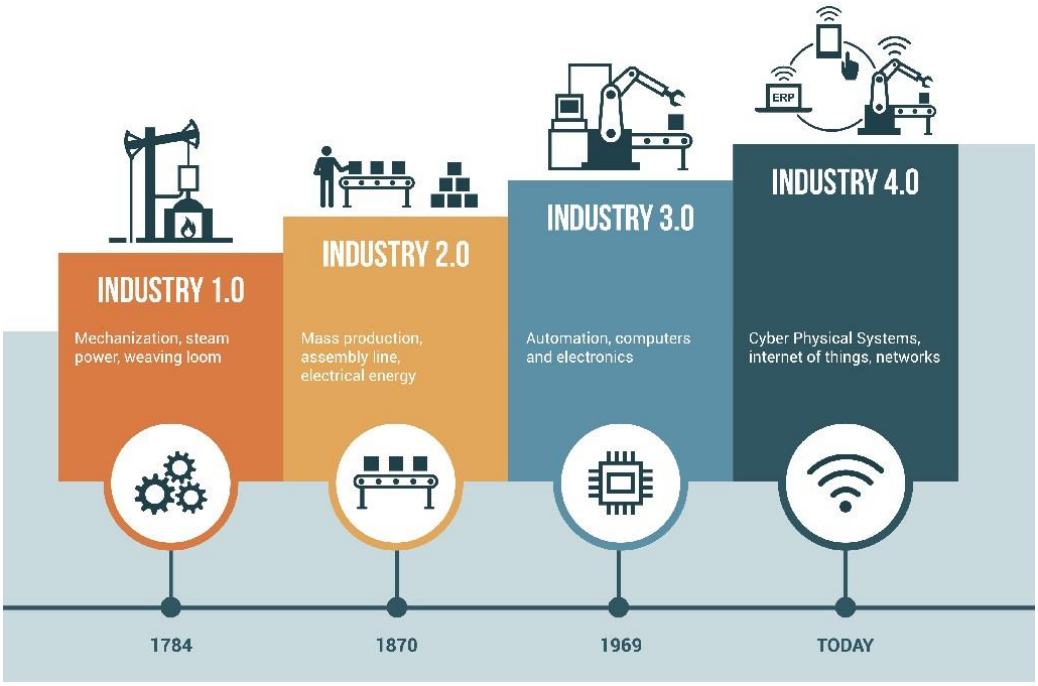

Figure 3- Industrial revolution stages: from steam power to cyber-physical systems, automation and internet of things. *Source: (Berdugo, 2018)*

According to Plattform Industrie 4.0 (Bundesministerium für Wirtschaft und Energie, 2016), the term Industry 4.0 stands for a new stage in the organization and management of the entire value chain over the life cycle of products. This development is based on satisfying individualized customer requirements. The idea is integrated digital support of the complete product life cycle from the development stage to the manufacturing and recycling processes and at least customer

related services. The most excellent prospects with the fourth industrial revolution are delivering information in real time through the networking of all entities, as well as the ability to optimize the value creation at any time. The fourth industrial revolution can be characterized by connectivity.

II.2.2.1 Technological Drivers

Industry 4.0, alongside with digitalization, capitalized on the developments in several technologies. These new technological trends became known as technological drivers, which is a current issue in the literature. Several authors have identified and studied different technological advances that promoted the appearance of Industry 4.0 (Jasperneite, 2013; Kovar et al., 2016; Rüßmann et al., 2015; Saturno, Pertel, Deschamps, De, & Loures, 2018). Cyber-physical systems (CPS), the Internet of things (IoT), big data, cloud technologies, 3D printing, radio frequency identification (RFID), cognitive computing, mobile technologies, machine to machine technologies, virtual reality, and augmented reality represent some of these solutions.

These technological drivers demonstrate that the competitiveness and innovation needed for Industry 4.0 depend on mastering a wide range of ICT skills and competencies (Sedlar et al., 2018). However, the fourth revolution is still in progress, so it is possible that these new technological solutions will be improved and will innovate even further. These technologies have mainly been studied in the production area. However, their utility can be expanded to services industries, like the case of tourism, helping in the transition of tourism into a new digital age. Some of the identified Industry 4.0 technological drivers will now be explored.

A. Cyber-physical-Systems (CPS)

CPS are intelligent systems integrated with physical and computational capabilities, that can interact with humans, and are responsible for the interconnectivity of devices, machines and moving objects, which are controlled by means of information technologies over the internet and exchange data. The objects are equipped with sensors that continuously record data from the environment, such as the state, location, process step, usage behavior, etc. By networking all objects, planning, control, production and logistics can be automated. An association of multiple CPS is referred to as a Cyber-Physical Production System (CPPS) (Wolter et al., 2015).

B. Internet of Things (IoT)

IoT refers to the networking of objects within the internet. The paradigm of IoT has given origin to different perspectives in literature, mainly because of being a disruptive tendency to ICTs (Bandyopadhyay & Sen, 2011). Methodically, IoT can be addressed as a "worldwide network of interconnected objects uniquely addressable, based on standard communication protocols" (Bassi & Horn, 2008). IoT logic is based on the making of "smart objects", that are then able to communicate with each other independently through the internet and exchange data (Tobergte & Curtis, 2013). IoT can be described as a new communication paradigm, in which objects will be equipped with microcontrollers, that will make them able to communicate with one another and with the users, becoming an integral part of the internet (Atzori, Iera, & Morabito, 2010). This technological driver can have a significant impact on the tourism industry, especially in visiting smart cities and the way different tourism objects interact with people, which is a crucial step to ensure accessibility in tourism.

C. Big Data (Analysis tools)

Due to digitalization, a lot of data is generated in a short time. The analysis and use of these

previously inaccessible data through innovative analysis tools (text analytics, machine learning, predictive analytics, statistics, etc.) are the basis for holistic management throughout the product life cycle (Wolter et al., 2015). Analysis tools allow big chunks of data to be carefully analyzed and the selection of only significant information.
The tourism sector relies a lot on shared data, so generation and sharing of data, can be critical to developing the sector further beyond. In big data touristic environments, most of the data has no interest. Therefore, the selection of appropriate data is critical. Analyze tools have the capacity to distinguish data that should become information from data that has no relevance. Select the right data in order to become information is one of the biggest challenges in Industry 4.0 (Schwab, 2016: 135).

D. Cloud-Technologies

These technologies can be perceived as data centers, where information can be stored and be available for many users (De Filippi & Mccarthy, 2012). The cloud makes it possible to access corporate data from anywhere in the world and to process and analyze it using provided software in the cloud. (Wolter et al., 2015). With communications between diverse ICTs becoming more and more common, the services industries will benefit for all the shared information and knowledge. Many companies have started to build business models for cloud technology. Three models of cloud technologies are worthy of being mentioned (IBM, 2015a):

- Software as a Service: Cloud-based applications that run on computers owned by another company that operates these applications.
- Platform as a Service: Cloud-based environment with everything a company needs.
- Infrastructure as a Service: Provides enterprises with computing resources such as servers, storage, and networks.

E. 3D Printing (Additive manufacturing processes)

3D Printing permits the use of several raw materials and creates new objects from 3D data, layer by layer (Huang, Liu, Mokasdar, & Hou, 2013). 3D printing allows replicating existing objects in a three-dimensional manner (Klein, Avery, Adams, Pollard, & Simske, 2014). 3D visualization and 3D printing play an important role in Industry 4.0. Three-dimensional visualizations make it possible to pre-test products during the development and design phase. 3D printing processes allow complete customization of products. In addition, shapes are possible in other production processes can be made only consuming and under the high cost of materials (Schwab, 2016: 18).

F. RFID

Radio Frequency Identification is a wireless technology that lets computers or other devices read/identify electronic tags from a given distance (Nath, Reynolds, & Want, 2006), using an object (generally referred to as an RFID tag) for identification and tracking with radio waves (Smyth & Crabtree, 2012). RFID systems use radio waves to transmit necessary information from an integrated circuit tag through a wireless interchange to a host device (Clarke, Twede, Tazelaar, & Boyer, 2006). Industry 4.0 is promoting diverse uses for this type of technologies, like the example of smart parking (Pala & Inanç, 2007).

This can represent significant changes in the tourism industry since it relies much on transportation industries. With RFID becoming a type of technology with relevance to manufacturing and services, it is expected to have an essential role in this current industrial revolution. RFID is, therefore, a technology, that existed before the beginning of the fourth industrial revolution, but because of new developments in the industry is improving even further.

G. Cognitive Computing

Cognitive computing incorporates digital systems that learn at scale, reason with purpose and interact with humans naturally (IBM, 2015b). These systems represent a step forward in artificial intelligence. The main goal with cognitive computing is achieved big data treatment (Esser et al., 2011), one of the significant problems in this digital era. With big amounts of data being created every day, cognitive computing appears as a solution to manage data, and help it become valuable information.

H. Mobile Technologies

Mobile technologies play a significant role in every dimension of an individual's daily life. In *Cambridge* Dictionary defines mobile technology as "Electronic equipment such as mobile phones or small computers that can be used in different places, and the technology connected with them" ("Mobile technology", 2019). One of the most critical concepts of connected technological impacts emerges in the form of cell phones apps (M. Emrouzeh et al., 2017). Mobile technologies can help in many aspects, such as Navigation, Social, Security, Transactional, Entertainment, and Information providing. Mobile devices have obtained an essential role in the automation of several industries (Jazdi, 2014). This led Industry 4.0 to be the result derived from recent developments in these technologies.

Smart devices like Smartphones are present in almost every aspect of daily lives, making mobile technologies a significant part of daily activities. The use of smartphones in travel led to the adaption of new business models by travel companies. Impacts on tourist experiences in terms of activities and emotions are also reported as communication and information sharing are a big part of the process of traveling (Wang, Xiang, & Fesenmaier, 2016).

I. Machine to Machine Technologies

Machine to Machine characterizes the interaction between devices and machines that are connected to the internet and to each other. Machines and devices integrate computing capabilities allowing them to capture data share this data with other connected devices, building an intelligent network of connected systems. The main objective of this type of technology is granting that machines can communicate and share information without the need for human interaction (IBM, 2016).

J. Cyber-security

With the fourth industrial revolution, markets became cyberspaces, where sellers and buyers can meet without the need for physical contact. Online security is becoming a big issue as threats like cybercrime, cyber espionage, cyber terrorism, and cyber warfare emerged (Magliulo, 2016). A relevant prerequisite, for the migration to Industry 4.0 is the security of data and information technologies infrastructures.

The use of wireless communication exposes companies to many risks such as hacking, malware, spyware, etc. Therefore, the introduction of new standards, norms and legal frameworks for data security, especially in the areas and services that work with personal data and a change in attitudes within the company, are necessary for connection with the change of education and work at all levels (VDMA, 2016).

K. Virtual Reality (VR) and Augmented Reality (AR)

In Oxford dictionary, VR is defined as "computer-generated simulation of a three-dimensional image or environment that can be interacted with a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with

sensors" ("Virtual Reality", 2019). A characteristic of a great VR experience is the feeling of being present as "users feel like they are truly in the synthetic environment being presented."(Barnes, 2017). As for AR, it can be defined as "a technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view" ("Augmented Reality", 2019). AR is capable of expanding the view of reality with virtual (computer-generated) objects that coexist in the same space as the real world (Krevelen & Poelman, 2010). This new technology accomplished the combination and of real and virtual objects in a real environment, running interactively, and in real time (Azuma et al., 2001). In VR the aim is to immerse the users in a simulated and virtual world, in AR the goal is to augment computer-generated graphics and information of real objects (Lu, Shpitalni, & Gadh, 1999). VR and AR help organizations to bring design and visualization together, providing realistic representation complex products and services, enhancing the experience and perception of clients (Nunes, Pereira, & Alves, 2017).

VR and AR are technologies that were originated in the gaming industry (Zyda, 2005), but the creation of digital environments has massive potential in many areas, including outstanding advances in the tourism sector. Development of VR and AR represent major technological breakthroughs, and despite still being in primary phases, they are now is being compared to the impact of social media back in 2008 (Barnes, 2017).

II.2.2.2 Benefits emerging from Industry 4.0 Technologies

According to (Siepmann & Graef, 2016), the following opportunities arise for companies through Industry 4.0 in the production area: i) High level of product customization, ii)Flexible production (supplier outages or short-term increase in delivery quantity), iii) Shorter lead time (responding time to customer inquiries); iv) Resources efficiency (resource and energy consumption); v)Decentralization (flat hierarchies for faster response times and faster decision-making); vi) Shorter time-to-market (due to digitalization, 3D prototype construction, etc.); vii) Optimized logistics (Machines order material themselves); and viii) New business Models (e.g. Predictive Maintenance).

The key technologies drivers enable the transformation of processes along the entire value chain, from the development phase up to the use and maintenance phase. There are different types of ICT that can contribute to de I4.0, but some of them have a crucial role for developing products and services, conducting research and promoting innovation activities (Sedlar et al., 2018), making them essential in this new digital era. Industry 4.0 is altering the landscape of industries with a particular impact on the relations between companies and clients and on the way they interact (Schwab, 2016: 21).

It is important to note that the identified opportunities can also be applied in the service industry. By customizing services, according to clients' specifications and by making the production of the service quicker and more efficient, it is possible to assure that the service creates value to the client. The same happens with the offer of touristic services as improvements like cost and time efficiency, quality improvement, flexibility, and innovation are estimated to add significant value to clients (Ndou & Passiante, 2005). The opportunities that Industry 4.0 brings to services can help the tourism industry grow by enhancing the various services present in tourism.

Industry 4.0 will radically change processes, production, products, and services. According to a study, the 17 most industrialized countries in Europe can gain 1.25 trillion euros in added value by 2025 through the digital transformation (Russo, 2015). Should Europe fail to advance digitization and use it to its advantage, up to 600 billion euros in added value could be at stake.

Linked to this, the goal of increasing the industrial share of Europe to 20% by 2020 would be unattainable (Russo, 2015) .

II.2.2.3 Value drivers

To help to embrace Industry 4.0, McKinsey developed the "Digital Compass". It represents the 8 value drivers of Industry 4.0 and their 26 levers (McKinsey Digital, 2016). The value drivers can help on the adaptation of industries to the new technological reality, introduced by the fourth industrial revolution. With the help of this compass, it is possible to understand how Industry 4.0 concepts can be applied to industries dedicated to services production, as is the case of tourism. The Digital Compass is based on data and information that the consulting firm has collected over the years on the topic of Industry 4.0 in various companies. It shows in which areas a company can benefit the most from the introduction of Industry 4.0 technologies (Kannan et al., 2017). At the center are the eight fundamental value drivers of Industry 4.0 (Time to market, Supply-demand match, Quality, Inventories, Labor, Asset utilization, Resource/Process and Service/aftersales.) The outer circle shows the 26 levers which are connected to the 8 value drivers (figure 4). The Digital Compass is only a support for companies to assist in the implementation of Industry 4.0, as it offers ideas and approaches. Nevertheless, it is crucial that companies don't cling to these approaches and start from their own goals and the resources available (McKinsey Digital, 2016).

Figure 4- McKinsey Digital Compass

Source: (McKinsey & Company, 2015)

1. **Resource/process**

Refers to improving a process in terms of material consumption, speed, and yield. Value comes from reduced material costs and higher revenues (McKinsey Digital, 2015). The productivity can be increased in this area through responsible energy consumption, intelligent lots and real-time yield optimization (McKinsey Digital, 2015).

2. **Asset utilization**

The improvement in plant utilization increases the value by optimizing the use of a company's machinery. Every minute of standstill causes millions of dollars in losses. The downtime of machines can be reduced by new technologies. This is made possible by increased flexibility, remote monitoring and control, predictive maintenance and the use of augmented reality (Schwab, 2016: 34).

3. **Labor**

Workers constitute a significant cost driver in all industries, so improving labor productivity can add significant value. The productivity in technical jobs can be increased through automation. Some examples are human-to-machine communication, remote monitoring and control, digital performance management and the automation of knowledge work (Schwab, 2016: 36).

4. **Inventories**

Increasing resource productivity (providing the highest output of products from a given volume of resources) and efficiency (using the lowest possible amount of resources to deliver a particular output) (Mrugalska & Wyrwicka, 2017).

5. **Quality**

Productivity and production quality are affected by design and scheduling. A smart system should be able to suggest task arrangements and adjust operational parameters to maximize productivity and product quality (J. Lee, Kao, & Yang, 2014).

6. **Supply/demand match**

Only the correct understanding of customer demand maximizes the value to be achieved in the market. For this to succeed, the supply must be adapted to the actual demand. This can be achieved using data-driven demand prediction and data-driven design-to-value, which can increase forecasting accuracy by 85%. (McKinsey Digital, 2015). The virtualization of the process and supply-chain ensures operations by providing real-time access to relevant product and production information for all participating entities. Boundaries fall apart, as autonomous systems exchange data, gained by embedded systems throughout the entire value chain (Brettel, Friederichsen, & Keller, 2014).

7. **Time to market**

When products reach the market faster, they add value and revenue. The lab-to-market time can be reduced by 20-50% using Industry 4.0 levers such as simultaneous engineering, faster experimentation and customer co-creation (McKinsey Digital, 2015). By flexibly adjusting the combination of standardized modules, the speed of new product development drastically increases and time-to-market can be shortened significantly (Baldwin & Clark, 2000).

8. **After sales**

Aftersales costs are related to service costs and machine downtime. By using predictive maintenance, remote maintenance, and virtual self-service, this type of costs can be reduced. This value driver illustrates that the fourth industrial revolution will also have an impact on the service

industry. The way that services will be produced delivered and the interaction with clients will most probably change due to new technologies and new data sharing platforms (Schwab, 2016: 58). This is the case with the tourism industry. Other industrial revolutions changed this service industry (computers completely changed how people booked trips), but this new industrial age, the author estimates it to change tourism forever. The industrial big data environment can provide key technology for sustainable and innovative services (Brettel et al., 2014).

II.2.3 The fourth Industrial Revolution in Tourism – Tourism 4.0

II.2.3.1 Smart Tourism

ICTs are, indisputably, the key to the conceptualization as well as the development of smart tourism (Gretzel, Sigala, Xiang, & Koo, 2015). Like studied before, ICT, in recent times, has seen a period of rapid development and innovation, which opens new opportunities for tourism (Put-van den Beemt & Smith, 2016). The tourism economy in today's world assents in information technologies and telecommunications. Many tourism organization, such as tour operators, travel agencies, rental agencies, cruisers, and hotels are undergoing some changes due to the impacts of ICTs (Jaremen, 2016).

Various technologies connect the physical, information, social, and commercial infrastructure of tourism, and generate value to multiple stakeholders of a touristic destination (Guo, Liu, & Chai, 2014). Cloud-based apps that help get around a city more efficiently, VR experiences increase experiences in historical museums, or understanding visitor behavior through algorithms (Wooden, 2017), Industry 4.0 is radically changing tourism.

Smart tourism relies on a new generation of ICTs aimed at meeting the needs of individual tourists for satisfying and quality tourism services while promoting the integration of social resources (Yunpeng, HU, Chao, & Liqiong, 2014). Tourists services can be upgraded with the use of ICTs as they can use public platforms to provide applications for government, enterprises, tourists, and residents, building an informational and modern tourism industry.

The best definition of Smart Tourism under these terms comes from Gretzel et al. (2015), as smart tourism is defined as "tourism supported by integrated efforts at a destination to collect and aggregate/harness data derived from physical infrastructure, social connections, government/organizational sources and human bodies/minds in combination with the use of advanced technologies". This definition constructs the idea of new technological foundations emerging in prowl of tourism.

The travel and tourism industries have always been influenced by technological development. Tourism has been greatly influenced by the internet, which led to a revolution in tourism objects (both in products and services), and the way they are offered to tourists. The role that technologies play in the tourism industry was developed over time. One example is the transition from a wired network base connected on the internet to a wireless network base through the use of mobile devices (Koo, Gretzel, Hunter, & Chung, 2015; Y. Li, Hu, Huang, & Duan, 2017). With new and smarter technologies, the tourism industry is again entering a new era. "Smart" has become a rather common term in marketing for all things which are enhanced by technology. Smartness paradigm for tourism has to consider all the dimensions of the market, including stakeholders and changing environments. Because tourism is such a complex activity, smartness applied to tourism

has to consider the supply as availability of services and efficiency of destination as a whole (Papa, 2014).

In order to conceptualize a Web-system for accessible tourism, it is necessary to understand how technologies are changing the tourism industry landscape. Smart tourism is a critical topic in this regard. Since, it is a typical example of integrated development by combining tourism industry with technological innovations (Yunpeng et al., 2014). Evidence indicates that information technology has turned out crucial for the competitiveness and prosperity of tourism organization because, this technology has influenced the ability to differentiate offerings, as well as their production and delivery costs (El-gohary, 2014).

II.2.3.1.1 Smart Tourism Applications

There is no doubt that ITC technologies play a primary role, supporting, optimizing, improving and integrating technologies and tourism (European Parliament, 2014). The most recent use of ICT in the tourism industry led to the rise of three critical applications: **Smart cities**, **Smart tourism destinations**, and **Smart tourism tools** (Wetzel & Barten, 2016).

A. Smart Cities

The concept of a smart city is a relatively new term, and it is a result of the application of ICTs and other new technologies like IoT (Internet of things) and cloud computing to every-day life activities. Smart cities integrate many views/ideas, but the review that follows is intended to relate this concept to smart tourism, new information technologies and also accessible tourism. The use of ICTs addresses the critical infrastructure components and services of a city. This way, services like administration, education, healthcare, public safety, real estate, transportation, and utilities become more intelligent, interconnected, and efficient (Washburn et al., 2010).

The concept of Smart City originated from a sort of combinations of six characteristics: smart economy, smart people, smart governance, smart mobility, smart environment, and smart living. These dimensions were proposed by urban and climate strategist Boyd Cohen, which led to the creation of “the smart city wheel” (figure 5) (Cohen, 2012). With the designed scheme in mind, smart cities could be defined as cities integrating these six characteristics, built on the combination of environments and activities of self-decisive, independent and aware citizens (Giffinger & Fertner, 2007). The six axes link regional competitiveness, transport and ICT economics, natural resources, human and social capital, quality of life, and the participation of society members in cities (Caragliu, del Bo, & Nijkamp, 2011).

The Smart City wheel introduced a proposal for the definition of smart city: “a city is to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and high quality of life, with a wise management of natural resources, through participatory governance” (Caragliu et al., 2011). There is, however, some discussion about if a smart city is smart if only some of the axes are ensured.

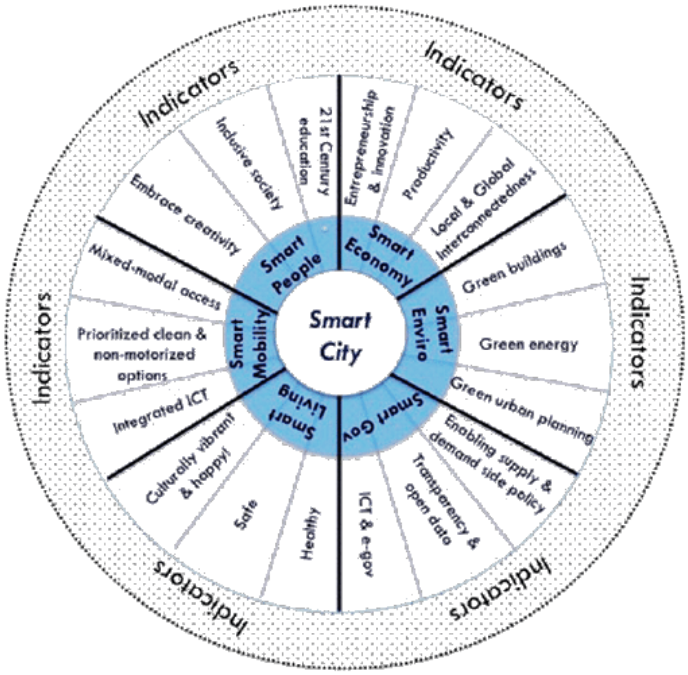

Figure 5- Smart city Wheel

Source: Cohen (2012)

According to a study from the European Union in 2014, there are already a considerable number of smart cities across Europe (figure 6). In this study, in order to be catheterized as a smart city, at least one of the six dimensions (Cohen, 2012), previously stated, must have been ensured. The total economic impact of accessible tourism in the European Union was about 786 billion Euros in 2012 (European Commission, 2014). Europe has always been a main destination to do holidays because many countries have strong ties to world history and the landscape can offer a lot of different tourism experiences. For winter lovers, there are northern countries like Finland and Norway that offer breathtaking activities in the snow, like seeing the northern lights in Lapland. And for people that prefer summer, there is always Mediterranean beaches, located in Greek islands, perfect for holidays during summer.

With tourism sector growing fast in Europe, it is expected that it will become a significant source of value for many countries. It is vital that cities are ready to attend the needs of tourists, and smart cities can be the best solution. On a side note, smart cities can also improve the life of the citizens of these cities. With technology embodied into their lifestyle, people can benefit, for example of better transports networks and easy communication through internet access spots, all over the cities.

Smart City strategies must adopt a multi-dimensional approach to maximize gains. If for example, a city only focuses on smart mobility, it can have negative impacts on the environment. Therefore, co-existent development is necessary. European smart cities are characterized, especially by two characteristics: smart mobility and smart environment (European Parliament, 2014), but the other traits are never relegated.

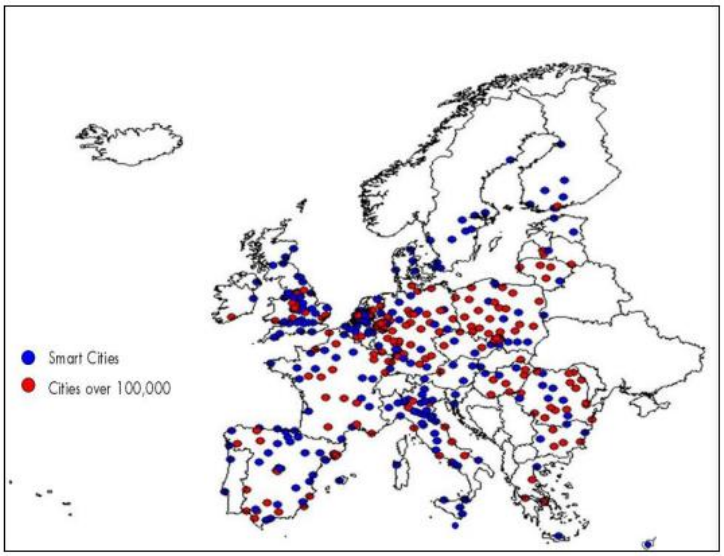

Figure 6- Smart cities in Europe

Source: (European Parliament, 2014)

Some examples of smart cities across Europe include London, Helsinki, Paris, Barcelona, Dublin, and Amsterdam. These cities are amongst the most visited European cities and Barcelona, London and Paris are also part of 2018 worlds' most visited cities (Bussiness Insider, 2018; GODFREY, 2018). This can prove the existent connection between smart cities and tourism.

A smart city should integrate human capital, infrastructure, and information. The use of ICTs makes cities more accessible and enjoyable for both residents and visitors through interactive service interconnecting all local organizations, providing real-time services and use data for better coordination (Buhalis & Amaranggana, 2012). Smart cities can become a reality with the help of Industry 4.0.

The relationship between smart cities and Tourism is easy to understand as by offering better living conditions, cities become better places to travel and visit. What makes a smart city a better place to live (improved transportation, crowd analytics, enhanced networking, predictive crime prevention, and green technology) makes it also a better place to visit (Wooden, 2017).
Zanella et al. (2014), described city services that could benefit from an urban IoT and have a potential interest in the Smart City context:

- Structural Health of Buildings (IoT may provide a database of building structural integrity measurements);
- Waste Management (the use of intelligent waste containers);
- Air Quality (an urban IoT can provide means to monitor the quality of the air in crowded areas);
- Noise Monitoring (offer a noise monitoring service to measure the amount of noise produced at any given (Maisonneuve et al., 2009));
- Traffic Congestion (traffic can be monitored using the Global Position System (GPS) of cars);
- City Energy Consumption (IoT may provide a service to monitor the energy consumption of the whole city;
- Smart Parking (road sensors that help drivers to find parking places (Sangwon Lee, Yoon, & Ghosh, 2008));

- Smart Lighting (sensors that measure the weather and optimize streetlights according to environmental conditions;
- Wi-Fi hotspots, improving internet access and easily sharing information, this would contribute a lot to improve tourism for disabled people, since most of the apps for accessible tourism rely on the internet);
- Automation and Salubrity of Public Buildings (sensors that control humidity, temperature light and other factors inside buildings, enhancing comfort and reducing costs (Kastner, Neugschwandtner, Soucek, & Newman, 2005).

Smart cities are clearly linked to accessibility. The technological improvements in several services, like smart lighting and Wi-Fi hotspots, can beneficiate PwD. Smart cities provide essential services not only to disabled tourists but also to disabled citizens. When a city is deeply connected, the utilization of technologies by tourists is facilitated, this can be especially important for tourists but also for regular citizens with disabilities. Smart Cities are a clear example of where technologies are at the disposal of people and contribute to a better tourism experience

B. Smart Tourism Destinations

Tourism destination is categorized as an area selected by visitors, which encompasses all necessary amenities such as accommodation, restaurant, and entertainment (Buhalis, 2000). They are formed by various tourist objects and managing it is not an easy task, because of the different demands, especially if accessible tourism is incorporated. The linkage between a tourism product and another at a destination level is vital due to the combination of multiple components served, that are perceived by the customers prior, during and after their trip (Soteriades, 2012).

According to Buhalis (2000), destinations can be structured as the 6As of tourism destinations: (1) Attractions which can be natural such as mountain; artificial such as amusement Parks; or cultural such as music festival; (2) Accessibility refers to the entire transportation system within destination that comprises of available routes, existing terminals, and adequate public transportations; (3) Amenities characterize all services facilitating a convenient stay, namely accommodation, gastronomy and leisure activities; (4) Available Packages refer to the availability of service bundles by intermediaries to direct tourists' attention to certain unique features of a respective destination; (5) Activities refer to all available activities at the destination which mainly trigger tourists to visit the destination; and (6) Ancillary Services are those daily use services which are not primarily aimed for tourists such as banking, postal services and health care.

Smart tourism destination can be defined as: "a platform, which is implementing ICTs such as Artificial Intelligence, Cloud Computing and Internet of Things to offer the tourist personalized information and enhanced services established by mobile end-user devices" (Boes, Buhalis, & Inversini, 2015). They are a consequence of the new technologies and ICT applied to touristic services, integrating users and stakeholders through the use of new technologies.

Smart Tourism Destinations take advantage of i) Technology embedded environments; ii) Responsive processes at a micro and macro levels; iii) End-user devices in multiple touch-points; and iv) Engaged stakeholders that use the platform dynamically as a system (Buhalis & Amaranggana, 2012). ICTs are a fundamental part of this concept because they allow share knowledge and information between diverse actors (Wang, Li, & Li, 2013).

The use of ICTs within a destination is not sufficient for it to become a Smart Tourism Destination. It is essential to understand that Smart Tourism Destinations requires the integration of four fundamental concepts: i) human capital, ii) leadership, iii) social capital, and iv) innovation (Boes et al., 2015). The real goal behind Smart Tourism Destinations is to focus on tourists' needs by combining the ICTs with culture and tourism innovations, to promote tourism service quality and improve tourism management (Huang, Yuan, & Shi, 2012).

Destinations should utilize available technologies to allow individual users to state their requirements and by doing so, initiate dialogue and enable participation of PwD, as directed by the social model of disability. The digitalization of tourism is having a significant impact on several tourism destinations, which also creates several challenges. Besides geographical and other attributes of destinations, the use of technologies is, in many cases, crucial to satisfy users' needs (Jovicic, 2019). By expanding tourism horizons, with new information technologies, it is possible reaching to more tourists and promote accessible tourism.

C. Smart Tourism Tools

The specific ICTs referred in smart tourism destinations and helping smart cities come to life, can be interpreted as the tools that make the concept "smart" work. Smart tourism tools can be defined as "a combination of mobile hardware, software, and networks that enable interactivity between tourists, stakeholders, and physical objects " (Put-van den Beemt & Smith, 2016: 5). Smart tools that have location-based services, instant access to information, content and/or recommendation sites relevant to the current location, can offer opportunities for the destination to connect, assist, and engage with the tourist in the online environment (Neuhofer, Buhalis, & Ladkin, 2012). This means that these tools can be used to improves touristic experiences and facilitate the use of touristic services.

These tools are responsible for smart destinations and they are essential components in smart cities. Buhalis and Amaranggana (2013), identified a set of tourism applications and identified their utility according to Destination Components (Buhalis, 2000) and the Smart Tourism Destinations dimensions (Cohen, 2012). As identified by the authors, leading technologies were related to Augmented reality (AR), Near field communication (NFC), mobile apps, Qr Codes and tracking systems. Benefits are gained in areas like interpretation, planning, guidance, and feedback.

These types of technological tools bring a lot of benefits to tourists, as communication is facilitated. This allows tourists access to personalized services providing in some cases, real-time information. When tourism becomes easy to do, accessible tourism starts being a reality. These technologies are responsible for making tourism available for all. If a disabled person has access to this type of technological tools and these tools are accessible and usable, accessible touristic experiences become a reality. Technology that makes tourism simpler has a significant role in promoting accessible tourism.

Smart tourism tools can bring improvements for tourists when implemented in destinations. With new technologies implemented and elevating the tourism sector, several benefits can be obtained for destinations and tourists. This is radically changing how tourism is delivered to the people. Advantages for tourists like dissemination of information, highly personalized services, and co-creating experiences (Michopoulou & Buhalis, 2013) are pointing out a new reality in tourism.

II.2.3.1.2 Challenges for Smart Tourism

Smart tourism is perceived as user-friendly, and it brings new technological advances that benefit tourism and indispensable for helping PwD. Nonetheless, some factors connected to human capabilities must not be forgotten. Technologies are revolutionizing this industry, but they should not replace the work of tourist guides, for example. Modern technologies can act as a double-edged sword, from safety to connectedness. Therefore, there has to be a balance in order to utilize its benefits while keeping its threats to a minimum (Wetzel & Barten, 2016). New technologies will change the nature of work in diverse sectors (Schwab, 2016: 6), and tourism is no exception. Therefore, adaptation is crucial.

Other concerns are related to security and safety due to hacking. Cerrudo (2014), identified that some components in smart tourism, that have a very high risk of suffering a cyber-attack. Some examples are Smart Street Lighting, City Management Systems, Sensors, Public Data, Mobile Applications and Location-based Services. It is important, in this new technological age, to protect all citizens. Smart tourism must take in concern overall security since it is a crucial factor for good tourism experiences. When the data that feeds smart city systems is blindly trusted and can be easily manipulated, that the systems can be easily hacked, which gives origin to security problems everywhere, that is when smart cities become Dumb Cities (Cerrudo, 2014). Cybersecurity should be assured, as tourists' personal data must be kept safe while using smart tourism technologies.

Location-based technologies can be indispensable for some user, but their utilization comes with some potential risks. Due to the sensitive nature of real-time location information and the existence of guidelines recommending clear notice to users, one would expect all location-sharing applications to detail their policies for the collection and use of personal information (Tsai, Kelley, Cranor, & Sadeh, 2009). But sometimes this is not verified, what might lead to privacy issues. The technical complexity of modern systems based on ICTs demands that all aspects of the innovation chain integrate their efforts. The concentration and coherence required to achieve both significant technological development , in tourism need engagement of all stakeholders to integrate the rapid evolution of technology with market, social, and administrative requirements (Buhalis & Law, 2008).

Another aspect that may influence the success of smart tourism is related to countries wealth. Applying the concepts of smart tourism may be difficult in third world countries. Some of these countries rely on tourism as a significant economic factor. However, due to the lack of financial resources, it may prove challenging to align new technologies and tourism.

II.2.3.2 Tourism 4.0

In recent times, different types of technologies have become a powerful ally to tourism. Developments became available in ICTs which were responsible for the origins of smart tourism (Gretzel, Sigala, Xiang, & Koo, 2015) and which helped tourism advance to new platforms, reaching more clients and present more quality services. With the fourth industrial revolution, new technologies are taking a step forward to develop tourism even further. The impact of the industrial revolution on the travel industry gave rise to a more advanced paradigm in tourism, named Tourism 4.0.

The concept of Tourism 4.0 first appeared as the largest government-sponsored research project in Slovenian tourism. This research was possible due to the establishment of a partnership between

the Arctur company and Slovenia's government. Arctur is a commercial supplier of computing services, which provides innovative and user-friendly digital solutions to businesses, public institutions, and research institutions. Artur's R&D department together with the Slovenian government sought a way to potentialize innovation in the tourism sector. The result of the research was the creation of the Tourism 4.0 consortium. According to the Tourism 4.0 consortium, Tourism 4.0 is defined as "a trend of big data processing, collected from a vast number of travelers, to create personalized traveling experience, based on a variety of modern high-tech computer technologies" (Arctur & Tourism 4.0 Consortium, 2018). Tourism 4.0 follows the slogan: "Green, active, healthy" (Peceny, Urbančič, Mokorel, Kuralt, & Ilijaš, 2019), which demonstrates that the concept encompasses many future trends. According to the World Economic Forum (World Economic Forum & Accenture, 2017), there are four subjects that are crucial for digital tourism transformation.

- **Living travel experience** according to tourists' habits - optimize and personalize the customer experience by collecting and exchanging data and continuously generating comprehension;
- **Enabling the travel ecosystem** by evolving different stakeholders;
- **Digital technologies** that promoted Industry 4.0 - optimizing the real-time use of resources and transforming operations, through innovations such as IoT, virtual reality, and digital platforms will enable flexible working and changes to basic operational processes and will optimize the real-time use of resources;
- **Safety and security**, using digital technologies to produce secure environments and enhance the global travel security system (Moavenzadeh & Maar, 2018).

Tourism 4.0 aims to integrate these four topics into the diverse industries connected with tourism. In fact, by applying new technologies in tourism, it is possible to promote personalized solutions to every tourist, while assuring that they are traveling with safely and securely. Tourism 4.0 also promotes sustainable tourism, encouraging a positive environmental, social, and economic impact and collaboration between all stakeholders. The success of Tourism 4.0 depends greatly on the different collaborations in the travel ecosystem.

With the objective of achieving sustainable tourism, Tourism 4.0 sets up a primary goal of **making tourism "accessible to everyone at any time"**, making it tremendously crucial for the development of accessible tourism. Technologies have a crucial role in helping the development of more accessible tourism. The main problem preventing people with different types of disabilities from traveling is mainly related to the shortage of information (Stumbo & Pegg, 2005).

There are several uses of technologies, that can help diverse tourism objects display greater accessibility features. With the new industrial revolution, technology is exceeding all expectations, making society evolve in many sectors and providing better life-conditions, especially for those with some type of impairment. Ensuring that tourism is accessible is very important from an economic point of view, due to the potential of the accessible tourism market. Furthermore, Tourism 4.0 has all the tools for achieving more inclusive travel ecosystems and boosting inclusiveness of PwD.
Industry 4.0 was responsible for launching the fourth industrial revolution, and now this revolution is impacting other sectors, like tourism. Industry 4.0 technological drivers are the tools responsible for making travel experiences more accessible, efficient, and affordable for travelers. Innovative information tourism platforms that offer innovative products and services will play a crucial part in the current and future digitalization of the travel industry. However, the question remains: how can the technological impacts of the fourth industrial revolution contribute to more accessible tourism?

II.2.4 Accessible@Tourism 4.0: How the fourth industrial revolution is revolutionizing Accessible Tourism

Accessible@Tourism 4.0 is the answer to the research gap presented in the first research question. Despite, the potential of technologies to develop accessible tourism, the literature in this area is very limited. In order to overcome this gap, it is necessary a lucid exploration of the application and the potential of the Industry 4.0 components in the scope of accessible tourism. For accomplishing this aim, a literature review of the application of Industry 4.0 technological drivers in accessible tourism was carried out. Additionally, some projects will be analyzed to identify the same shreds of evidence that can contribute to Accessible@Tourism 4.0.

The launch of new technologies and their application on diverse industries promoted the appearance of Industry 4.0. The different innovations became known as technological drivers. As the relationship between new technologies and tourism developed to a very narrow one, the use of Industry 4.0 technological drivers in touristic activities was the main responsible for the urge of Tourism 4.0. In smart tourism, technology was already responsible for improving tourism services and products. However, the technologies that Tourism 4.0 present are one step forward to the future of tourism. Industry 4.0 technological drivers and other technological innovation have opened the doors to the digitalization of the travel industry. IoT, virtual and augmented reality, big data, RFID, and even 3D printing are technological drivers, that were born in the manufacturing world but have the capacity to transform the tourism industry. Other innovative technologies like robotics and Virtual assistants are also drivers of the fourth industrial revolution (Schwab, 2016: 13,19) and can have a significative impact on many sectors. Tourism 4.0 is adapting all these technologies to tourism, transporting tourism to this new digital era. This era made tourism more accessible by stimulating the inclusion of disabled travelers. Accessible@Tourism 4.0 is an overview of different technological innovations developing accessibility conditions in tourism.

This overview will be obtained by illustrating examples of technological innovations that are promoting the fourth industrial revolution and transforming the world of tourism, making it more accessible. The impact of Industry 4.0 technological drivers and other technological innovations in accessible tourism allows the literature gap to be addressed by showing how Tourism 4.0 can help in the development of accessibility conditions for PwD.

A. Mobile Technology

Mobile technologies, especially mobile apps, have become significant players for smart tourism and crucial tools for assuring accessible tourism. Similar to their role in smart tourism, Tourism 4.0 also relies much on mobile apps to take tourism to a new level. The evolution that this type of technology has undergone in recent years made this device turn into a tour guide, a travel agency, a restaurant locator, and a map. Mobile apps and cell phones are side by side with tourists during the entire tourism experience. Services for passengers aligned with the use of social media have made mobile technology indispensable for all phases during a trip: i) planning (online bookings and places to visit), ii) while traveling (cell phone as the best traveling friend), and iii) post-trip (sharing experiences in social media) (Belén, 2018). Another example is related to apps that allow sharing and matchmaking. Airbnb and Uber became disruptive innovations because technology allows peer-to-peer sharing and matchmaking. (World Travel & Tourism Council, 2015).

Nowadays, with the help of smartphones, the entire trip can be planned (from booking to bedtime and home again) without leaving home (Newman, 2018). This easier process is especially important for disabled people since proper planning can be done, and all information needed can be obtained.

Some authors have already studied the importance of mobile apps in tourism. Emrouzeh, Dewar, Fleet, & Bourgeois (2017) reviewed some mobile apps helping tourists. The most used apps were related to Navigation (Wayfinding), Social (sharing, collaborating and communicating), Mobile Marketing, Security, Emergencies (health monitoring, and weather alerts), Transactional (transaction of some sorts for tickets, reservations, and shopping), Entertainment (games, movies, e-readers, etc.) and Information.

B. Virtual Assistants

A virtual assistant is "a computer program or device that is connected to the internet and can understand spoken questions and instructions" (Virtual Assistant, 2019). Voice recognition technology and voice assistant software have experienced growth in recent years. Voice assistant products from Amazon, Apple, and Google enable users to ask questions and issue commands in natural language. *Siri* and *Alexa* are examples of voice assistants that can help people in various ways. Some functionalities include: sending and reading text messages, making phone calls, answering basic informational, setting timers, alarms, and calendar entries; controlling media playback and even controlling IoT enabled devices (thermostats, lights, alarms) (Hoy, 2018).

These services on offer can help accessible tourism by making significant contributions to the daily activities of disabled tourists. By helping tourists with these activities, they make traveling more personalized and less troublesome. The main contribution of this type of technology is reducing the information barriers which disabled tourists experience and offering more customized services. The tourism sector is now experimenting with the arrival of virtual assistants specially designed for their atmosphere. IBM launched Watson Assistant, an AI-powered virtual assistant that creates interactive and personalized solutions for tourists. Watson Assistant creates customized experiences, taking in consideration factors like the age, gender and travel interests, forming personalized activity agendas that users can modify. This system learns more every time the client uses it, providing better recommendations with each use (IBM, 2017). The fact that this virtual assistant adapts to users can be fundamental to accessible tourism, due to the particular necessities of disabled tourists. The Watson Assistant arrived because IBM understood that the travel ecosystem is evolving, so travel and hospitality providers have an obligation to evolve too.

C. Virtual Reality and Augmented Reality

Virtual reality and augmented reality offer a new set of experiences for tourism. Simulating digital environments can have a significant impact on traveling, leading to big changes in touristic experiences.

Virtual reality can help in removing many accessible tourism barriers. It can deliver 3D and immersive experiences to disabled tourists, providing touristic guide services in sign language and even remove physical barriers in museums. This technology can be even used to access sites that are usually closed or inaccessible (Jung, tom Dieck, Lee, & Chung, 2016). The use of VR may be an essential step to ensure more accessible tourism, but in fact, it also brings positive aspects to the regular tourist. VR can be a platform to capitalize on digital tourism in cultural attractions like museums and archaeological sites. Improving visitors experiences and increasing tourist engagement raises income and intentions to return (Han, Jung, & Gibson, 2014).

AR makes use of the traveler's real-time environment, joining it with a 3D environment, and recreates digital tourism experiences (Kounavis, Kasimati, & Zamani, 2012). Augmented reality is also much connected to travel mobile apps, that have been revolutionizing tourism. A great example of the utilization of AR is the travel guide apps developed by the *eTips* company (eTips, 2019). The apps provide digital travel guides to many cities like Dubai, Los Angeles, London, and Rio

de Janeiro. These mobile apps are also capable of recreating in 3D several points of interest like monuments, museums, buildings, and other touristic attractions.

One practical example of the use of these technological drivers is the Geevor Tin Mine Museum (Jancenelle, Vivien, Storrud-Barnes, Susan, Javalgi, 2017). This museum is a UNESCO world heritage site and uses VR and AR to produce engaging experiences for its main target markets (school groups, families, and elderly visitors). Some parts of this mining museum are difficult to access (underground mines). A VR/AR application is used for pre-visit stage and on-site underground mining experience.

If a mobility impaired person has the dream of climbing the Everest, EVEREST VR app can provide this person to see the top of the world. VR opens the doors for amazing virtual touristic experiences, improving touristic services, especially for disabled tourists. Some museums are already offering VR and AR installations as part of their exhibits, which can be essential to ensure touristic experiences in accessible tourism. AR and VR are also revolutionizing marketing in tourism. A preview of what is being offered can be delivered, helping travel decisions by providing relevant information. VR is a technology that can even help convincing someone to take their first overseas trip, so the value that this brings to tourism is undeniable. This comes with a risk, though. Technologies can become so innovative that tourists prefer the digital experience over the real thing (Newman, 2018).

D. Internet of Things

IoT is a major player in smart cities (Dohler, Vilajosana, Vilajosana, & Llosa, 2011). This makes this technology indispensable also for smart tourism. But the advances that IoT can bring for tourism go way beyond offering more quality services in cities, as IoT allows the connection between several devices. A network of smart devices enhances businesses by connecting clients and service providers, thus generating a large amount of data that can be stored and computed on available cloud services (Kaur & Kaur, 2016). Tourists trends and patterns can be easily stored. This connection can be useful to offer more personalized tourism offers. The more information known about guests, the better services can be offered, and satisfaction increases.

A practical example is IoT data identifying that a customer has booked a room every year, so it sends a message asking the guest if they would like to make another booking this year (Newman, 2018). IoT is quickly becoming a significant technology for tourism. Some services that IoT has the potential to maximize are: i) helping to select destinations and searching for suitable travel arrangements; ii) helping tourists during preparation for a trip; iii) providing real-time support to the tourist during the trip, iv) helping managing memories after the trip, v) providing highly personalized onsite support to frequent travelers and vi) providing personalized services for tourist groups (Balandina, Balandin, Koucheryavy, & Mouromtsev, 2015).

Similar to the application in smart cities, IoT has the ability to locate points of interest for the tourist. Customized and adaptable service solutions make personalization the main benefit of IoT in tourism. An example of the use of IoT is the case of some Virgin Hotels. They offer an app to their clients that lets them connect with the room's thermostat and operate the television in the room. There are also suitcases that have devices that allow users to use their cell phones to follow where their suitcase is at any time to avoid lost baggage or mobility equipment at the airport or other attractions sites (Belén, 2018).

Significant gains that shared data brings are, for example, personalized solutions, as they have a particular influence on accessible tourism. The sharing of information that IoT allows can put an end to the problems of a lack of information. Having all the information available is especially

important for disabled people when planning a trip. In addition, having personalized services is crucial for disabled tourists. This particular group has different requirements according to the type of disability, so the offer of rapid and customized solutions is boosting disabled tourism. Examples vary from reserving a room with the right requirements to the use of smart devices to enter and explore museums and monuments. IoT can also bring significant improvements to accessible tourism by offering real-time support. Assistance and support for disabled tourists in real time may just unlock all the potential of accessibility tourism markets. It is noteworthy that IoT promotes the quick and efficient flow of information. A better-connected world where information is a crucial aspect is vital for the development of accessible tourism.

E. 3D Printing

3D printing may not be a very common technology associated with tourism. However, the potential to print perfect replicas can have a significant influence on improving touristic experiences in museums, art galleries, and archaeological sites. 3D printing has particular significance, in the context of museums due to the low costs in replicating objects (Allard, Sitchon, Sawatzky, & Hoppa, 2005; Short, 2016).

Another use, in museums, can be in creating and producing customized 3D souvenirs (Jancenelle, Vivien, Storrud-Barnes, Susan, Javalgi, 2017). In the case of art and design, creating exhibits in art galleries, using 3D printing also proves the potential of this technology to tourism (Walters & Davies, 2010).

3D printing has particular importance for accessible tourism because it allows a more immersive experience. This technology helps to make artifacts more tangible and accessible to the public, improving the experience of visiting an art gallery or a museum. 3D printing objects also help in eliminating barriers for people with cognitive disabilities, which may experience learning difficulties, during touristic trips to museums or archaeological sites. For this group of disabled tourists, a 3D replica may just be the answer to their particular requirements.

A practical example of the application of 3D printing to tourism is the *Underwater Maya Project* (Mckillop, 2013). The project uses 3D printing to build replicas of ancient Maya wooden buildings. This makes archaeological sites more accessible since exhibiting 3D replicas do not require loans of actual artifacts, or extended security measures. The project already led to the open of exhibits in some remote places, which also promotes accessibility. The main objective of this project is contributing to sustainable archaeological tourism, while promoting access conditions and engaging people with archaeological sites.

F. Big Data (Analyze tools)

With the internet becoming a significant player in tourism, tourists rely on various web-based platforms to plan trips. The electronic trace left by tourists, also known as digital footprint (Girardin, Blat, Calabrese, Dal Fiore, & Ratti, 2008), generates a lot of data. In tourism 4.0 once again it is verified the big data problem. And analyzes tools have a critical role in generating the right information, do it can become a source of competitive advantage.

Data can have different sources. From booking websites to search the best places to visit and sharing in social media, the digital footprint can help develop customized solutions in tourism. Chareyron, Da-Rugna, and Raimbault (2014) studied how social networks provide essential information on the perceptions of the tourist destination, by analyzing two types of community websites: Photo sharing ones (*Flickr*) and review/opinion ones (*TripAdvisor, Booking*). The sites help understand typical consumer behaviors. Analyzing the information provided can be a valuable help

when attending special needs from disabled tourists. By focusing in analyze tools, Li, Xu, Tang, Wang, and Li, (2018) identified three sources of big data generation: **user-generated content data** (**UGC),** including online textual data and online photo data; **device data** (devices), including GPS data, mobile roaming data, Bluetooth data; and **transaction data** (operations), including Web search data, webpage visiting data, and online booking analytics for tourism.

Some practical examples of the use of generated data come from Meliá hotels and Airbnb. The Meliá hotel chain uses information about its guests to define marketing campaigns. By analyzing their database (amount spent, the reason for the trip, the country of origin), they are able to cross-checks information to develop an appropriate customer profile and achieve a higher success rate. The objective is to obtain better market segmentation and optimize their promotional campaigns (Belén, 2018). Airbnb is able to use customer data to identify guests who chose not to book because they were displeased by hosts failed to respond to their expectations (Newman, 2018).

Another example is the Destination Management Information System Åre, presented by Fuchs, Höpken, and Lexhagen (2014). This information system, for the Swedish mountain tourism destination Åre, measures destination performance and customer behaviors by analyzing data from customer-based knowledge sources, like Web search, booking, and feedback.

The analyze of big data is a vital element of Tourism 4.0, and it is becoming a significant success factor for accessible tourism. Similar to IoT, the analysis of big data main advantage is allowing to offer personalized tourist solutions. By studying different data sources, it is possible to identify tourists' behaviors and establish patterns. Through the analysis of data derived from disabled travelers, one can understand the main difficulties and address them in order to optimize touristic experiences. Since disabled tourists needs differ according to the type of disability, much data is generated, making analysis tools indispensable. The data obtained can become valuable knowledge, and a simple understanding of disabled tourist behaviors is essential to promote accessible tourism. Analysis tools should be able to collect and analyze data from accessible tourism knowledge sources, in order to deliver more personalized and enlightened touristic services.

G. RFID

Radio frequency identification is an automatic identification method that retrieves and stores data using RFID tags. This technology is being popularized by Industry 4.0, as it is mainly utilized in retail and supply chain management. Nonetheless, while its main application is in manufacturing, RFID can also help enhance services by improving quality, speed, and customer satisfaction. In the case of tourism, Öztayşi, Baysan, and Akpinar (2009), described RFID applications in four major RFID areas:

- Human tracking and control systems (E-passports, customer loyalty management, tracking children or people with special needs, airport security);
- Assets and valuables tracking systems (luggage tracking and food and beverage management);
- Contactless payment systems (toll collection system, RFID-tagged public transport cards, payments in a hotel, keyless room entry);
- RFID-based information (museums, archaeological sites, art galleries, monuments)

All of the mentioned examples are essential in assuring more accessible tourism. Tracking systems can help disabled tourists with navigation and wayfinding and prevent the loss of specialized equipment like wheelchairs while traveling (Konkel, Leung, Ullmer, & Hu, 2004). Contactless payment systems and digitally activated transport and hotel cards also improve accessibility and inclusiveness by making processes easier for disabled tourists. RFID applications have been studied

in maritime cruises (Dias et al., 2016) and even in the organization of cultural events in a tourist destination (Zeni, Kiyavitskaya, Barbera, Oztaysi, & Mich, 2009).

In literature, it is possible to identify some practical examples of RFID use in tourism which can also contribute to the inclusiveness of disabled tourists. When visiting a capital city, mobility and visually impaired people often find it difficult to cross busy streets. RFID can allow communication between tourists with disabilities and the crossing equipment to automatically activate a location message and input a request for the green light (Smyth & Crabtree, 2012).

Another practical example is related to navigation at attractions. Disabled tourists can experience difficulties when moving around an attraction, so RFID can propose a route recommendation system that informs tourists which facilities they should visit and in what order. A proposal for this application comes from Tsai and Chung (2012), in the context of theme parks. At the entrance, tourists are provided a wristband embedded with an RFID tag. RFID readers are installed on the entrances and exits of each facility. Whenever a tourist enters the area of an RFID reader, the system records the entrance and time and transfers that information to a route database. This way, information can be stored, and a personalized route can be presented to the tourists based on personal preferences and avoid busy rides. A system like this can be priceless for a disabled tourist who wishes to enjoy the most while avoiding crowded areas. It is interesting to note that technology often associated with manufacturing industry has many applications in the tourism sector. From resolving accessibility problems in accommodation, hotels, attractions, and monuments to make navigation in cities simpler, RFID definitely has a massive impact on developing accessible tourism.

H. Robotics

Automation in tourism attracted the use of robots. Robots are capable of performing automated tasks and delivering value to clients. Their utilization in tourism and hospitality is already a reality. Ivanov, Webster, and Berezina (2017) identified some current uses of robots across the tourism sector. Their findings highlighted six areas where robots are being used to improve services. **Hotels** have been evolving for adopting the use of robots in assisting people in their rooms (delivery and cleaning robots) or even working as staff (robot receptionist and porter). One practical example is Henn Na Hotel in Japan, which uses technologies in order to maximize excitement, efficiency, and comfort for guests. Amongst other innovations (voice- and face-recognition), the hotel staff consists mainly of robots. The reception is operated by three multi-lingual robots responsible for greeting, checking-in and assisting guests, there is a robotic arm for storing luggage in the cloakroom, and there are porter robots to carry bags to the rooms (Alexis, 2017). Robots also have been used in **restaurants** (robot servers and even chefs), **amusement parks** (concierge robots), **airports** (robot-guide and bag drop robots), at **events** (delivery and entertainment robots) and **galleries and museums** (robot guides).

The use of robots in tourism already led to the creation of the concept of R-tourism (robot tourism), proposed by Alexis (2017). R-tourism is deeply connected to Tourism 4.0 since some of the robotic impacts in tourism are already visible. Also, the relation with accessible tourism is quite close since the automation of some services can captivate the interest of disabled tourists. Robot guides represent a significant breakout for tourists to experience museums and art galleries, providing, for example, help to visit inaccessible exhibits. Also, the aid provided in a hotel with cleaning and assistive robots can fulfill some challenging accessibility requirements. In fact, one may recognize that a primary driver of R-tourism is accessibility.

Another example of robotics improving accessible tourism is the proposal a robot that takes pictures and records videos from a faraway place and sends it to the user in real time. This proposal

comes from Cheung, Tsang, and Wong (2017)**,** and aims to build a robot capable of helping disabled people to perform virtual tour to places where they cannot reach because of their mobile impairments**.** The authors were already successful in implementing a remote-controlled robot and a visual recognition system that the user can control the robot by using simple hand gestures. Robots can provide indispensable help to disabled tourists, giving the opportunity to view landscapes and cultural sites in ways never imagined before. Despite the lack of empirical studies, robots hold great potential for tourism, especially for accessible tourism.

The following table (Table 5) presents a synopsis of the study conducted. The leading technologies promoting the fourth industrial revolution and impacting accessible tourism were identified. Various projects in the area of these technologies were explored with the help of some authors' work in respective innovative areas. After analyzing the fundamental discoveries, the impact of each technology in accessible tourism was discussed. The table sums up the purpose of Accessible@Tourism 4.0 in describing how Tourism 4.0 has the power to promote more accessible tourism.

Table 5- Technological Drivers Promoting Accessible Tourism

Technological Driver	Author(s)	Impact in Accessible Tourism
Mobile Technology	Emrouzeh, Dewar, Fleet, and Bourgeois, (2017)	• Navigation (wayfinding). • Planning (trips, what to visit, accessible conditions) • Social (sharing, collaborating, and communicating). • Security and emergencies (health monitoring, weather alerts, real-time assistance). • Transactional (buying tickets, making reservations, and shopping). • Entertainment (tour guides, e-readers, etc.). • Information access.
Virtual Assistants	Hoy, (2018)	• Simplifying daily activities of disabled tourists. (setting timers, alarms, and calendar entries; setting reminders, making lists, and doing basic math calculations; controlling media playback; controlling IoT-enabled devices). • Making traveling more personalized and less complicated with fewer information barriers.
Virtual Reality and Augmented Reality	Jung, tom Dieck, Lee, and Chung, (2016) Kounavis, Kasimati, and Zamani, (2012) Jancenelle, Vivien, Storrud-Barnes, Susan, Javalgi, (2017)	• Recreating several points of interest in 3D, like monuments, museums, buildings, and other touristic attractions. • Creating realistic 3D environments for touristic activities and allowing immersive experiences for disabled tourists. • Potentializing better holiday planning functionalities. • Providing touristic services in sign language. • Improving access sites that are generally closed or inaccessible. • Preview of disabled tourism offers. • Helping in travel decisions by providing relevant information about accessibility conditions.
Internet of Things (IoT)	Balandina, Balandin, Koucheryavy, and Mouromtsev, (2015) Kaur and Kaur, (2016)	• Tourists trends and patterns can be easily stored. • More personalized tourism offers (rapid and customized solutions). • The sharing of information can put an end to the problems of lack of information. • Assistant and support to disabled tourists in real-time. • Automatically reserving rooms with the right accessibility requirements. • Allowing the use of smart devices to enter and explore museums and monuments.

Continues in the next page

Technological Driver	Author(s)	Impact in Accessible Tourism
3D Printing	Jancenelle, Vivien, Storrud-Barnes, Susan, Javalgi, (2017) Mckillop, (2013)	• Replicating objects offering more immersive touristic experiences. • Artifacts more tangible and accessible to the public. • Eliminating barriers for people with cognitive disabilities who may experience learning difficulties while visiting museums or archaeological sites.
Analysis Tools (Big Data)	Li, Xu, Tang, Wang, and Li, (2018) Fuchs, Höpken, and Lexhagen, (2014)	• Identifying tourists' behaviors and establishing patterns. • Identifying the main difficulties and addressing them in order to optimize touristic experiences. • Collecting and analyzing essential data from different accessible tourism systems can promote interconnection between several digital databases. • Providing more personalized tourism offers.
Radio Frequency Identification (RFID)	Öztayşi, Baysan, and Akpinar, (2009) Tsai and Chung, (2012) Dias et al., (2016)	• Tracking systems help in navigation/wayfinding and prevent the loss of special equipment. • Contactless payment systems. • Digital activated transport. • Autonomous processes in hotels. • RFID in attraction sites can guarantee better access conditions. • Providing digital solutions in tickets. • Informing users by giving information about nearby objects.
Robotics	Cheung, Tsang, and Wong, (2017) Ivanov, Webster, and Berezina, (2017) Alexis (2017)	• Helping disabled people to perform virtual tours of places which they cannot reach because of their mobility impairments. • Robot guides represent a significant breakout for tourists to enjoy museums and art galleries, providing, for example, help to visit inaccessible exhibits. • Cleaning and assistive robots can help PwD in hotels, restaurants, touristic events, and amusement parks.

Tourism 4.0 reflects the integration of technological tools into tourism. This integration has the potential to innovate tourism and make it accessible for everyone, offering disabled tourists the possibility of experiencing the wonders of traveling. Accessible@Tourism 4.0 can be considered the answer to the research gap on the role of Industry 4.0 and new technologies in tourism and their importance in developing more accessible tourism.

Accessible@Tourism 4.0 shows the effect of Industry 4.0 and technologies in the accessible tourism sector, sending shockwaves across tourism and revolutionizing the way of traveling. Tourism 4.0 clearly shows that "Integration of technology makes life easier, especially for disabled people" (Altinay et al., 2016: 95). Technological advantages are finally allowing many disabled tourists to fulfill their dreams of exploring the world. Although many technologies can be already applying to tourism, Tourism 4.0 is still a topic that lacks significant literature. The approach to this topic has the goal of stimulating further research and investigation on this topic, especially for the importance of promoting accessible tourism.

The adoption of fourth industrial revolution components in accessible tourism (Accessible@Tourism 4.0) enables the development of a new technological solution that can facilitate access to tourism products by disabled people, contributing to the development of accessible tourism. Many of the technologies analyzed demonstrate the significance of connectivity, one of the pillars of the fourth industrial revolution, in the promotion of accessible tourism.

II.3 Accessibility in Web platforms promoting Accessible Tourism

Information is essential to accessible tourism. However, it is also crucial the way that information is delivered. For the conceptualized Web application to be truly accessible, it should not focus on promoting information, but also ensuring that the available content is accessible.

Web platforms still take center stage in sources of information (Vila,González, & Darcy, 2018). Technological development led more tourists to search for information on Web platforms to plan holidays. Nonetheless, as studied in the literature review part dedicated to accessible tourism, the number of disabled tourists is increasing, and some disabilities affect peoples' use of the web. This group includes visual, hearing, cognitive and neurotically impairments, and some mobility disabilities (Shi, 2006). Making Web platforms accessible to every tourist is necessary in other to promote accessible tourism.

II.3.1 Web Accessibility

Web accessibility can be defined as "'an approach to web design that aims for maximal inclusion, both in terms of people who use websites, and the technologies that are utilized in the process'' (Alexander, 2004). Web platforms should allow access to the broadest range of people, including those who suffer from any type of disability. As the function of websites is to efficiently supply the right information, at the right time to the right tourists. However, information on the Web only has value if individuals have access to it (L. Wang, Law, Guillet, Hung, & Fong, 2015). Consequently, website accessibility can have a significant impact on the service quality of web services.

There are several tools capable of evaluating websites accessibility (W3C, 2019), and guidelines promoting Web inclusiveness. The Web Content Accessibility Guidelines (WCAG), developed by the World Wide Web Consortium (W3C) (W3C, 2018b) have been a cornerstone on assuring that websites are accessible. Currently, the available versions are WCAG 1.0, WCAG 2.0, and WCAG 2.1. Notably, in 2012, WCAG 2.0 was approved as an ISO/IEC international accessibility standard (Akgül & Vatansever, 2016). WCAG 2.0 is divided into four general principles, structured into 12 guidelines (W3C, 2018a). This principles and guidelines were used on the realization of the study about Web accessibility in websites belonging to hotels, in Chapter 3.

The principles of WCAG 2.0 are: Perceivable (the criteria allow the product to be perceivable by people, regardless of their disabilities); Operable (the user interface components and navigation must be operable); Understandable (the information and the operation of user interface must be understandable); and Robust (the content must be robust, so that it can be interpreted reliably by a wide variety of user agents, including assistive technologies) (W3C, 2018a). Every principle has some guidelines, which can be evaluated using success criteria based on three available conformance levels: A – basic accessibility representing the minimum level; AA – intermediate accessibility, when the website meets all criteria under levels A and AA; and AAA – high accessibility, when a set of requirements are added to level AA . Table 6 presents a description of every success criteria, providing better knowledge of what is pretend to evaluate in websites, by describing every success criteria, in accordance with the information displayed on the W3C page on "Understanding WCAG 2.0" (W3C, 2016b).

Table 6- Description WCAG Principles, Guidelines, Success Criteria and Conformance Level, and a brief description of each success criterion

Principles	Guidelines	Success criteria – Conformance level	Description (How to meet WCAG2 guidelines)
Perceivable	1.1 Text alternatives	1.1.1 Non-text Content –A	Help people with difficulty perceiving visual content or audio information making information conveyed by non-text content accessible through the use of a text alternative
	1.2 Time-based media	1.2.1 Audio and Video Only – A 1.2.2 Captions – A 1.2.3 Audio Description or Media – A 1.2.4 Captions (live) – AA 1.2.5 Audio Description – AA 1.2.6 Sign Language – AAA 1.2.7 Extended Audio Description – AA 1.2.8 Media Alternative – AAA 1.2.9 Audio Only – AAA	Make the information in prerecorded audio-only and prerecorded video-only available to all Enable people who have hearing difficulties in accessing information through captions Help people who have difficulty watching a video or other media content Access the auditory information in the synchronized media content through captions. Blind and cognitive disabled benefit from audio description of visual information Sign language interpretation to provide access to the synchronized media content Extended audio to provide the additional information needed to understand a video Get access to information in audio-visual presentations. Make information conveyed by live audio accessible through the use of a text alternative
	1.3 Adaptable	1.3.1 Info and Relationships – A 1.3.2 Meaningful Sequence – A 1.3.3 Sensory Characteristics – A	Info and relationships implied formatting is preserved when the format changes Help people who rely on assistive technologies that read content aloud Providing additional information other than shape and/or location
	1.4 Distinguishable	1.4.1 Use of Colour – A 1.4.2 Audio Control – A 1.4.3 Contrast – AA 1.4.4 Resize Text – AA 1.4.5 Images of Text – AA 1.4.6 Contrast – AAA 1.4.7 Low or No Background Audio- AAA 1.4.8 Visual Presentation – AAA 1.4.9 Images of Text (no exception) – AAA	Access information where each color has a meaning assigned to it. Screen reading technologies can hear the screen reader without other sounds playing Provide enough contrast between text and its background so that it can be read Ensure that visually rendered text can be scaled successfully When requiring a particular visual presentation of text people are able to adjust it as needed Enough contrast between text and its background so that it can be read Non-speech sounds are low enough that a user can separate it from background sounds Rendered text is presented in a manner that it can be perceived without its layout interfering Text presentation can be changed or provide a mechanism by which users can alternate text
Operable	2.1 Keyboard accessible Navigable	2.1.1 Keyboard – A 2.1.2. No Keyboard Trap – A 2.1.3 Keyboard (no exception) – AAA	Ensure when possible, content can be operated through a keyboard interface Content does not "trap" keyboard focus within subsections of content Ensure that **all** content is operable from the keyboard
	2.2 Enough time	2.2.1 Timing Adjustable – A 2.2.2 Pause, Stop, Hide – A 2.2.3 No Timing - AAA 2.2.4 Interruptions – AAA 2.2.5 Re-authenticating – AAA	Users are given adequate time to interact with Web content whenever possible Avoid distracting users during their interaction with a Web page Minimize the occurrence of content that requires timed interaction Allow users to turn off updates from the author/server except in emergencies Allow all users to complete authenticated transactions that have inactivity time limits
	2.3 Seizures	2.3.1 Three Flashes /Below Threshold – A 2.3.2 Three Flashes – AAA	Allow accessing the full content of a site without inducing seizures due to photosensitivity Eliminating all 3-per-second flashing to reduce the risk of seizures
	2.4 Navigable	2.4.1 Bypass Blocks – A 2.4.2 Page Titled – A 2.4.3 Focus Order – A 2.4.4 Link Purpose – A 2.4.5 Multiple Ways – AA 2.4.6 Heading and Labels – AA 2.4.7 Focus Visible – AA 2.4.8 Location – AAA 2.4.9 Link Purpose – AAA 2.4.10 Section Headings – AAA	Promote more direct access to the primary content of the Web page Ensuring that each Web page has a descriptive title Navigate documents sequentially with logical and sequential reading order. Understand the purpose of each link so they can decide if they want to follow the link Locate content in a manner that best meets their needs (comprehensive or easy way) Understand how information is organized (Web-page headings clear and descriptive) Help a person know which element has the keyboard focus Provide a way for user orientation in Webpages and find related information Understand the purpose of each link in the content, to decide if they want to follow it Provide headings for sections of a Web page, when the page is organized into sections
Understandable	3.1 Readable	3.1.1 Language of Page – A 3.1.2 Language of Parts – AA 3.1.3 Unusual Words – AAA 3.1.4 Abbreviations – AAA 3.1.5 Reading Level – AAA 3.1.6 Pronunciation – AAA	User agents/assistive technologies present text and other linguistic content correctly User agents/ assistive tech can correctly present content written in multiple languages Understand nonliteral word usage and specialized (scientific) words. Ensure that users can access the expanded form of abbreviations Additional content is available to aid the understanding of a difficult/complex text Understand content in cases where meaning depends on pronunciation.
	3.2 Predictable	3.2.1 On Focus – A 3.2.2 On Input – A 3.2.3 Consistent Navigation – AA 3.2.4 Consistent Identification – AA 3.2.5 Change on Request – AAA	Functionality is predictably reducing the chance of changing context unexpectedly Ensure that entering data or selecting a form of control has predictable effects Consistent presentation and layout so users can easily find information Ensure consistent identification of functional components that appear repeatedly Eliminate potential confusion that may be caused by unexpected changes of context
	3.3 Input assistance	3.3.1 Error Identification – A 3.3.2 Labels or Instructions – A 3.3.3 Error Suggestion – AA 3.3.4 Error Prevention (Legal) – AA 3.3.5 Help – AAA 3.3.6 Error Prevention (All) – AAA	Ensure that users are aware that an error has occurred and can determine what is wrong Instructions or labels that identify controls in a form to know what input data is expected Users receive appropriate suggestions for correction of an input error if it is possible Avoid serious consequences as the result of a mistake of an action that cannot be reversed Help users avoid making mistakes (Assistance for text input) Avoid consequences that may result from making a mistake when submitting all form data
Robust	4.1 Compatible	4.1.1 Parsing – A 4.1.2 Name, Role, Value – A	User agents, including assistive technologies, can accurately interpret and parse the content The role, state, and value information on all user interface components enables compatibility with assistive technology

Source: Adopted from (W3C, 2018a) and (W3C, 2016b)

For a better understanding of how Web accessibility and WCAG 2.0 criteria affect the different types of disabilities, table 7 was created. With the help of this table, it is possible to understand what types of disabilities are affected by each success criterion. The different segments of the accessible tourism market were aligned with WCAG 2.0. As stated in the literature review about the accessible tourism market, the segmentation proposed by Buhalis and Darcy (Buhalis & Darcy, 2011:38) was adopted.

Success criteria can focus on diverse kinds of disabilities, but with different intensities. Therefore, three different types of effects are proposed. Each effect has a different symbol: + corresponds to a low effect; ++ corresponds to a medium effect and +++ resembles a high effect of the conformance level on the type of disability. The allocation of the three levels of effects was made with the help of the descriptions of each success criterion, provided by W3C (W3C, 2016b). For example, success criteria 2.1.1-Keyboard with conformance level A has a high effect on mobility impairments, a medium effect in cognitive impairments, and low effect among people with visual impairments.

By carefully studying table 7, it is possible to verify that Web accessibility affects especially people with visual, hearing, cognitive and neurotically impairments, and some mobility disabilities. This confirms the findings by Shi (2006). In addition, Elder/Seniors tourists are affected by almost every single success criterion, making this a critical segment for the promotion of accessible tourism.

Table 7- The impact of WCAG 2.0 guidelines and success criteria on the different accessible tourism market segments

WCGA 2.0			Accessible Tourism Market segments						
Principles	**Guidelines**	**Success criteria – Conformance level**	**Mobility Impairment**	**Blind/Visual Impairment**	**Deaf/Hearing Impairment**	**Speech Impairment**	**Cognitive Impairments**	**Hidden Impairments**	**Elderly/ Seniors**
Perceivable	1.1 Text alternatives	1.1.1 Non-text Content –A		+++	+++				
	1.2 Time-based media	1.2.1 Audio and Video Only – A		+++	++		++		+
		1.2.2 Captions – A			+++				+
		1.2.3 Audio Description or Media – A		+++			+		+
		1.2.4 Captions (live) – AA			+++				++
		1.2.5 Audio Description – AA		+++			++		
		1.2.6 Sign Language – AAA			+++	++			
		1.2.7 Extended Audio Description – AA		+++					
		1.2.8 Media Alternative – AAA		++	++				
		1.2.9 Audio Only – AAA			+++				++
	1.3 Adaptable	1.3.1 Info and Relationships – A		+++	+++		++		++
		1.3.2 Meaningful Sequence – A		++		++	++	++	
		1.3.3 Sensory Characteristics – A		+++			+		+
	1.4 Distinguish able	1.4.1 Use of Colour – A		+++			++		+
		1.4.2 Audio Control – A	+		+++	++			
		1.4.3 Contrast – AA		+++					+
		1.4.4 Resize Text – AA		++					++
		1.4.5 Images of Text – AA		++			++		+
		1.4.6 Contrast – AAA		++					+
		1.4.7 Low or No Background Audio- AAA		+	+++	+			+
		1.4.8 Visual Presentation – AAA		++			+++		
		1.4.9 Images of Text (no exception) – AAA		+++			++		+
Operable	2.1 Keyboard accessible Navigable	2.1.1 Keyboard – A	+++	+			++		
		2.1.2. No Keyboard Trap – A	++	++					+
		2.1.3 Keyboard (no exception) - AAA	+++	+			+		+
	2.2 Enough time	2.2.1 Timing Adjustable – A	+++	++	++	+	++	+	+
		2.2.2 Pause, Stop, Hide – A		+++			+++		++
		2.2.3 No Timing - AAA	++	+			++		
		2.2.4 Interruptions – AAA		+			+++		+
		2.2.5 Re-authenticating – AAA	++	+	+		++		+

Continues in the next page

WCGA 2.0			Accessible Tourism Market segments						
Principles	**Guidelines**	**Success criteria – Conformance level**	**Mobility Impairment**	**Blind/Visual Impairment**	**Deaf/Hearing Impairment**	**Speech Impairment**	**Cognitive Impairments**	**Hidden Impairments**	**Elderly/ Seniors**
Operable	2.3 Seizures	2.3.1 Three Flashes or Below Threshold – A					+	+++	+
		2.3.2 Three Flashes – AAA					+	+++	+
	2.4 Navigable	2.4.1 Bypass Blocks – A		+	+		++	+	+
		2.4.2 Page Titled – A	++	++			+		++
		2.4.3 Focus Order – A	++	++			+++		+
		2.4.4 Link Purpose – A	+	++			++		
		2.4.5 Multiple Ways – AA	+	++			+++		+++
		2.4.6 Heading and Labels – AA	+	+	+		+++		+
		2.4.7 Focus Visible – AA	++				++		
		2.4.8 Location – AAA	++				+++		
		2.4.9 Link Purpose – AAA	++	+			++		
		2.4.10 Section Headings – AAA	+	++			+++		+
Understandable	3.1 Readable	3.1.1 Language of Page – A	++	+++	+++		++	++	+
		3.1.2 Language of Parts – AA	++	+++	+++		++	++	+
		3.1.3 Unusual Words – AAA				++	+++		++
		3.1.4 Abbreviations – AAA		+	+		+++		+
		3.1.5 Reading Level – AAA					+++		+
		3.1.6 Pronunciation – AAA		++		++	+++		
	3.2 Predictable	3.2.1 On Focus – A	++	++			++		+
		3.2.2 On Input – A		++			++		+
		3.2.3 Consistent Navigation – AA		++			+++		++
		3.2.4 Consistent Identification – AA		+			++		
		3.2.5 Change on Request – AAA		++			+++		+
	3.3 Input Assistance	3.3.1 Error Identification – A		++	++		+++		+
		3.3.2 Labels or Instructions – A	+	+	+	+	+++		+++
		3.3.3 Error Suggestion – AA	+	+	+		++		+
		3.3.4 Error Prevention (Legal) – AA	+	+	+	+	+++		++
		3.3.5 Help – AAA					+++		++
		3.3.6 Error Prevention (All) – AAA	+	+	+		+++		++
Robust	4.1 Compatible	4.1.1 Parsing – A	++	++	++	+	++	+	+
		4.1.2 Name, Role, Value – A	++	++	++	+	++	+	+
+ Low Effect / ++ Medium Effect / +++ High Effect									

II.4 Conclusion

The literature review on five main terms: Industry 4.0, ICTs, Smart Tourism, Tourism 4.0 and accessible tourism conducted to a better understanding of how technologies are helping in development of accessible conditions in tourism. Technologies have a crucial role in helping the development of more accessible tourism. The main problem, as studied before, preventing people with different types of disabilities from traveling, is mainly related to the shortage of information (Stumbo & Pegg, 2005), which justifies the importance of ICTs in this context. With the information displayed, the decision to travel becomes more comfortable, since there is a notion of what requirements are fulfilled.

The accessible market is rising, mostly because disable tourists are starting to become a very relevant group of consumers. But despite this fact, many stakeholders in the tourism industry are not ready for the new wave of accessible tourism. Technologies can be the key to adaptation to a new reality. There are several uses of technologies that can help diverse tourism objects becoming more accessible. With the fourth industrial revolution, technology is exceeding all expectations, making society evolve in many sectors, providing better life-conditions, especially for those with some type of impairment. Ensuring that tourism is accessible is very important from an economic point of view but is also crucial for achieving a more inclusive society. Smart Tourism and Tourism 4.0 are responsible for eliminating barriers in speaking, traveling, reading and writing, problems that disabled tourists encounter when traveling. It can also enable them to participate and enjoy the benefits of the digital touristic world with equal access to information. And, perhaps most importantly, new technologies can enable disabled tourists to act more independently, providing the conditions to maximize the leisure activities that tourism provides.

Accessible@Tourism 4.0 is the answer to the technological impact in accessible tourism, by reason of the fourth industrial revolution significant contribution, in promoting this kind of tourism. Now, the study must focus on the second research gap and conceptualize the Web application. The first research method for identifying the requirements was this theoretical background chapter.

II.4.1 Requirements for building the *AccessTour@WebApp*

With the help of the theoretical background of this dissertation, some requirements for the building the Web Application for support information management in the context of accessible tourism were identified. The key finding of each analyzed literature topic provided ideas for possible requirements for the web application. Many of the requirements reflect the literature review on technologies improving accessible tourism. Since ICTs were identified as leading technologies for accessible tourism, the requirements intend to demonstrate the need for connectivity.

Table 8 presents some ideas that can potentially be implemented in the intended Web Application for accessible tourism. In fact, As the lack of information was described as a considerable barrier to accessible tourism, these requirements validate the importance of technologies that can spread information and enable communication.

Much of the examined literature referred to the importance of the Web platforms to be built according to the WCAG principles. With that in mind, a posteriors practical study will be presented where these set of principles will be the main focus. W3C guidelines are crucial to ensure the accessibility of Web platforms, and with their help, more requirements and functionalities can be identified and explored.

Table 8- Requirements retrieved from the literature review

Requirements for the *AccessTour@WebApp*
• Allow users to state their accessibility requirements or special need • Display Information regarding accessibility • Allow the building of an individual profile (User profile) • Integrate content from the broadest possible range of reliable sources, addressing the multifaceted needs of a wide range of users • Capable of maintaining tourists' personal data safe. • Allow Interoperability (creating an accessibility path online, for interlinking all of the accessible products and services required) • Have a **Feedback** system so user satisfaction can be evaluated • Designed in a way that is usable by every market segment of accessible tourism • Allow Personalization and adaptation of the system according to the user profile and individual preference • Provide an easy/secure navigation system with structured browsing —Large size, in order to be better viewed and mouse accessible. —Descriptive text on mouse over. —Horizontal and vertical alignment to reach a better understanding of the interface. —The alternative image on mouse over. In this design, the alternative image inducts border and color change. —Alternative mouse pointer on mouse over. Selection pages show a list of alternatives to the user, where one of them must be selected by the user. —Every page containing a selection page also should contain multimedia reproduction. The different steps that compose the task are represented, for example, by pictograms. The function of these pictograms is to provide information in a simpler way to the user. • Use of Vocabulary in the system should be as simple as possible. Special attention to the use of technical and scientific language • Use structured data from other digital platforms so that information can be interlinked. • Match Specified user profiles with the correct type of information regarding accessibility • Designed in a way so it could also work in mobile devices, as a mobile app • Integration with social media. The ability of sharing, collaborating and communicating • Offer GPS features to help people access places and navigate through it • Deliver **real-time information** so people can navigate an unfamiliar environment • Have an option that presents features in black and white, so that color blind people can access their content • Be compatible with the use of assistive technologies. Users may require the help of the technologies to interact with Web systems. • Present Standard content in sign language • Allow users to ask questions/receive answers in sign language (through video chats with tourism information consultants using sign language). • Support different types of language (at least Portuguese, English, and Spanish) • Allow non-disabled people to be part of the touristic experience and help disabled tourists enjoy most of the touristic activities

In conclusion remark, the theoretical background proved that tourism is changing due to the new technologies. One of the most powerful impacts of this technological revolution will be in the market of accessible tourism. Every day, society experiences the birth of new technologies, that can contribute to making tourism accessible for all. As verified with Tourism 4.0, a more technological tourism might be the answer to providing better accessibility conditions in tourism, especially for disabled tourists

CHAPTER III

Practical Studies: Requirements Elicitation and Conceptualization of a Web Application for Accessible Tourism

III.1 A study about Website accessibility of Portuguese Hotels

III.1.1 Introduction to the study

The literature review demonstrated different problems associated with accessible tourism and how technologies can provide significant help in improving it. In accessible tourism, information and access to it are crucial factors. Technologies that allow the sharing of data and dissemination of information have an essential role. In order to collect more requirements for the construction of the *AccessTour@WebApp*, it is vital to analyze Web accessibility of online platforms like websites, that provide relevant information for tourists. This is the case of hotels' websites, as they have a crucial role in providing good accommodation experiences. The content of these websites and the way they are presented to tourists should be accessible to everyone. Tourist with disabilities should have no problem in gathering information or booking a room. The analyze of the accessibility of hotels websites provided major user requirements of the Web application.

This study aims to analyze the website accessibility of hotels and *Pousadas de Portugal*, located in the central region of Portugal. The websites were analyzed using the Web Content Accessibility Guidelines (WCAG) 2.0. The evaluating tools used were AccessMonitor and "Test de Accesibilidad Web" (TAW). Both of these tools are automatic and available online. The study was made in accordance with all three conformance levels (A/AA/AAA). The main goal with the realization of this study was to gather up some requirements for the construction of the intended Web application for accessible tourism. In the results and discussion part, the main problems affecting disabled users on the websites will be presented. With the main issues identified, requirements that eliminate accessibility barriers can be identified. Also, the study provided some insight into how Web accessibility varies, according to the category of the hotels.

III.1.1.1 The role of hotels and their websites on accessible tourism

Hotels can be considered the backbone of the travel industry, as the quality of accommodations has a significant influence on tourism experiences. Choi and Chu (2001), identified seven hotel factors essential to traveler: (i)staff service quality; (ii) room quality; (iii) general amenities; (iv) business services; (v) value; (vi) security, and (vii)facilities. A bad experience at any of these factors may reflect in a bad overall tourism experience. To accessible tourism, these factors represent dimensions that one must consider, while addressing satisfaction levels and the influence of satisfaction on the probability of returning.

The selection of hotels or other kind of tourism accommodation has a central role in the planning phase of a tourism trip. The booking of accommodation is particularly essential for disabled tourists because they need to assure that the accommodation meets their particular needs. Information about adapted bathrooms, the presence of elevators or sign language support are some example of meaningful information for tourists.

Information is one of the main barriers in purchasing touristic products, and the offer of personalized solutions is critical for unlocking the potential of accessible tourism.

Tourism 4.0 brings significant technological improvements like analyze tools, and that can be used to monitor clients' needs and improve satisfaction by offering personalized solutions in hotels (Xiang, Schwartz, Gerdes, & Uysal, 2015). On the other hand, websites continue to be one of the primary sources of information, when tourists fell the need for searching for more details. Traditional touristic products such as air tickets, car rental, and **lodging** continue to dominate the online travel market (Xiang, Magnini, & Fesenmaier, 2015). This is why it is so crucial to ensure accessibility in hotels and other tourism products websites.

III.1.2 Methodology

III.1.2.1 Data collection

For the analysis of accessibility level of hotels websites, a multistage procedure was adopted. First, the National Register of Touristic Enterprises (RNET) database, from the National Registry of tourism of Portugal (https://rnt.turismodeportugal.pt) was consulted to identify Portuguese hotels and *Pousadas de Portugal*. The database reported 1678 enterprises all over Portugal. Of all cases, 394 (around 23,5% of the total) are located in the Central region of Portugal. Secondly, only the data related to hotels and *Pousadas de Portugal* in the Central region was transported to an Excel database. Further, in order to complete the missing information in terms of Web address, a search on google was done.

From the 394 websites, 23 (5.8%) were not evaluated because the reported website did not work and official websites were not found, 25 (6.3%) did not report any website and were also excluded, and 2 (0.5%) others were discarded due to only present Facebook pages. A total of 50 websites were not evaluated. The research displayed that **344 websites** (87.3%) did not have any problems and were evaluated.

III.1.2.2 Data analysis method

To analyze the website accessibility of hotels located in the central region of Portugal, first, it was imperative to select the adequate tools to do the study. W3C specifies a list of 122 possible tools (W3C, 2019). Moreover, other tools were identified in the literature review related to the topic of websites accessibility (Vila et al., 2018; Mohd Isa, 2011). After searching and identify several tools, two were select to proceed with the practical study. AccessMonitor (http://www.acessibilidade.gov.pt/accessmonitor/) and “Test de Accesibilidad Web” (TAW) (https://www.tawdis.net/) were selected to analyze Web accessibility of hotels’ websites. These tools were selected because they contain wanted features, and both are online free solutions.

TAW is an automatic online tool that evaluates the accessibility in the design and development of web pages, using WCAG 2.0 success criteria as the reference. The results presented are divided into three categories: “problems” (corrections are needed), “warnings” (human review is necessary) and “not reviewed” (a fully manual review is necessary). Only problems and warnings were exhibited in this study. “Not reviewed“ category was also analyzed, but as given that this type of problems involves a manual review and the results obtained are practically the same results for every website, the results will not be presented in this report. The analyze to the success criteria, with this tool was made using A/AA/AAA conformance levels. This allows us to understand if a website meets all priority 1, 2 and 3 checkpoints from WCAG 2.0. By evaluating according to WCAG 2.0 principles godliness and success criteria, is easy to realize if websites apply or not some guidelines, and where critical mistakes are located.

Access Monitor can be described as an automatic validator which verifies the application of the accessibility guidelines on the contents of a website. The content is evaluated according to the WCAG 2.0 three conformance levels (A/AA/AAA), but it doesn't present problems according to the success criteria of WCAG 2.0. This tool was developed by the Foundation for Science and technology of Portugal. Access Monitor also presents a global index of each website, that ranges from 1 (very poor) to 10 (excellent Web accessibility practices).

SPSS software was used to analyze the data. First, descriptive analysis (mean, standard deviation) was used to characterize the sample and to examine the Web accessibility. Second, to compare the level of Web accessibility of hotels analyzed, according to their category, ANOVA and Kruskal-Wallis were used. When the assumptions of ANOVA (homogeneity and normality) were not met, the Kruskal-Wallis test was used.

III.1.3 Descriptive Analysis

Only hotels and *Pousadas* located in the central region of Portugal were analyzed. According to figure 7, most of the websites (about 55.5%) were from hotels located across the coastline, while 13.6% of hotels analyzed are located in more interior zones (*Beira Baixa* e *Serra da Estrela*).

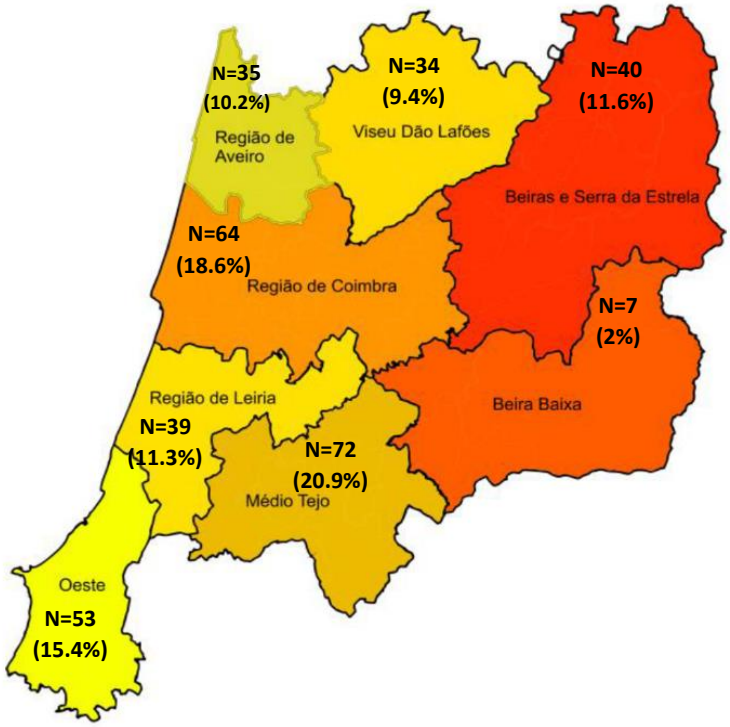

Figure 7- Sample of Hotels websites in the central region of Portugal

In terms of profile, the 344 hotels and *Pousadas* have different characteristics. Table 9 highlights that differences, by showing some overall descriptions of the hotels, in which the website accessibility was analyzed. Most of the websites analyzed belonged to hotels (94.2%), but only 10 of these hotels were classified with five stars. The services offered may also influence Web accessibility, due to descriptions of accessible conditions of these services. Also, very few hotels obtained quality and environmental certifications. However, it is important to highlight that these two types of certification are not related to accessibility conditions.

Table 9- Sample profile of the analyzed hotels

Description		Frequency (N)	Percentage (%)
Type of accommodation	Hotel	324	94.2
	Hotel Apartment	11	3.2
	Inn	9	2.6
Category	5 Stars	10	2.9
	4 stars	103	29.9
	3 stars	141	41.0
	2 stars	70	20.3
	1 star	11	3.2
	Inn	9	2.6
Closing Period	Yes	50	14.5
	No	294	85.5
Touristic Utility	Yes	51	14.8
	No	293	85.2
Offered Services	Meeting Room	192	55.8
	SPA	61	17.7
	Outside Pool	99	28.8
	Inside Pool	63	18.3
	Tennis Court	35	10.2
	Gym	53	15.4
	Golf Court	8	2.3
Certification	Quality	28	8.1
	Environmental	21	6.1

The number of rooms specially equipped for mobility impaired persons was very low. Around 23% of all hotels don`t offer any accessible rooms, and around 57% only display one single room for PwD. The maximum of accessible rooms in a single hotel is 38, and the overall mean is 1.27 special adapted rooms per hotel.

III.1.4 Web Accessibility Analysis

Results of the AccessMonitor

AccessMonitor allows the identification of problems on the website content. The problems are related to the three types of conformance level of WCAG 2.0 (A, AA and AAA). Although Access Monitor does not evaluate sites according to the success criteria of WCAG 2.0, the identification of components with problems Provides important information related to the accessibility level of the websites analyzed and concerning the type of actions that can be implemented to improve the accessibility level of these websites.

The results presented in tables 10 and 11 were obtained with AccessMonitor. The global index varies between 3 and 8.3, with a mean of 5.1. A total of 3041 failures in content components were detected. 2196 failures of type A, 369 failures of type AA and 476 of type AAA were identified. Errors of type A are the most critical but also the most frequent with a mean of 6.38 per website. Results demonstrated that every site has

at least one error of the type A. This means that none of the analyzed websites fulfills the minimum accessibility aspects.

Table 10- Global Index and errors in Web accessibility of hotels websites

AccessMonitor	Min	Max	Mean	Std. Dev.
Global Index	3	8.3	5.08	1.017
Errors type A	1	15	6.38	2.679
Errors type AA	0	3	1.07	0.869
Errors type AAA	0	4	1.38	0.818
Total errors (A + AA + AAA)	2	18	8.84	3.338

Note: *Std. Dev* – standard deviation

Components of websites with higher type A errors are most critical since, this level guarantees that basic accessibility needs are attended. Additionally, Access Monitor only evaluates the content available. The lack of certain crucial content may also provide accessibility difficulties to PwD

In summary, most problems were related to: (i) links to surpass information blocks (537 errors of type A and 2 of type AA); (ii) forms marking (412 errors of type A); (iii) links, menus and links' text marking (202 errors of type A, 19 of type AA and 259 of type AAA) and also (iv) alternative to texts in images (164 errors of type A).

Table 11 offers a closer look at the global index, obtained with AccessMonitor. The results show that the most significant number of hotels websites were classified as regular practices. Only a few were classified as very good practices (1.2 % of the total websites analyzed). There are no websites classified as with excellent practices.

Table 11- Access Monitor Global Index of accessibility on the analyzed websites

Web accessibility practices	Global Index Value	N	%
Very bad practices	[0,2[	0	0
Bad practices	[2,4[	43	12.5
Regular practices	[4,6[	233	67.7
Good practices	[6,8[	64	18.6
Very Good practices	[8,9[	4	1.2
Excellent Practices	[9,10]	0	0

Results of TAW

Table 12 demonstrates the results obtained in the **problems** related category. A total of 27251 problems were detected. Guidelines (1.4) Distinguishable and (2.3) Seizures didn't register any problems. The understandable principle is the one with less detected problems, with a mean of 7.1 per website and a standard deviation of 10.5. The most significant share of problems belongs to Perceivable guidelines, where there were websites with 1250 problems and where the mean is 30.6 per website with a standard deviation of 72.3.

Table 12- Problems Identified with TAW

Principles and Guidelines		Problems Detected	Min	Max	Mean	Std. Dev.
Perceivable	1.1 Text alternatives	5467	0	229	15.89	22.346
	1.2 Time-based media	4	0	2	0.01	0.152
	1.3 Adaptable	5045	0	1021	14.66	56.647
	1.4 Distinguishable	0	0	0	0	0
	Total Perceivable	10516	0	1250	30.56	72.343
Operable	2.1 Keyboard accessible Navigable	474	0	51	1.38	4.994
	2.2 Enough time	7	0	3	0.02	0.222
	2.3 Seizures	0	0	0	0	0
	2.4 Navigable	6619	0	1040	19.20	58.203
	Total Operable	7100	0	1091	20.60	61.383
Understandable	3.1 Readable	160	0	3	0.47	0.533
	3.2 Predictable	109	0	7	0.32	0.749
	3.3 Input assistance	2167	0	104	6.30	10.287
	Total Understandable	2436	0	104	7.08	10.528
Robust	4.1 Compatible	7199	0	235	20.89	32.693
	Total Robust	7199	0	235	20.89	32.693

Note: *Std. Dev* – standard deviation

A closer look at the problems provided by TAW allowed the identification of the most critical WCAG 2.0 guidelines. The guidelines with most problems detected were (1.1) Text alternatives, (1.3) Adaptable, (2.4) Navigable, (3.3) Input assistant, and (4.1) Compatible.

A more in-depth analysis (attachment 1) detailed which success criteria have more incidents in each one of these guidelines. Inside 1.1 Text Alternatives, in success criteria 1.1.1 - Non-text Content - were detected 5467 problems. In (1.3) Adaptable, 1.3.1-Info and relationships - accused 5045 problems. Guideline (2.4) Navigable registered 3132 problems in 2.4.4-Link Purpose. In (3.3) Input assistance, most incidents were related to 3.3.2-Labels or Instructions - with 2165 problems. The final critical guideline (4.1) Compatible registered in success criteria 4.1.1-Parsing - a total of 4785 problems.

A study elaborated by Vila et al. (2018) on official tourism organizations websites also observed most problems in Perceivable principles. In the case of this study in hotels website, beyond Perceivable, Robust also shows a high number of problems.

Table 13 illustrates the results obtained in the **warnings** category. A total of 80099 warnings were detected. Enough Time (2.2), Seizures (2.3) and Readable (3.1) guidelines didn't register any warnings. It also should be pointed out that every website has at least one warning in guideline Navigable (2.4). The Understandable principle is the ones with less detected warnings, with a mean of 18.1 per website and a standard deviation of 19.7. The most significant share of warnings belongs to Perceivable guidelines, where there were websites with 2155 warnings and with a mean of 94.9 warnings per website with a standard deviation of 152.2.

Table 13- Warnings Identified with TAW

Principles and Guidelines		Warnings Detected	Min	Max	Mean	Std. Dev.
Perceivable	1.1 Text alternatives	6682	0	163	19.32	20.147
	1.2 Time-based media	217	0	54	0.63	5.025
	1.3 Adaptable	13107	0	315	38.05	46.162
	1.4 Distinguishable	12737	0	1976	36.93	116.417
	Total Perceivable	32743	0	2155	94.92	152.188
Operable	2.1 Keyboard accessible Navigable	474	0	51	1.38	4.994
	2.2 Enough time	0	0	0	0	0
	2.3 Seizures	0	0	0	0	0
	2.4 Navigable	12907	1	2324	37.48	127.122
	Total Operable	13381	1	2375	38.86	130.145
Understandable	3.1 Readable	0	0	0	0	0
	3.2 Predictable	3150	0	124	9.10	15.088
	3.3 Input assistance	3096	0	40	9.00	9.101
	Total Understandable	6246	0	133	18.10	19.693
Robust	4.1 Compatible	27729	0	1457	78.81	158.944
	Total Robust	27729	0	1457	78.81	158.944

Note: *Std. Dev* – standard deviation

The guidelines with most warnings detected were: Text alternatives (1.1), Adaptable (1.3), Distinguishable (1.4), Navigable (2.4), and Compatible (4.1).

A more in-depth analysis (attachment 2) allowed to detail success criteria with more incidents, contributing to the high share of warnings in each one of these guidelines. Text Alternatives (1.1) registered most of the incidents in success criteria 1.1.1 - Non-text Content - with 6682 warnings identified. Guideline (1.3) Adaptable had two success criterions accountable for the high number of warnings. 1.3.1-Info and Relationships - registered 5581 warnings and 1.3.2 - Meaningful Sequence - had 7526 warnings. In (1.4) Distinguishable, most incidents were related to 1.4.4 - Resize Text - with 12540 warnings identified. Guideline (2.4) Navigable registered 2053 warnings in 2.4.3 - Focus Order and 6790 warnings in 2.4.6 - Heading and Labels. The final critical guideline (4.1) Compatible registered in success criteria 4.1.1 - Parsing - 27729 warnings.

With the help of table 6 and table 7, presented in chapter II, it is possible to understand what segments of the accessibility market are affected by the identified problems and warnings. Most of the errors in success criteria are related to the conformance level number A, which means the minimum Web accessibility requirements are not respected, by the majority of the analyzed websites.

The failures identified in **Perceivable** were related to 1.1.1 - Non-text Content, 1.3.1 - Info and Relationships, 1.3.2 - Meaningful Sequence - and 1.4.4 - Resize Text. The incidents on these success criteria tend to affect, especially blind or visual impaired people. The lack of audio alternatives or color change are the main obstacles in assuring Web accessibility for people with visual problems. Older adults might also find difficulties in visual problems related to advanced age. Text without size options was verified in many websites, which constitutes the main problem for older adults that have either myopia or astigmatism.

In **Operable** part, problems were mainly related to guideline (2.4) Navigable, especially 2.4.4 - Link Purpose- 2.4.3 - Focus Order - and 2.4.6 - Heading and Labels. This affects mobility and visually impaired people but

also people with cognitive deficits. The lack of clear titles and mouse and keyboard focus still represent barriers for accessing information on hotels websites. On an important note, 2.3 – Seizures - didn't register any problems or warnings. This may be related to the fact that no issues were found, or the guideline could not be evaluated. The success criteria for this guideline is related to photo sensibility and affects people with hidden impairments, such as epilepsy. The websites did not display flashing lights or any other type of content that could trigger seizures for people with epilepsy. Therefore, due to the lack of this type of content, TAW did not detect any issue.

The **Understandable** principle was the one with fewer warnings and problems identified. However, the lack of labels and explanation on websites (3.3.2 – Labels or Instructions) represents a factor that should be corrected, to improve web accessibility. Besides that, this failure affects all types of disabled tourists excepts for the ones with hidden impairments.

The failures in the **Robust** principle were related to the most website not being ready for assistive technologies. Many disabled people rely on assistive technologies to access websites. If websites are not compatible or do not allow the use of these technologies, then it becomes inaccessible for many disabled people. The errors related to guideline 4.1 – Compatible and specifically 4.1.1 – Parsing - affect all type of disabled tourists, so they should be corrected with maximum urgency.

III.1.5 Differences in website accessibility according to hotel category

For better understanding Web accessibility across the hotel industry, the hotels were divided into 3 groups (table 14). This will allow comparisons between different websites.

Table 14- Division of the Hotels analyzed according to their categories

Groups		N	%
Group 1 – Low-class Hotels	1 and 2-Stars Hotels	81	23.5
Group 2 – Middle-class Hotels	3-Stars Hotels	141	41
Group 3 - High-class Hotels	4 and 5-Stars hotels and *Pousadas*	122	35.5

Table 15 presents an overview of the Global Index and the different errors identified with Accessible Monitor and compares the different means across the diverse categories of hotels.

Table 15- Evaluating Web accessibility of Hotels using AccessMonitor

Global Index and Errors	Total Sample (N= 344)	Low-class Hotels (N= 81)	Middle-class Hotels (N= 141)	High-class Hotels (N= 122)	ANOVA		Kruskal-Wallis	
	Mean	Mean	Mean	Mean	*F-value*	*p-value*	*χ2*	*p--value*
Global Index	5.085	5.4272[b]	5.1638[b]	4.7656[a]	11.703	0.000		
Errors type A	6.380	5.680	6.080	7.200			13.115	0.001
Errors type AA	1.070	0.900	1.040	1.230			6.160	0.046
Errors type AAA	1.380	1.14[a]	1.4[b]	1.52[b]	5.731	0.004		
Total errors (A + AA + AAA)	8.840	7.720	8.520	9.960			20.495	0.000

Note: a and b represent homogeneous sub-groups

In terms of categories distribution of the hotels analyzed, hotels classified with fewer stars generally obtained a better global index and fewer errors. Hotels with the highest category verified the lowest global index and more errors in all three types.

There is a clear difference in the global Index between middle- and low-class hotels and high-class hotels. Hotels with the lowest category and medium category offer websites and usually with higher global Index. However, despite this, both are classified as regular practices.

Beyond this, there are also statistical differences verified on the errors of AAA type. Low-class hotels present fewer errors related to the other categories.

Table 16 presents an overview of the Problems identified with TAW, on the W3C guidelines and compares the different means across the diverse categories of hotels.

Table 16- TAW Problems of Web accessibility in Hotels Websites

WCAG 2.0 Principles and Guidelines	Total Sample (N= 344) Mean	Low-class Hotels (N= 81) Mean	Middle-class Hotels (N= 141) Mean	High-class Hotels (N= 122) Mean	ANOVA *F-value*	ANOVA *p-value*	Kruskal-Wallis *χ2*	Kruskal-Wallis *p--value*
1.1 Text alternatives	15.890	10.210	14.090	21.730			20.249	0.000
1.2 Time-based media	0.010	0.000	0.030	0.000			2.888	0.236
1.3 Adaptable	14.660	5.420	12.110	23.750			33.081	0.000
Total Perceivable	30.561	15.630	26.227	45.484			28.116	0,000
2.1 Keyboard accessible Navigable	1.378	0.840	0.943	2.238			5.227	0.073
2.2 Enough time	0.020	0.086	0.000	0.000			9.798	0.007
2.4 Navigable	19.201	8.506	15.298	30.812			39.618	0.000
Total Operable	20.599	9.432	16.241	33.049			32.862	0,000
3.1 Readable	0.465	0.482	0.468	0.451	0.084	0.920		
3.2 Predictable	0.317	0.247	0.220	0.475			14.219	0.001
3.3 Input assistance	6.299	2.568	6.546	8.492			37.224	0.000
Total Understandable	7.081	3.296	7.234	9.418			31.585	0.000
4.1 Compatible	20.890	12.963	16.340	31.410			31.603	0.000
Total Robust	20.890	12.963	16.340	31.410			31.603	0.000

Hotels with higher category displayed more problems in all four guidelines. All three categories presented more problems in the Perceivable type, especially on guideline (1.3) Adaptable. Robust and Operable principles also presented a considerable number of problems in all three categories. The Understandable principle was the one with the lowest number of problems in all three categories. However, the guideline with the lowest number of problems was (1.2) Time-based Media. This is probably due to the fact that not many websites the content didn't present content with this feature.

The better results were again obtained by websites belonging to hotels with the lowest category. The websites of hotels with lower category had the lowest number of problems identified in all four principles and almost every guideline except for (2.2) Enough time, (3.1) Readable and (3.2) Predictable.
Table 17 presents an overview of the Warnings identified with TAW, on the W3C guidelines and compares the different means across the three categories of hotels.

Table 17- TAW warnings of Web accessibility in hotels websites

WCAG 2.0 Principles and Guidelines	Total Sample (N= 344) Mean	Low-class Hotels (N= 81) Mean	Middle-class Hotels (N= 141) Mean	High-class Hotels (N= 122) Mean	ANOVA *F-value*	*p-value*	Kruskal-Wallis *χ2*	*p--value*
1.1 Text alternatives	19.317	11.321	17.426	26.812			20.249	0.000
1.2 Time-based media	0.631	0.333	0.5177	0.959	0.436	0.647		
1.3 Adaptable	38.047	27.951	35.972	47.148			33.081	0.000
1.4 Distinguishable	36.930	23.963	28.305	55.508			28.116	0.000
Total Perceivable	94,924	63.568	82.220	130.426			5.227	0.073
2.1 Keyboard accessible Navigable	1.378	0.840	0.943	2.238			9.798	0.007
2.4 Navigable	37.483	17.037	28.504	61.434			39.618	0.000
Total Operable	38.861	17.877	29.447	63.672			32.862	0.000
3.2 Predictable	9.105	5.5432[a]	8.2837[ab]	12.418[b]	5.551	0.004		
3.3 Input assistance	9.000	4.6667[a]	9.0142[b]	11.8607[c]	16.591	0.000		
Total Understandable	18.105	10.2099[a]	17.2979[b]	24.2787[c]	13.547	0.000		
4.1 Compatible	78.811	60.272	106.582	59.025			31.603	0.000
Total Robust	78.811	60.272	106.582	59.025			31.603	0.000

Note: a, b, ab and c represent homogeneous sub-groups

The number of warnings in every category is more significant than the number of problems identified. The better results regarding Web accessibility of websites were once again obtained by websites oh hotels with the lowest categories. Hotels with higher category displayed low website accessibility by presenting more warnings. The exception is in the Robust principle where hotels with 3 stars had more warnings with particular impact on guideline (4.1) Compatible. Hotels with one or two stars and high category hotels observed more warnings in Perceivable principle. However, in the case of low category hotels, guideline (4.1) Compatible listed more warnings. The hotels with higher category observed a vast number of warnings in guideline (2.4) Navigable.

Robust and Perceivable principles were the ones with the most prominent rate of warnings. Understandable principle was the principle with the lowest number of identified warnings, but in this principle, there were significative statistical differences verified. Their differences were mostly detected in (3.3) Input assistance and the Total Understandable, where the results are considered statistical different in all the three categories.

In all three cases (Access monitor, TAW problems and TAW warnings), the best results were obtained by low category hotels. The study reflects the reality of Web accessibility in the accommodation industry, in the central region of Portugal. However, the reason for these results is not apparent. There can be many causes for the accessibility results to be divergent.

One of the reasons may be the fact that accessibility tourism market is mostly ignored. There are few attempts from hotels to captivate and attract disabled tourists, and that is reflected on the lack of accessibility contents on websites.

Another reason for the high percentage of incidents in websites, belonging to hotels of a higher class is related to the quantity of information available. The websites of high-class hotels usually display more information than the websites belonging to low and medium classes hotels. The more information provided, the more content is evaluated, which can cause more errors to be detected.

III.1.6 Requirements for building the *AccessTour@WebApp*

With the help of techniques proposed by W3C (W3C, 2016a), guidance for meeting WCAG 2.0 success criteria was possible to be obtained. W3C proposes some informative but not required websites' techniques that ensure website accessibility. W3C highlights that the displayed techniques are not mandatory in other to fulfill the success criteria, as they are just proposals that can be adopted. The techniques are divided into groups, which are composed of letters and numbers. Each technique has a letter or letters that identify the group and the corresponding number. The groups are G (general techniques); H (HTML and XHTML Techniques); C (CSS (Cascading Style Sheets) Techniques); SCR (Client-side Scripting Techniques); SVR (Server-side Scripting Techniques); SM (SMIL (Synchronized Multimedia Integration Language)Techniques); T (Plain Text Techniques); ARIA (ARIA Techniques); FLASH (Flash Techniques); SL (Silverlight Techniques); PDF (PDF Techniques) and F (Common Failures). Table 18 presents an overview of the success criteria with the problems and warnings identified in this research study, and W3C proposed techniques to surpass these failures.

Some of the techniques improving critical success criteria can be converted into requirements for the *AccessTour@WebApp*. W3C Techniques that can be applied to the context of Web application were selected and successfully originated ideas for guidelines and requirements that improve Web accessibility. With this study, only non-functional requirements were obtained due to the use of automatic evaluation tools. The obtained requirements are related not to the system functionalities but ensuring that the system is accessible to every user. The list of potential ideas of requirements is presented in table 19.

Table 18- Critical success criteria and WCAG 2.0 techniques to ensure website accessibility

Success criteria- Conformance level	WCAG 2.0 Techniques	Description of the Technique
1.1.1 Non-text Content –A	G94	Providing short text alternative for non-text content that serves the same purpose and presents the same information as the non-text content
	G95	Providing short text alternatives that provide a brief description of the non-text content
	G82	Providing a text alternative that identifies the purpose of the non-text content
1.3.1 Info and Relationships – A	ARIA20	Using the region role to identify a region of the page
	G115	Using semantic elements to markup structure
	H49	Use semantic markup to emphasize special text
	G117	Using text to convey information
	FLASH8	Adding a group name to the accessible name of a form control
1.3.2 Meaningful Sequence – A	G57	Ordering the content in a meaningful sequence
	H34	Using a Unicode right-to-left mark (RLM) or left-to-right mark (LRM) to mix text direction inline
	C27	Content in the source code is the same as the visual presentation of the content
	FLASH15	Using the tabIndex property to specify a logical reading
	PDF3	Ensuring correct tab and reading order in PDF documents
	SL34	Using the Silverlight Default Tab Sequence
1.4.4 Resize Text – AA	G142	Using a technology that has commonly available user agents that support zoom
	G178	Providing controls on the Web page that allow users to incrementally change the size of all text on the page up to 200 percent
	G179	Ensuring that there is no loss of content or functionality when the text resizes, and text containers do not change their width
	SL22	Supporting Browser Zoom
	SL23	Using A Style Switcher to Increase Font Size
2.4.3 Focus Order – A	G59	Placing the interactive elements in an order that follows sequences and relationships within the content
	H4	Creating a logical tab order through links, form controls, and objects
	SCR26	Inserting dynamic content
2.4.4 Link Purpose – A	G91	Providing link text that describes the purpose of a link
	H24	Providing text alternatives for the area elements of image maps
	H30	Providing link text that describes the purpose of a link for anchor elements
	FLASH27	Providing button labels that describe the purpose of a button
	G198	Providing a control near the beginning of the Web page that changes the link text
	G53	Identifying the purpose of a link using link text combined with the text
	H33	Supplementing link text with the title attribute
	G91	Semantically indicating links using one of the following techniques
	PDF11	Providing links and link text using the Link annotation
2.4.6 Heading and Labels – AA	G130	Providing descriptive headings
	G131	Providing descriptive labels
3.3.2 Labels or Instructions – A	G131	Providing descriptive labels
	H44	associate text labels with form controls
	FLASH32	Using auto labeling
	FLASH29	Setting the label property for form components
	FLASH25	Labeling a form control by setting its accessible name
	PDF10	Providing labels for interactive form controls in PDF documents
	SL26	Associate Labels and Targets in Silverlight
	H71	Providing a description for groups of form controls
	FLASH8	Adding a group name to the accessible name of a form control
	H65	Using the title attribute to identify form
	SL8	Displaying Help Text in Silverlight User Interfaces
	G167	Using an adjacent button to label the purpose of a field
4.1.1 Parsing – A	G134	Validating Web pages
	G192	Fully conforming to specifications
	H88	Using HTML according to specifications
	H75	Ensuring that Web pages are well-formed.
	SL33	Define a Silverlight User Interface

Source: Adopted from (W3C, 2016a)

Table 19- Requirements obtained from studying Web accessibility in hotels' websites

Requirements for the *AccessTour@WebApp*
• Provide links to surpass information blocks • Insert links, menus and links' text marking • Provide an alternative to texts in images • Provide a text alternative to content that has no text —text that provides a brief description of the non-text content —Providing text alternatives for image or maps —identify the purpose of the non-text content • Make important information, structure, and relationships available in text —Use semantic markup —Adding the name of a form of control • Resize text without assistive technology and without loss of content or functionality —Supporting Browser Zoom — Using A Style Switcher to Increase Font Size —Ensuring that, when the text resizes there is no loss of content • Provide navigation sequences that don't affect meaning or operation —Place the interactive elements in the correct order of the sequence —Create a logical order —Content should be dynamic • Explain the purpose of every link —Provide text describing links —Provide text describing elements of images containing links —Provide button labels that describe the purpose of the button • Initiate changes in context only by user request —Avoid implement automatic updates —Avoid implement automatic redirects —Only open new windows upon user request • Provide Labels and instructions when user input is required —Implement auto labeling —Set the name of the form control • Modify or delete user-controllable data in data storage systems —Recover deleted information —Provide a checkbox in addition to a submit button —Request confirmation to continue with a selected action — Before submitting allow the user to review and correct answers • Implement content using markup languages —Content with complete start and end tags —Ensuring that Web pages are well-formed —Ensuring that Web pages can be parsed

III.1.7 Conclusion of the Study

The study evaluated the accessibility of 344 websites of hotels and *Pousadas de Portugal* located in the Central Region of Portugal, using two automated tools, AccessMonitor and TAW, which both considered WCAG 2.0. AccessMonitor allowed the identification of website components that should be improved, and TAW identified most Problems and Warnings according to WCAG 2.0 success criteria.

From the sample analyzed, it was possible to retrieve three main conclusions. First, the study revealed that Web accessibility level of the hotels analyzed is low. Second, Perceivable and Robust principles are the most critical, as they displayed the highest mean value of problems and warnings identified. Third, the results revealed differences in Web accessibility according to the category of hotels.

Since Perceivable and Robust principles were identified as most critical, it is crucial to understand which segments of the accessible market are most affected. The accessible issues identified in principle Perceivable tend to affect, especially blind or visual impaired people. The failures in the Robust principle were related to the lack of support for assistive technologies. This affects all segments of the accessible market, especially people with visual and mobility impairments and people with cognitive deficits. It can be concluded that tourists suffering from mobility and visual impairments and cognitive deficits are the ones that are most affected by the lack of accessibility in hotels websites. Particular attention should be given to this issue, during the development of websites.

In general, hotels with the lowest number of stars present websites with more accessible content than hotels with highest rantings. This can be mainly because hotels with lowest classes present more personalized websites and with less content. On the other hand, hotels with high classifications belong to chains and generally present a very standardized website, with much more content. Results also made clear that there have been few attempts to attract disabled tourists, proving that the accessible tourism market, despite all the potential, is still ignored by tourism organization.

After identifying main accessibility issues, these issues were analyzed and based on the techniques proposed by WCAG 2.0, requirements for the construction of the intended Web application could be obtained. Of course, every single WCAG 2.0 success criterion is essential and all websites' component should be accessible, but Web platforms cannot integrate all, because that might cause inefficiency. By focusing on criteria with most problems and warnings, solutions that act to eliminate them can be identified.

Even though the study contributed to the diagnosis of Web accessibility of hotels websites and identification of possible requirements, some limitations can be found. The use of automatic evaluation tools only made possible the identification of non-functional requirements. Besides, these tools do not take into consideration the experience of disabled people in real life situations. It is essential to evaluate the perception of people, that experience some disability while interacting with Web platforms. In the creation process of a Web application for disabled tourists, it is critical to have in mind that this platform must be used without any constraints by PwD. The analyze of Web accessibility of websites related to tourism is very important, to understand the main errors preventing access to information in Web platforms.

III.2 Study and Analysis of some Web Platforms for Accessible Tourism

III.2.1 Introduction to the study

To understand how an eventual Web Application for promoting accessible tourism should be developed, it is important to study other similar application available on the market. Although there is no solution on the market that fully replicates the concept of the platform to be proposed in this project, there are some solutions available that respond in a partial way to the needs of accessible tourism.

III.2.2 Methodology

To identify user requirements, and verify what main functionalities are offered, seven platforms related to accessibility and accessible tourism were studied. Six of these platforms are directly related to the promotion of accessible tourism. One, even though it is not directly related to accessible tourism, it presents functionalities that can be perceived as fundamental for the Web application under study in this project. Table 20 characterizes the analyzed platforms, displaying the name, the link where they can be accessed and the objective with the functionalities they offer.

This practical study tries to understand how the platforms work and what main requirements for users are presented. The main characteristics of each system are explained, and the main functionalities are collected and converted in requirements.

Table 20- Analyzed Concurrent Platforms

Platform	Available at	Objective
Tourism for All	www.tourism-for-all.com	Promote tourism conditions for people with mobility impairments
siosLife	www.sioslife.com	Help old adults surpass aging problems
Hands to discover	www.handstodiscover.com	Help people with hearing impairments overcome the barriers of communication in tourism activities
ENAT	www.accessibletourism.org	Make European tourism destinations accessible to all travelers
Tur4all Portugal	www.tur4all.pt	Promote information about accessible tourism resources
PREDIF	www.predif.org	Promote accessible tourism for people with mobility impairments
Reisen für Alle	www.reisen-fuer-alle.de	Present certified accessible tourism offers

III.2.3 Analyze of Concurrent Platforms

A. Tourism for All

Tourism for All is a touristic operator/ travel agent specialized in accessible tourism, for people with mobility impairments and older adults. The aim is to provide quality services to tourists visiting Portugal, regardless of their health condition, as well as to meet their needs and expectations, providing comfort, safety, leisure, and accessible conditions (Tourism for All, 2019).

This travel agent has an extensive transportation fleet adapted to PwD. It offers conditions for the transportation of wheelchairs and security conditions for the users. As a touristic operator, it provides an extensive list of activities which include surfing, diving, sky-diving, monuments visits and other tours in Portugal (Turismo de Portugal, 2019).

Tourism for All has an online platform that provides touristic offers and services for PwD. This platform has many partnerships with companies connected to tourism. These partnerships allow Tourism for All to offer many services and touristic products.

There are five types of offers**:**

- **Transportation -** transport, services tours, transfers**)**;
- **Accessible tourism** - cultural package beach package, culture-beach package, city breaks, visits and circuits, specialized transportation, accommodation, activities and experiences, living in Portugal, consulting);
- **Wellness tourism** - beauty care package, thalassotherapy package, hydrotherapy package, nutrition package, physical condition package);
- **Health tourism (Health Tourism -** hydrotherapy, rehabilitation, medical assistance, nursing care therapies, special diets, hemodialysis, nutrition, physical condition);
- **Medical tourism -** surgery, primary care tests, births, fertility treatments, consultations).

The offers in accessible tourism have a presentation format that displays a short description and accessibility symbols, representing the accessible conditions. If the user is interested, that offer can be carefully explored by selecting an additional button. Every offer includes a highlight of the destination, a description of what will be done during the tour and the assurance of accessible conditions. Figure 8 is an example of an offer presentation to visit Estoril and Sintra.

Figure 8- Example of an offer presented by the platform.

Source: Tourism for All, 2019)

Also, every offer page has a simple design, with a straightforward image illustrating the content, and simple text mostly well divided for easy comprehension. Every page also has a clear return button. Most important, every offer comes with a form so that tourists can clarify any doubts or if help is needed. This form may also be used to obtain information about availability and booking if interest in that offer is verified.

B. Platform siosLife

siosLife is a Portuguese startup company that provides seniors, families, and organizations innovative technological solutions. These technologies help old adults surpass aging problems, through interactive and easy to use platforms (siosLife, 2019).

Platform siosLife is a technological platform designed for old adults that promotes active aging and aims at reducing social isolation. The interactive system uses touchscreens, movement sensors, and voice recognition command. siosLife supports : (i) **Cognitive Stimulation** (games and playful activities that stimulate cognitive capacities); (ii) **Physical Stimulation** (games and activities that are connected to sensorial movements that help seniors be physically active); (iii) **Entertainment** (music, movies, and religious content

adapted to every user); (iv) **Simplified communication** (easy to make calls or send pictures to friends and family); and, (v) **Personalization** (every environment is adapted to users' needs and preferences).

The available information explains some of the content on the platform. However, to better study all the functionalities that the system offers, it is necessary to acquire the system. Some features are valuable assets in promoting Web accessibility for older adults.

- Explaining video tutorials (the button to close the video is big and explicit);
- Easy/secure log in on the platform for senior users (there is no need for e-mail or password as the login is done with a card and RFID technology);
- Communication with family and friends (senior users can receive and send photos and video messages);
- The user can interact with the system only with touch or movement recognition.
- Ergonomic adaptation (the physical equipment is adjustable according to the type of impairment/disability);
- Software Personalization (the software can be adjusted according to specific user's needs).

Even though this platform is not directly associated with tourism, there are some requirements presented in this siosLife that have great importance to create an accessible tourism platform. The adaption, according to users' needs and the use of motion capture are characteristics promoting accessibility on a large scale. The highlight of this platform goes to the simple login configuration, which can help eliminate many accessibility problems, particularly for people with cognitive and mobile impairments.

C. Hands to discover

CTILG (Serviços De Tradução E Interpretação De Língua Gestual, Lda.) is a Portuguese company dedicated to communication within the deaf community, providing services of translation and development of materials in sign language. This company, in association with *Turismo de Portugal,* developed Hands to discover. This innovative system has national and international responses that enable pure accessibility and autonomy in places of tourist interest to deaf citizens who plan their leisure time (CTILG, 2019).

The platform helps people with hearing impairments to participate in touristic activities. The objective is promoting tourism in Portugal as an "accessible display window" to the level of receptivity, culture, history, heritage, and gastronomy. It displays information about places, scheduling, choice of points of interest, for both deaf citizens and those who want to visit Portugal.

The system even provides users with the option of being accompanied by a certified sign language interpreter. The system can help tourists on the planning and assist them throughout their holidays. This accessible platform also has functionalities for deaf or hard-of-hearing, that do not have knowledge of sign language.

The platform divides the offers into three zones: Oporto, Lisbon, Algarve. The types of offers are accommodation (hotels), gastronomy (restaurants and bakeries), nightlife (nightclubs and bars), culture (museums and theaters), shopping (shopping malls) and outdoors (outside experiences). Every main description on the website is also available in sign language. A button that links to a video containing an explanation in sign language was added to the central part in websites.

When an offer is viewed, the platform presents a description, contact/address, directions and the option to book a reservation. Every offer also offers the chance to book sign language interpreters. The system allows the user to select the day(s) and the time so that a budget can be stated.

D. ENAT – European Network for Accessible Tourism

ENAT is a non-profit association for organizations that aim to be 'frontrunners' in the study, promotion, and practice of accessible tourism. This platform is a project-based initiative created in 2006 by six EU member states. The goal was to make tourism destinations and tourism activities (products and services) accessible to all travelers and to promote accessible tourism around the world (ENAT, 2019). This platform has a section dedicated to news, events, and projects about accessible tourism. ENAT also publishes the profiles of cities that wish to showcase their achievements and good practices in accessible tourism.

One of the most critical accessible features of this platform is that Every page has a button that allows the user to listen to what is written (figure 9). The user can listen and follow the text without the need of reading. Also, the part that is being listened appears highlighted. This is possible with the use of *Read Speaker* software.

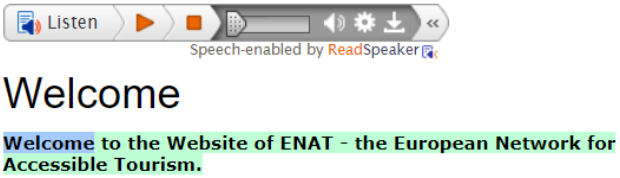

Figure 9- Listening Accessibility feature.
Source: (ENAT, 2019)

This feature may just be crucial for people with visual impairment or people with cognitive difficulties. Allowing the user to access and understand the content in a much simpler way. For some users, this can be the difference maker in accepting the system. This “one in a kind” functionality, is not verified in many websites. So, for Web platforms to be genuinely inclusive, this feature is a must.

E. Tur4all Portugal

Tur4 all is a Web platform but also offers a mobile app available for download in Google Play and App Store. The aim is providing and promoting information about accessible tourism resources in Portugal. Tur4all is also available for Spanish regions (Tur4all Spain).

Tur4allPortugal is a project developed by Accessible Portugal, a private, non-profit Association financed by *Vodafone Portugal* and *Turismo de Portugal*. Accessible Portugal qualifies tourism supply and demand for all segments of the market according to their distinctive characteristics and developed Tur4all to answer the challenges and expand the accessible tourism market. Enabling all individuals with accessibility needs to travel and enjoy the "tourist experience" by taking part in all leisure activities, just like any other tourist (Accessible Portugal, 2019).

Tur4all displays to users:

- Information about accommodation, restaurants and recreational activities;
- Content available in different Languages: Spanish, French, English, German, Italian, Portuguese and Chinese;
- Possibility to interact with social media (Facebook and Twitter);
- An active user community that evaluates scores and comments issues related to accessibility of all resources;
- Promotion of tourism establishments and destinations accessible to PwD;
- Registration in the system, so that users can register themselves in the platform and non-registered users can interact with it.

The platform asks the user to select a category of touristic offer. The categories are accommodation, restaurants, culture, museums, conventions, sports facilities, beach, leisure, wellness, public toilets, financial services, healthcare resources, parking, transports, and routes. After selecting the category, the user can specify subcategory, the district and then the city (figure 10).

Figure 10- Tur4all select tabs.

Source: (Accessible Portugal, 2019)

Besides selecting a district and city, there is also the opportunity to filter content by selecting accessibility criteria (figure 11). Every accessibility criterion is also represented by a symbol. This representation ensures that accessible tourism options are adapted to different disabled tourists.

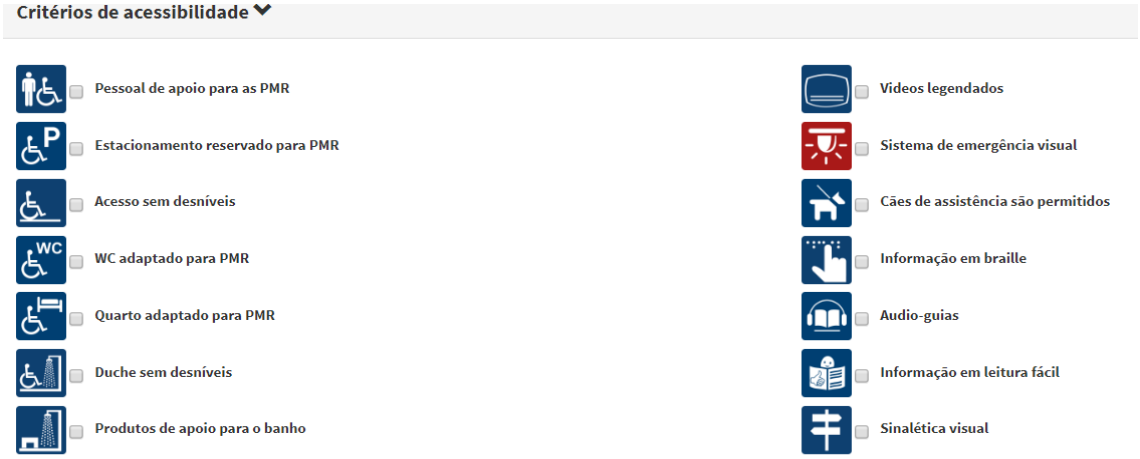

Figure 11- Accessible criteria from Tur4all

Source: (Accessible Portugal, 2019)

Once the search is over, the user is taken to a page with all the current available offers. The user can choose to verify the offers in a list format or on the map. The map is supported by google maps.

When an offer is clicked, several types of information appear. Each offer has an accessibility ranking provided by the users, information about contact and location and most important, an accessibility report. The report is available in PDF and it includes photos that complement the information. The reports vary according to the selected category.

For example, for accommodation offers, the reports contain accessible conditions about the Entrance, Customer service area, Services, and amenities, inside circulation and about adapted facilities like rooms, restaurants, and toilets. The user can improve the offer by contributing to the rantings, share on social media,

or leaving comments on the platform. Users can also contribute by adding offers. A registered user can add an offer to the platform as long as all necessary descriptions are provided.

F. PREDIF (Plataforma Representativa Estatal de Personas con Discapacidad Física)

PREDIF is a Spanish non-profit organization that promotes accessible tourism for people with mobility impairments. The platform offered by this organization displays news about accessibility topic and accessible tourism (PREDIF, 2019). The system is connected to Tur4all Spain.

The organization was responsible for developing the Tur4all in Spain in conjunction with Vodafone Spain. The platforms present an interactive map of Spain (figure 12). The user can select a district of Spain, and it takes him to Tur4all Spain platform, where accessible tourism offers are presented. After that, the procedure follows the same path, explained before, when Tour4all functionalities were explained.

Figure 12- Interactive Spain map

Source: (PREDIF, 2019)

G. The "Reisen für Alle" (Travel for All) project

This project results of cooperation between the Deutsches Seminar für Tourismus (DSFT) Berlin and the association Tourismus für Alle Deutschland.

Deutschland has well-defined criteria to ensure high-quality standards across all industry sectors. Businesses related to tourism service chain in Germany are recorded, assessed, and certified according to a consistent set of nationwide criteria (Tourismus für Alle Deutschland, 2019). The results can be consulted in the database, available on the platform. By dividing by category, federal state, and travel region, the platform makes it possible, with just a few clicks, to independently select, evaluate and book a package in line with personal requirements.

The platform functions in a similar to Tur4all, but the users don't have the option to register themselves into the system. The user can select a category and the travel region and verify the existent options. There is also the option of filter content by amenities (figure 13).

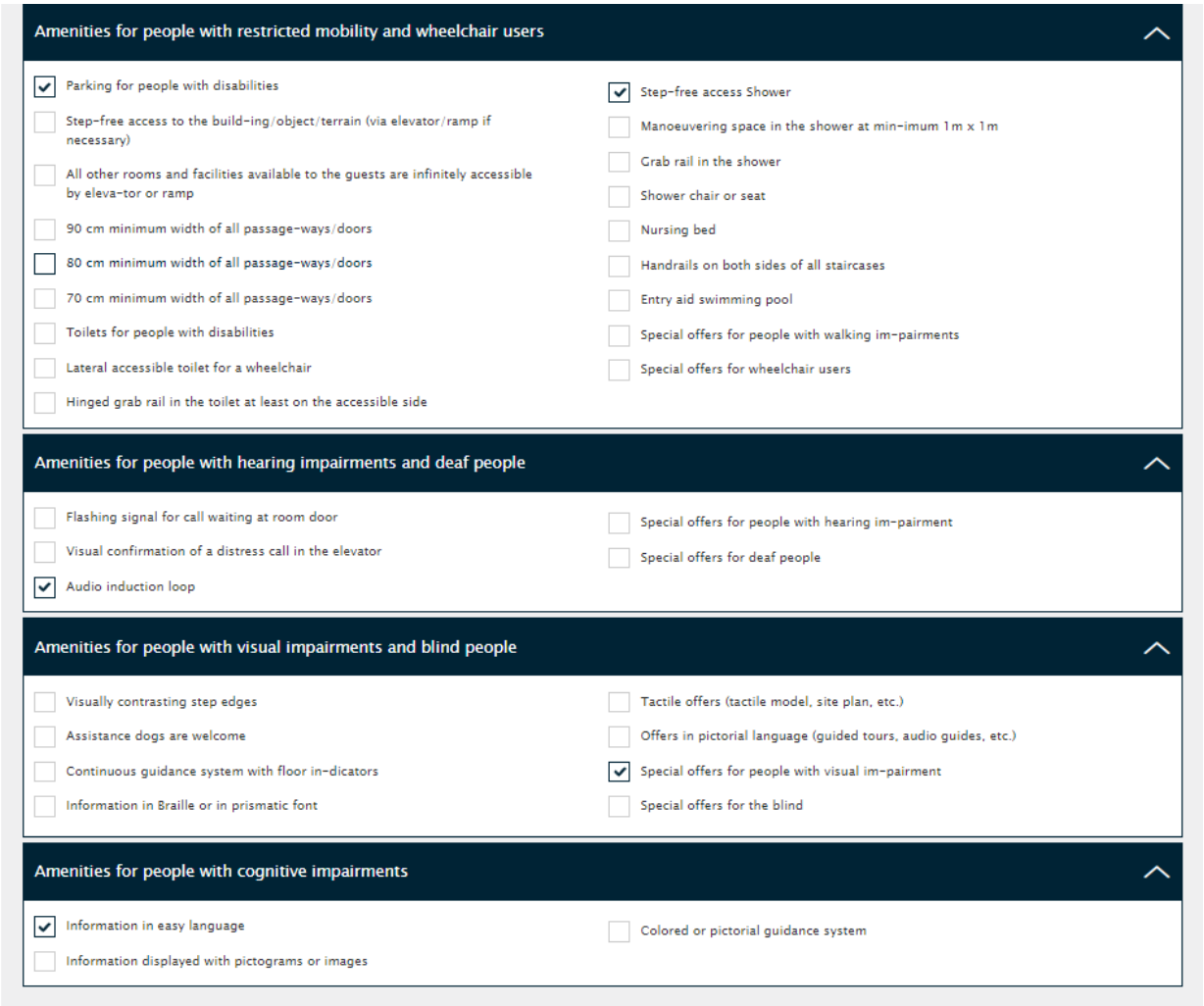

Figure 13- Accessibility criteria from Reisen für Alle

Source: (Tourismus für Alle Deutschland, 2019)

There are amenities for people with restricted mobility and wheelchair users, for people with hearing impairments and deaf people, for people with visual impairments and blind people and for people with cognitive impairments. Each type of amenities offers some request options such as parking for PwD or Information in uncomplicated language. If options like these are marked, then the content is filtered, and research becomes more personalized and adjusted to particular needs.

The offers are presented in an interactive map. Once an offer is selected, more information about the contacts are available, and certifications symbology related to accessibility are displayed. In every offer, it is also a report in PDF containing critical information to people with different types of impairments. The reports contain detailed accessibility conditions of all types of referred impairments

.

Some information like in the case of an acoustic house alarm, no visually perceptible flashing or flash signal appears are very important to people with hearing impairments can be very important. The information displayed can be a crucial factor for the selection of that touristic offer. This reports on accessibility and

content filter functionalities represent breakthroughs amongst these types of databases. These two attributes give this Web platform primary detachment in promoting accessible tourism.

III.2.4 Requirements for building the *AccessTour@WebApp*

After analyzing the content of accessible tourism databases, several requirements were retrieved for conceptualizing the Web application for accessible tourism. The list of potential ideas of requirements is presented in table 21.

Table 21- Requirements retrieved from the analysis of concurrent platforms

Requirements for the *AccessTour@WebApp*
• Allow tourism organizations to reach out to disabled tourists
• Provide offers that contemplate different types of tourism services
• Provide offers accompanied by an overall description (photos, activities...)
• Inform users about every type of accessibility condition
• Present clear return buttons on every page
• Provide an option for users to ask for support or request more information about the offers
• Include explaining videos about system functionalities
• Display information about contacts (cellphone contact) in case of doubts
• Provide a simple login system (ex: using a card with RFID technology or facial recognition)
• Allow the possibility to share photos and video with other users and families
• Allow integration with social media
• Allow movement recognizing and motion capture
• Provide solutions personalized to users
• Provide the option of being accompanied by a certified sign language interpreter
• Spread information and news about accessible tourism
• Provide information about availability, while booking an offer
• Provide a button that allows the user to listen to what is written (ex: *Read Speaker* software)
• Share information about upcoming events and conferences related to accessible tourism
• Allow compatibility with assistive technologies
• Support different types of language
• Provide an accessible search system and select tabs so offers can be easily found (indicating location and category)
• Filter content by selecting accessibility criteria or indicating special needs
• Make an interactive user community
• Allow users to evaluate offers according to accessibility (star rating system for example)
• Allow users to leave comments about the experience
• Provide accessibility reports (a PDF file containing an intensive description of accessibility conditions), when an offer is registered
• Provide an interactive map for searching offers

III.2.5 Conclusion of the study

Of all studied platforms, Tur4all Portugal and Reisen für Alle are the ones that share more common ideals to what was idealized with the *AccessTour@WebApp*. The way that offers can be searched and presented an excellent way to promote accessible tourism. Also, the accessibility reports presented with each offer and the possibility to filter offers by specifying special needs can contribute significantly to the success of this type of platforms. To verify all the functionalities of some systems, a registration was necessary. Despite that, several functionalities for conceptualizing the Web application were obtained.

The functionalities that other platforms have can also bring significant benefits for disabled tourists. The login system that siosLife presents can help eliminate accessibility constraints for people that have difficulties remember passwords or typing on a keyboard. The interactive map with offers that PREDIF provides can be an excellent alternative to a regular search bar, making the search for offers more straightforward and proficient. ENAT grants the possibility to listen to what is written.

This characteristic is often ignored but represents large-scale accessible gains for visually impaired people. Finally, it should be considered the option of the Web application also works as a mobile app, similar to Tur4all. Furthermore, in general, every system can be integrated with assistive technologies, which may also represent an essential feature for ensuring accessible conditions.

The conceptualization of an accessible tourism platform aims exactly at applying technologies to tourism and make it more accessible. With that in mind, this study proves that Web platforms are a technological way to promote accessible tourism. The urge of digital tourism platforms is also related to Tourism 4.0, like cloud computing, and other technological drivers are present in this type of systems.

This type of platforms allows the flow of information and are capable of connecting tourists with touristic services providers. The increasing digitalization of tourism offers new challenges to every stakeholder. With the rise of the tourism sector and digitalization, competition is growing, and tourists have other demands and higher expectations. If tourism industries want to stay relevant in the digitalization era, adaptation is pivotal.

One of the main challenges in accessible tourism is to deliver accessible information to disabled tourist. These systems are excellent platforms for information sharing between disabled tourists and tourism organizations, which helps to promote accessible tourism. Despite this, this research shows that currently, the existing number of platforms promoting accessible tourism is short. With the rising of the accessible tourism market and all the potential associated with it, Web platforms can be an excellent way to capitalize on it. The conceptualization of the Web application for accessible tourism needs to align the digitalization of tourism and accessible tourism.

III.3 Proposal of a Web Application for Accessible Tourism

It is a great challenge to develop an innovative tourism information system to provide communication, information sharing, suggestions based on users' profiles, and knowledge transfer among all stakeholders. There are essentially two type of stakeholders for this system: consumers or visitors (PwD, the elderly and other people with functional limitations); and tourism suppliers or tourism organizations (accommodation units, food & beverage units, transport and tourism animation enterprises, outdoor activities promoters, tour operators, and public organizations with responsibility in the sector). This research project is of high relevance to increase the differentiation and competitiveness of tourism destinations, encouraging the development of accessible tourism and simultaneously contributing to the promotion of more inclusive societies. Given the nature and complexity of the phenomenon under study, a multidisciplinary approach, with a triangulation of methods regarding data collection and analysis and information and communication was adopted.

The Web system conceptualized in this project should work as a mediator between offer and supply and be both accessible and smart. The accessible part is visible by the way the system is presented, and the smart part represents what the system allows users to do. Both functional and non-functional requirements display an essential role in assuring that the system is smart and accessible.

The *AccessTour@WebApp* aims to promote accessible tourism for all. By working as a platform where both visitors (demand) and tourism organizations (offer) interact, there is a win-win situation for both parties. Disabled tourists can search for tourism related offers according to their needs, and experience touristic activities. Besides this, tourism organizations get the chance to promote their offers and unlock the potential of the accessible tourism market.

III.3.1 Requirements for the conceptualization of the *AccessTour@WebApp*

Tables 22 and 23 present a resultant triangulation matrix that lists high-level requirements on one dimension and the three different analysis and validation methods on the other dimension. Table 22 provides an overview of the identified functional requirements and table 23 an overview of the identified non-functional requirements. The most critical identified requirements were related to the deliverance of information about accessible offers (Search for accessible tourism offers / Insert accessible tourism offers). This is related to the main goal of the Web Application conceptualize in this project and the fact that information is a crucial factor for tourism.

Both triangulation matrixes indicate which of the methods was responsible for the identification of the requirement (x); and after its identification, if it had confirmation by one of the subsequent methods (+) or if it was not considered (NA). The three research sources utilized were (i) literature review; (ii) accessibility analyzes of hotels websites; and (iii) content analysis of concurrent platforms. According to both triangulation matrixes presented in tables 22 and 23, the results of some parts of the study were indeed validated by the results from other parts, and all parts combined contributed to understanding what requirements should be present during the conceptualization process of the system. It is important to note that the second research method only displayed non-functional requirements because automated tools were used to evaluate website accessibility.

Table 22- Triangulation matrix based on three different analysis and validation methods with the final list of functional requirements of a Web Application for accessible tourism

Actors/ **Functional** Requirements Identified	Research Sources		
	Literature review	Website analysis	Concurrent platforms analysis
Visitor:			
Search for accessible tourism offers			
—about adapted bedrooms	x	NA	+
—about adapted bathrooms	x	NA	+
— about parking for people with disabilities		NA	x
— about step-free access to the buildings (elevator/ramp)	x	NA	+
—about accessibility to rooms or other facilities available	x	NA	+
—about outdoor experiences	x	NA	+
—about the presence of audio guides	x	NA	+
—about the guidance system with floor indicators	x	NA	+
—about visual signposting	x	NA	+
—about multimedia guides	x	NA	+
—about upcoming events related to accessible tourism	x	NA	+
—about accessible transportation			x
Search for accessible tourism Information/Communication			
—about support staff	x	NA	+
—available in Braille	x	NA	+
—available in sign language	x	NA	+
—available in easy language	x	NA	+
—represented by pictograms or pictures	x	NA	+
—about assistance dogs' allowance	x	NA	+
When an offer is selected, provide the option of being accompanied by a certified interpreter			x
Build an individual profile, stating accessibility requirements /special needs	x	NA	+
Receive offers according to the user profile and individual preference	x	NA	
Use GPS features to help access places and navigate through it	x	NA	
Obtain real-time information to navigate in unfamiliar environment	x	NA	
Ask questions and receive answers in sign language (through video chats with tourism information consultants using sign language)	x	NA	+
Select language (the system should support at least French, German Portuguese, English, and Spanish)	x	NA	+
Contact non-disabled people to be part of the touristic experience and help disabled tourists enjoy most of the touristic activities	x	NA	+
Interact with other disabled visitors	x	NA	+
Search about upcoming events about accessible tourism		NA	x
View explaining videos about system functionalities		NA	x
Search offers in an interactive map		NA	x
Filter offers by selecting accessibility criteria or indicates special requests		NA	x
Ask for support or request more information about the offers		NA	x
Share photos and video with other users and families		NA	x
TOURISM Organization:			
Insert/Update/Delete accessible tourism offers	x	NA	+
Insert/Update/Delete accessible tourism information/communication	x	NA	+
Display contacts (cellphone contact) in case of doubts		NA	x
Provide the availability of the offers		NA	x
Provide more details about an offer in an accessibility PDF report		NA	x

x, identify; +, confirm; NA, no-applicable

Table 23- Triangulation matrix based on three different analysis and validation methods with a final list of non-functional requirements of the Web Application for accessible tourism

Non-Functional and Accessibility Requirements Identified	Research Sources		
	Literature review	Website analysis	Concurrent platforms analysis
Integrate content from the broadest possible range of reliable sources, addressing the multifaceted needs of a wide range of users	x		
Maintain every personal tourist data safe	x		
Allow Interoperability with other systems	x		+
Present a structured browsing system	x	+	+
Use Vocabulary as simple as possible (Special attention to the use of technical and scientific language)	x		+
Match user profiles with the correct type of offers and information	x		+
The system should be compatible with the use of assistive technologies			
—Allow the utilization of screen readers	x	+	+
—Allow the utilization of software that converts text to braille	x	+	+
—Allow the utilization of text to voice software	x	+	+
—Allow the utilization of Voice recognition software	x	+	+
—Allow the integration with alternative keyboards	x	+	+
Present an option that allows the user to listen to what is written			x
Present an option to view features in black and white	x		
Present an option to view standard content presented in sign language	x		+
Interact with the platform using movement recognizing and motion capture			x
Improve forms marking by showing marks on the edges of the pages		x	
Insert links, menus and links' text marking		x	
Provide an alternative to text in images		x	+
Provide a text alternative to all non-text content that is presented			
—text that provides a brief description of the non-text content		x	+
—text that identifies the purpose of the non-text content		x	+
Information and structure can be programmatically determined or are available in text		x	
Resize text without assistive technologies			
—Support Browser Zoom		x	
—Ensure that there is no loss of content or functionality when the text resizes		x	
Present content in an order that ensures meaning and operability			
—Place interactive elements in an order that follows sequences		x	
—Insert dynamic content		x	
The purpose of each link is explained			
—Provide text describing elements of images with links		x	
—Provide text describing links		x	
—Provide button labels that describe the purpose of the button		x	
Insert Headings and labels that correctly describe topic or purpose		x	
Changes of context are initiated only by user request			
—Request update of the content instead of updating automatically		x	
—Implementing automatic redirects on the server		x	
Provide Labels or instructions when content requires user input		x	
Modify or delete user-controllable data in data storage systems			
—Providing the ability for the user to review and correct answers		x	
—Providing the ability to recover deleted information		x	
—Providing a checkbox in addition to a submit button		x	
—Requesting confirmation to continue with the selected action		x	

x, identify; +, confirm;

Two different actors were identified: Visitors and Tourism Organizations. These two types of actors are directly related to the demand and offer for this type of platforms. Visitors have an individualized home page, which can only be accessed by themselves or by a caretaker (friend or familiar), through a login system. This way, visitors can create a personalized profile, stating for example type of disability or special needs. Visitors interact with the system by searching accessible tourism offers.

An offer can only be searched by a Visitor if a Tourism organization inserts it on the system. Tourism organizations can be of different types and can set various offers in the system, as long as all descriptions about accessible conditions are provided.

The triangulation approach has two main goals: confirm results with data from different sources, and aggregate data to obtain a complete system. Validation is achieved when results from one research method are confirmed by results from other methods. Complementation of results is achieved when one research method presents results which have not been found with another method. It is interesting to note that most of the requirements elicited with the literature review are validated by the findings in the analysis of concurrent platforms.

The used methodological approach of requirements triangulation contributed to the validation and completion requirements for the system, but it also allowed to look across all methods used and decide what requirements are critical for the system success. On the functional requirements, notoriety for the search/input of accessible tourism offers and information: i) Search for accessible tourism offers, Information, and Communication; ii) Insert/Update/Delete accessible tourism offers, information, and communication). The non-functional requirements presented in all three research sources should be given special attention. The matrix identified two crucial requirements: i) the compatibility of the system with assistive technologies and ii) the implementation of structured browsing system, for searching about accessible tourism offers and information. These four requirements must be present on the conceptualized Web application.

III.3.2 Conceptualization of a Web Application for Accessible Tourism (*AccessTour@WebApp*)

For a better understanding of how the system operates, two UML diagrams were elaborated. The use-cases diagram offers an overview of how the actors can interact with the system. The class diagram offers a more in-depth look at the type of accessible offers and information available for disabled tourists. UML is a standard language for specifying and visualizing information systems. With the representation of the system in these two diagrams, a better idea of the capabilities and functionalities of the system can be transmitted. Both diagrams were elaborated using the *Visual Paradigm* software

The use-case diagram represented in figure 14 identifies the different interactions that exist within the system. The main goal of this diagram is to describe the various services present on the platform. Actors represent the group of users of the system. As stated before, actors can be divided into two groups: Visitors (representing demand) and Tourism Organizations (representing demand). Following the identification of the actors, a description of the services (use-cases) to be provided to each actor is presented. The different use-cases demonstrate how to meet the specified requirements. A reflection on the various interactions between activities was made, and the use-case diagram was elaborated.

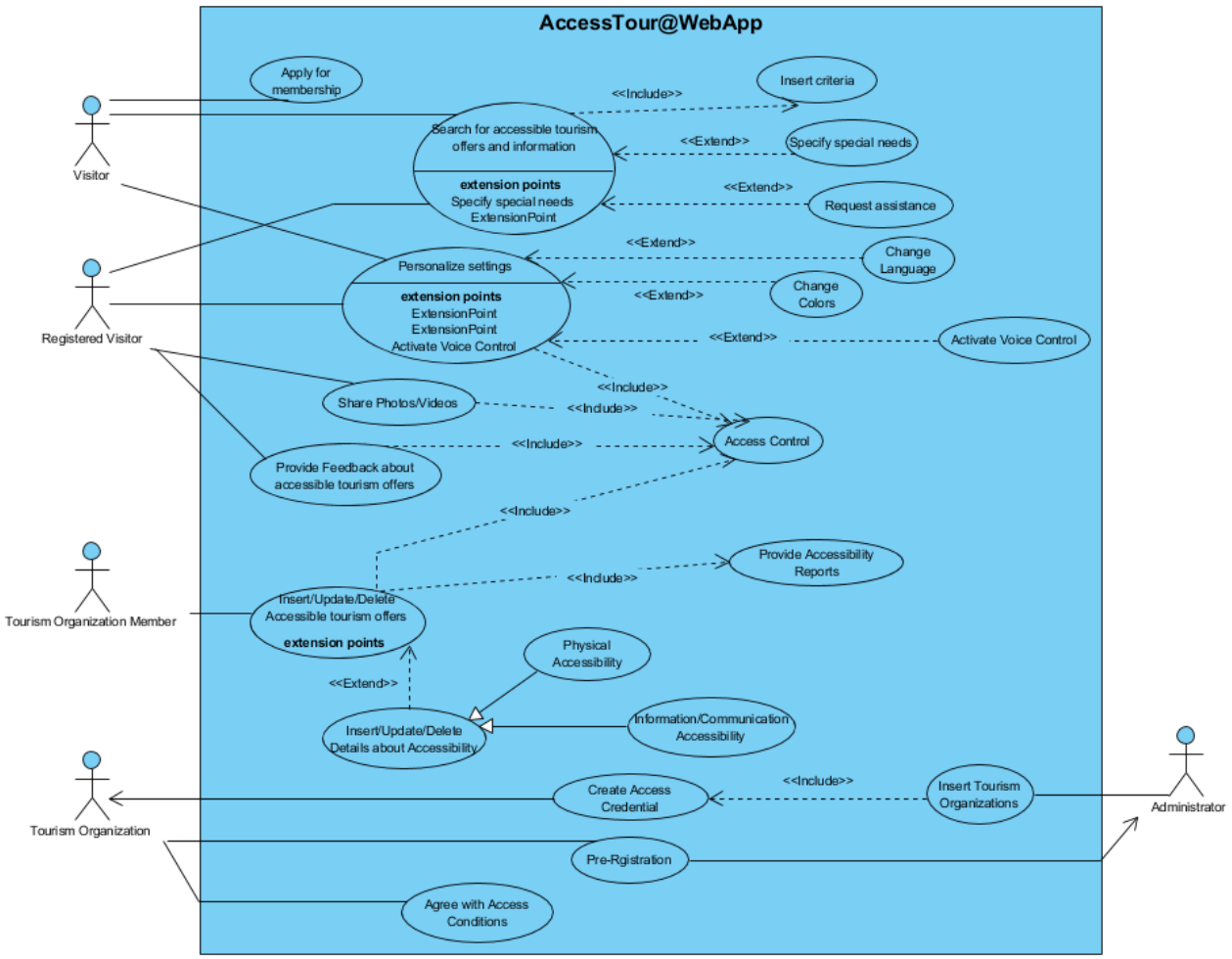

Figure 14- Use-cases Diagram

Every Visitor can access the contents of the system. They can search for accessible tourism offers and personalize settings according to their needs. Color blind can change the colors, and visually impaired visitors can activate voice control. During the search for accessible offers and information regarding those offers, special needs can be indicated, in order to search adequate offers. There is always the possibility to request assistance during the realization of touristic activities. For example, requesting a sign language interpreter or audio guides. A visitor can register in the system and become a registered user. Once the registration in the system is completed, registered visitors can share photos and videos with other user or via social media. They also can provide feedback, in order to improve accessibility conditions and review offers. Tourism organization makes a pre- registration on the system. This pre-registration is validated by the Administrator of the system. Once the registration on the system is confirmed, Tourism Organization become members of the system. Tourism Organization Member insert offers and information regarding accessibility. The offers can be edited or deleted. It is very important to insert details regarding physical and information accessibility. If possible, every offer should be accompanied with an accessibility report, with more detailed information.

The class diagram represented in figure 15 describes the various classes that make up the system, as well as the various attributes that compose the existing relationships. The presented classes were elaborated regarding the requirements that the system must fulfill. The different classes should make the system functional. The various attributes that compose each class were then described, alongside the different relationships between classes.

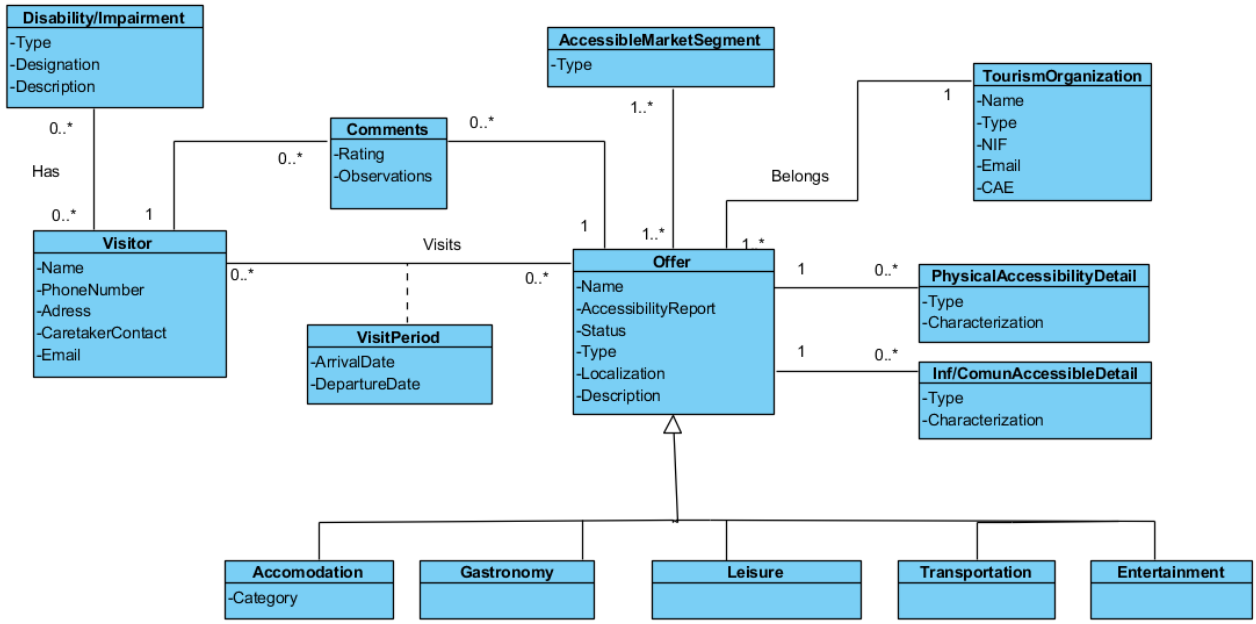

Figure 15- Class Diagram

There are different types of offers that can be found on the Web Application: Accommodation (Hotels, Hostels, *Pousadas*), Gastronomy (Restaurants, Coffee shops, Pastries), Leisure (Outdoor experiences), Transportation and Entertainment (movies, Theatres, monuments, museums, art galleries). Besides the offers in the system, it is important to present all the information, communication, and physical accessibility details. For a Visitor to be connected within the *AccessTour@WebApp*, it is especially important to indicate the type disability/impairments and the phone number so that the system can provide the best offers according to their special needs and assist them. Thus, during the time a Visitor is experiencing an offer, a class named VisitPeriod is created so that the user can get real-time assistance. This can be made by interacting with the user through the mobile phone number. The visitor will be able to receive important messages (audio or text), regarding accessibility, which fulfills the crucial requirement for accessible tourism about real time assistance.

CHAPTER IV

Conclusion

This thesis studied how the application of technologies in tourism led to the development of accessibility conditions across the sector. In order to investigate the technological impact on accessible tourism, both empirical and theoretical parts were included in this study. Two research questions were created. The first research question of the study was “What is the impact of the fourth industrial revolution in tourism, and how can it contribute to the development of more accessible tourism?”. The second question was, “What are the main requirements for the construction of Web application, for accessible tourism, and how should the system be conceptualized?". This second question works as significant research contribute since it helped clarify the selected topic by conceptualizing a practical example of a technological platform developing accessible tourism.

IV.1 Main Findings

The empirical part of this thesis shows that Industry 4.0 is a hot topic not just among the manufacturing firms but also in services industries. Special attention was given to tourism, particularly accessible tourism. The technological impact can be a crucial factor in promoting inclusiveness in the tourism industry. Accessible tourism market is much more than a niche (Darcy & Dickson, 2009), and the conceived study may just have provided the tools to unlock all its potential. The different segments in accessible tourism prove that the market has potential to grow and become an essential factor for the development of tourism-based economies. However, the constraints to accessibility that disabled tourists encounter show that there is still a need for creating accessible conditions to tourism practices.

Technologies are the key to surpass the barriers in accessible tourism. The internet, and other technologies introduced a revolution in tourism and were responsible for smart tourism. Smart tourism emerged with the use of ICTs in different services connected to the tourism industry and caused the appearance of smart cities and smart destinations. The use of ICTs in tourism showed that technologies could have a profound impact in this sector. However, there are a few constraints that influence the success of more technological progress. The lack of access to the internet and cyber security are examples of many challenges that may affect the use of technologies in tourism.

Industry 4.0 and overall digitalization are relatively new phenomena that were born amongst manufacturing sectors, but also have significant implications in service industries. The fourth industrial revolution was capitalized due to diverse technological drivers. In the literature, different authors identified different technological trends that promoted Industry 4.0. The works of Jasperneite (2013); Kovar et al. (2016); Rüßmann et al., (2015); and Saturno et al. (2018) are consistent and together demonstrate the leading technologies responsible for this new digital era. With new technologies dominating markets, clients will become more and more exigent. Services will need to offer quick and customized solutions to clients, which can be obtained with the integration of industry 4.0 foundations.

The technological drivers and value drivers elaborated by McKinsey (McKinsey Digital, 2015), aim precisely to validate the fact that Industry 4.0 principles and technologies can be integrated with services industries. Tourism is a particularly good example of that.

The principles underlying Industry 4.0 are the communications that allow continuous interaction and exchange of information between humans, human and machine, and machines themselves. This recent phenomenon originated in the manufacturing industry launched a revolution, that is having impacts in other

types of industries, including tourism. Industry 4.0 technologies like cloud computing, IoT, VR, and AR are becoming crucial to the development of tourism.

The technological impact of the fourth industrial revolution in tourism led to the appearance of a new paradigm: Tourism 4.0. This new concept was first presented in Slovenia, as the result of a research project between Slovenia's government and Arctur company. The main goal of Tourism 4.0 is to introduce technological innovations, coming from Industry 4.0 on tourism sectors. The integration of innovations contributes to promoting more sustainable and accessible tourism. Technological integration allows tourism personalization of tourism offers, alongside ensuring security and the safety of travelers. Tourism 4.0 also brings significant changes to tourism markets, since it dramatically changes the dynamic between the diverse stakeholders.

The application of Tourism 4.0 in accessible tourism holds the answer to **the first research question**. The identified literature gap was surpassed by the introduction of a new concept: Accessible@Tourism 4.0. The adoption of Industry 4.0 components in the accessible tourism (Accessible@Tourism 4.0) promote the development of a new technological solution that can facilitate the access of tourism products by disabled people, contributing for the development of accessible tourism. In a nutshell, Accessible@Tourism 4.0 is the answer to the role of the fourth industrial revolution in accessible tourism, emphasizing the effect of Industry 4.0 components in the tourism sector.

The **second research question** developed a study in accessible tourism, understanding the main requirements for this market, and conceptualizing a Web application, for promoting accessibility in tourism, named *AccessTour@WebApp*. Information was identified as a pillar for accessible tourism. The problem of information in accessible tourism, presented by Waschke (2004), justifies the need for the creation of systems that deliver the right kind of information to the correct type of tourists. Besides aligning technologies and tourism, the conceptualized platform works as a response to this problem, by ensuring the deliverance of information in an accessible way to disabled tourists.

The success of every Web systems depends on how well it is adapted to user needs (Irestig & Timpka, 2008). For elaborating the system, requirements identification was necessary. To perform a user needs analysis and to write requirements specification, different techniques of requirements elicitation and validation were applied. Three research methods were used: i) Literature review, ii) Website accessibility analysis and iii) Concurrent platforms content analysis. The obtained requirements are presented in tables 8, 19 and 21.

As stated before, the *AccessTour@WebApp* should not only promote information circulation but also ensure that the information is delivered in an accessible way. Before advancing to the research methods, a perspective about Web accessibility was conducted. WCAG 2.0 developed by W3C (W3C, 2018b) has been a cornerstone on assuring websites are accessible. The Web accessibility guidelines determined meaningful insights about accessible tourism. An essential discovery was that the disabilities that most affect peoples' use of the Web are visual, hearing, cognitive and neurotically impairments, and some mobility disabilities, which confirmed the findings by Shi (2006).

The first research method was the literature review related to the role of the fourth industrial revolution in accessible tourism. The main focus was to determine the leading technologies in tourism and understand the contribution to accessible tourism, which allowed the identification of user requirements. The theoretical background proved that technologies capable of spreading information are crucial for tourists, identifying mobile technologies and information systems as significant players in ensuring accessible tourism.

Beyond the evident importance of ICTs in tourism, the study shows that web-based platforms can be fundamental for ensuring accessible conditions to disabled tourists. In addition, accessible Web touristic platforms beneficiate not only disabled tourists but also non-disabled people. An insight into the several literature topics allowed the identification of functional and non-functional requirements. In overall, this

research method confirmed the findings related to technological impacts and demonstrated the importance of conceptualizing a Web application for accessible tourism.

The second research method was the evaluation of the accessibility of 344 websites of hotels and *Pousadas de Portugal,* located in the Central Region of Portugal. The study was elaborated using two automated tools (AccessMonitor and TAW) that considered WCAG 2.0 principles. The study revealed three significant findings. First, the Web accessibility level of the hotels analyzed is low. Second, Perceivable and Robust principles are the most critical, as they displayed the highest value of problems and warnings identified. Third, the results revealed differences in Web accessibility according to the category of hotels. Generally, hotels with the lowest number of stars present websites with fewer issues. A possible explanation is hotels with highest categories display websites with more content, so more errors are detected. Additionally, with the identification of the most critical success criteria, visual and mobility impaired tourists and tourists with cognitive deficits can be established as risk groups, regarding Web accessibility. Finally, with the help of techniques proposed by W3C (W3C, 2016a), guidance for Web content in meeting WCAG 2.0 success criteria, was possible to be obtained and non-functional requirements for conceptualizing the *AccessTour@WebApp* could be obtained.

The third and last research method was the content analysis of concurrent platforms. Profound research was conducted to identify existent Web platforms responsible for promoting accessible tourism. The investigation revealed that there is a lack of this type of platforms. Only six platforms promoting accessible tourism and one platform promoting active aging for older adults were identified. As the importance of Web-based platforms in digital tourism is clear, they are a great example of the technological impacts in touristic services, and how digitalization promotes accessible tourism. These systems are an excellent way to capitalize on the rising of both digital tourism and accessible tourism markets. The content analysis of these platforms contributed to spotting important functionalities that this type of systems should offer to disabled tourists. Subsequently, essential user requirements for conceptualizing the *AccessTour@WebApp* were gathered.

The results of the three elaborated research methods specified the inputs for the realization of the triangulation matrix. The obtained requirements are presented in table 22 and table 23. The validation of the requirements was achieved when results from one research method were confirmed by results from other methods. Complementation of the requirements was achieved when one research method presented results which have not been found with another method. This matrix demonstrated that the requirements recoiled in the literature review (first research method) were in the majority confirmed and validated by the findings in the analysis of concurrent platforms.

This matrix revealed what user requirements should be given special attention. The most important requirements were related to: i) the deliverance of offers and information related to accessible tourism (Search for accessible tourism offers, Information and Communication; ii) Insert/Update/Delete accessible tourism offers, information, and communication); ii) the compatibility of the system with assistive technologies and iii) the implementation of a structured research browsing. Every one of these requirements was identified on the three research methods and are equally important for both parts of the system (Tourists-Demand; Tourism Institutions-Offer). The requirements found demonstrated that accessible information is a crucial factor for accessible tourism.

With the help of the matrix, two diagrams (use cases and class diagram), elaborated in UML were obtained (figure 14 and figure 15). The representation of the system allows a better understanding of the capacities and functionalities offered by the system. The result of the study is the conceptualized *AccessTour@WebApp* that works as a technological solution for promoting accessible tourism.

This user-friendly Web application allows communication between visitors and tourism organizations. It offers a platform to promote accessible tourism options and reach potential clients. Disabled tourists can have access to relevant information, allowing them to find tourism options, adapted to their particular needs.

This way, the conceptualized system has improved the process of information managing associated with accessible tourism, since it allows tourists quickly access to a set of meaningful data. This system has the potential of helping to improve the quality of tourism for disabled tourists. Finally, as the users can interact with the system, tourism institutions can figure out how to reach to PwD. Based on the work done, it is possible to conclude that retrieving requirements for systems promoting accessible tourism is a complicated task. Nevertheless, the application of the triangulation matrix alongside the used research methods used can be considered a good process for developing a Web application for accessible tourism.

IV.2 Limitations and Future Research

The used publications were carefully selected to answer research questions and promote accuracy and validity in this dissertation. Despite all the potential of technologies to develop accessible tourism, the literature in this area is severely limited. Although there is a large number of studies in the field of smart tourism, there are not many specially dedicated to accessible tourism. There is an evident lack of research specifying the application of technologies to enhance accessible tourism. The same happens with Industry 4.0 technological drivers in tourism. Many authors describe the potential these technologies can have but never apply it to the case of accessible tourism. The concept of Accessible@Tourism 4.0 was mainly explored by using examples of the application of Industry 4.0 technological drivers in tourism and explaining how they could benefit and promote accessible tourism. Therefore, it is of utmost relevance carry out studies regarding the use of this kind of new technology in the accessible tourism.

Some limitations have been found on the Web accessibility study. Only hotels' websites were analyzed due to time constraints. The study of Web accessibility of other players in the tourism value chain, such as travel agencies or touristic activities promoters, can complement the findings of Web accessibility in the tourism sector. The tools used to evaluate Web accessibility only made possible the identification of non-functional requirements. Also, automatic evaluation tools make analysis easy, but some relevant elements tend to be ignored, as they do not take into account the view and the perception of disabled tourists in real life situations. Additionally, every single WCAG 2.0 success criterion is essential, and every website component should be accessible, but Web platforms cannot integrate all, because that can lead to inefficiency.

The study of content analysis of concurrent platforms also had some limitation. First, one of the platforms was not directly related to accessible tourism. However, since the functionalities could offer significant contributes, it was not excluded from the analysis. Second, to study all the features of some systems, registration in some platforms and acquisitions of software was necessary, which, due to constraints was not possible.

Irrevocably, limitations were found during the *AccessTour@WebApp* final conceptualization. Some of the identified user requirements may not work well together well, be inconsistent with the system or maybe they cannot be implemented due to technical reasons. This thesis only focused on the conceptualized part, and not in implementation. For starting the implementation of the system, it can be tested with some tourism organizations. After the viability and reliability of the system are confirmed, the conceptualized application could incorporate other national or international accessible tourism offers.

The conceptualized Web application must also be tested and validated with the help of potential users. This can be done by interviewing diverse PwD, to comprehend if the implanted requirements are indeed necessary and to identify other possible system functionalities. The launch of a prototype is also fundamental, to verify which aspects are most crucial and if improvements are needed. For the *AccessTour@WebApp* to be successful, it is vital that it is successfully tested by the primary users of the system.

Tourism 4.0 is a new topic in literature, and the impact of technologies in promoting accessible tourism also remains a very unexplored issue. Thus, both topics could benefit from additional research, especially about the changing on tourism environments and the effects on the diverse stakeholders related to the tourism sector.

This work studies the concept of Tourism 4.0, integrated with accessible tourism. The fourth industrial revolution is also revolutionizing other sectors. Future researches could study the impact of this new revolution in other areas and compare with the impacts on tourism. Also, studies could be conducted focusing on applying Tourism 4.0 in other types of tourism (educational, religious, medical) and compare the results. Since this investigation is conducted in a quantitative and quality manner of research, further studies could apply the same or similar methods and compare and complete this dissertation's findings. This research hopes to stimulate research, inspiring more tourism researchers and educators to incorporate this interdisciplinary area into their activities.

Bibliography

Abbott, S., & McConkey, R. (2006). The barriers to social inclusion as perceived by people with intellectual disabilities. *Journal of Intellectual Disabilities*. https://doi.org/10.1177/1744629506067618

Accessible Portugal. (2019). Tur4all Portugal. Retrieved May 1, 2019, from www.tur4all.pt

Agarwal, P., & Alam, M. A. (2018). Use of ICT for sustainable transportation. *IOP Conference Series: Earth and Environmental Science*, *150*(1). https://doi.org/10.1088/1755-1315/150/1/012032

Ahmad, N., Kaiwartya, O., Cao, Y., Puturs, G., & Khalid, M. (2018). Intelligent Transportation Systems Enabled ICT Framework for Electric Vehicle Charging in Smart City. *Handbook of Smart Cities*, 311–330. https://doi.org/10.1007/978-3-319-97271-8_12

AkgÜL, Y., & Vatansever, K. (2016). Web Accessibility Evaluation of Government Websites for People with Disabilities in Turkey. *Journal of Advanced Management Science*. https://doi.org/10.12720/joams.4.3.201-210

Alén, E., Domínguez, T., & Losada, N. (2018). New Opportunities for the Tourism Market: Senior Tourism and Accessible Tourism. *Intech Open*, *2*, 64. https://doi.org/10.5772/32009

Alexander, D. (2004). How accessible are Australian university web sites? *Ariadne (38)*. http://www.ariadne.ac.uk/issue/38/alexander/

Alexis, P. (2017). R-Tourism: Introducing the Potential Impact of Robotics and Service Automation in Tourism. *Tourism Management*, *29*(3), 458–468. https://doi.org/10.1016/j.tourman.2007.07.014

Allard, T. T., Sitchon, M. L., Sawatzky, R., & Hoppa, R. D. (2005). Use of Hand-held Laser Scanning and 3D Printing for Creation of a Museum Exhibit. *The 6th International Symposium on Virtual Reality, Archaeology and Cultural Heritage*.

Alter, S. (1992). *Information Systems: A Management Perspective*. Retrieved from http://books.google.com

Altinay, Z., Saner, T., Bahçelerli, N. M., & Altinay, F. (2016). International Forum of Educational Technology & Society The Role of Social Media Tools : Accessible Tourism for Disabled Citizens, *19*(1), 89–99.

Arctur, & Tourism 4.0 Consortium. (2018). What is Tourism 4.0 ? Retrieved February 27, 2019, from https://www.tourism4-0.org/

Asongu, S. A., & Nwachukwu, J. C. (2017). ICT, Financial Sector Development and Financial Access. *Journal of the Knowledge Economy*, (September). https://doi.org/10.1007/s13132-017-0477-x

Atzori, L., Iera, A., & Morabito, G. (2010). The Internet of Things: A survey. *Computer Networks*. https://doi.org/10.1016/j.comnet.2010.05.010

Augmented Reality. (2019) In Oxford dictionary. Retrieved from https://en.oxforddictionaries.com/definition/augmented_reality

AVIS, A. H., CARD, J. A., & COLE, S. T. (2005). Accessibility and Attitudinal Barriers Encountered By Travelers With Physical Disabilities. *Tourism Review International*, *8*(3), 239–248. https://doi.org/10.3727/154427205774791591

Azuma, R., Baillot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. (2001). Recent advances in augmented reality. *IEEE Computer Graphics and Applications*. https://doi.org/10.1109/38.963459

Baines, T., Ziaee Bigdeli, A., Bustinza, O. F., Shi, V. G., Baldwin, J., & Ridgway, K. (2017). Servitization: revisiting the state-of-the-art and research priorities. *International Journal of Operations and Production Management*. https://doi.org/10.1108/IJOPM-06-2015-0312

Balandina, E., Balandin, S., Koucheryavy, Y., & Mouromtsev, D. (2015). IoT Use Cases in Healthcare and Tourism. *Proceedings - 17th IEEE Conference on Business Informatics, CBI 2015*, *2*, 37–44. https://doi.org/10.1109/CBI.2015.16

Baldwin, C. Y., & Clark, K. B. (2000). *Design Rules: The Power of Modularity Volume 1*. *Academy of Management The Academy of Management Review*. https://doi.org/10.1159/000348293

Bandyopadhyay, D., & Sen, J. (2011). Internet of things: Applications and challenges in technology and standardization. In *Wireless Personal Communications*. https://doi.org/10.1007/s11277-011-0288-5

Barbeau, S., Georggi, N., & Winters, P. (2010). Global positioning system integrated with personalized real-time transit information from automatic vehicle location. *Transportation Research Record: Journal of the Transportation Research Board*, *2143*(1), 168–176. https://doi.org/10.3141/2143-21

Barnes, S. (2017). *Understanding Virtual Reality in Marketing: Nature, Implications and Potential*. *Ssrn*. https://doi.org/10.2139/ssrn.2909100

Bassi, A., & Horn, G. (2008). *Internet of Things in 2020 a roadmap for the future*. *European Technology Platform on Smart Systems Integration*.

Bekiaris, E., Loukea, M., Spanidis, P., Ewing, S., Denninghaus, M., Ambrose, I., Papamichail, K., & Castiglioni, R. C. (2018). Research for TRAN Committee - Transport and tourism for persons with disabilities and persons with reduced mobility. Retrieved from http://www.europarl.europa.eu/RegData/etudes/STUD/2018/617465/IPOL_STU(2018)617465_EN.pdf

Belén, V. (2018). Tourism and Technology: How Tech is Revolutionizing Travel. Retrieved February 27, 2019, from https://www.wearemarketing.com/blog/tourism-and-technology-how-tech-is-revolutionizing-travel.html

Berdugo, C. (2018). Industry 4.0: Are You Ready for the Fourth Industrial Revolution? Retrieved January 22, 2019, from https://medium.com/@carmitberdugocohen/industry-4-0-are-you-ready-for-the-fourth-industrial-revolution-464de2dea3b1

Blocksidge, D. (2003). *Dictionary of Disability Terminology*. Retrieved January 24, 2019, from http://www.dpa.org.sg/wp-content/uploads/2013/01/Dictionary.pdf

Boes, K., Buhalis, D., & Inversini, A. (2015). Conceptualising Smart Tourism Destination Dimensions. In *Information and Communication Technologies in Tourism 2015*. https://doi.org/10.1007/978-3-319-14343-9_29

Bosch, S., & Gharaveis, A. (2017). Flying solo: a review of the literature on wayfinding for older adults experiencing visual or cognitive decline. *Applied Ergonomics*, *58*, 327–333. https://doi.org/10.1016/j.apergo.2016.07.010

Breidbach, C. F., & Maglio, P. P. (2016). Technology-enabled value co-creation: An empirical analysis of actors, resources, and practices. *Industrial Marketing Management*, *56*(April), 73–85. https://doi.org/10.1016/j.indmarman.2016.03.011

Brettel, M., Friederichsen, N., & Keller, M. (2014). How virtualization, decentralization and network building change the manufacturing landscape: An industry 4.0 perspective. *International Journal Of*. https://doi.org/10.1016/j.procir.2015.02.213

Buhalis, D. (2000). Marketing the competitive destination of the future. *Tourism Management*. https://doi.org/10.1016/S0261-5177(99)00095-3

Buhalis, D., & Amaranggana, A. (2012). Information and Communication Technologies in Tourism 2012, 553–564. https://doi.org/10.1007/978-3-7091-1142-0

Buhalis, D., & Darcy, S. (2011). Accessible Tourism Concepts and Issues. Bristol: Channel View Publications

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. https://doi.org/10.1016/j.tourman.2008.01.005

Buhalis, D., & Michopoulou, E. (2011). Information-enabled tourism destination marketing: addressing the accessibility market. Current Issues in Tourism, 14(2), 145–168. https://doi.org/10.1080/13683501003653361

Buhalis, D., & O'Connor, P. (2005). Information communication technology revolutionizing tourism. Tourism Recreation Research, 30(3), 7–16. https://doi.org/10.1080/02508281.2005.11081482

Buhalis, D., Eichhorn, V., Michopoulou, E., & Miller, G. (2005). ACCESSIBILITY MARKET AND STAKEHOLDER ANALYSIS One-Stop-Shop for Accessible Tourism in Europe (OSSATE), 27(1), 1–17. https://doi.org/10.1080/15022250.2018.1478325

Bundesministerium für Wirtschaft und Energie. (2015). Digitale Souveränität: Schlüssel für Wachstum und Beschäftigung in der digitalen Welt. *Industrie 4.0 Und Digitale Wirtschaft Impulse Für Wachstum, Beschäftigung Und Innovation*.

Bundesministerium für Wirtschaft und Energie. (2016). Plattform Industrie 4.0 - Was ist Industrie 4.0? Retrieved December 08, 2018, from https://www.plattform-i40.de/PI40/Navigation/DE/Industrie40/WasIndustrie40/was-ist-industrie-40.html

Burgstahler, S. (2001). Universal design of instruction. *Remedial and Special Education*, *24*(6), 369. Retrieved from http://www.washington.edu/doit/Brochures/Academics/instruction.html

Business Insider. (2018). The 20 most visited cities around the world in 2018. Retrieved February 25, 2019, from https://www.businessinsider.com/most-visited-cities-in-the-world-2018-9

Byrne, D. M., & Corrado, C. A. (2017). ICT Services and Their Prices: What Do They Tell Us About Productivity and Technology?. https://doi.org/10.17016/FEDS.2017.015r1

Caragliu, A., del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology*, *18*(2), 65–82. https://doi.org/10.1080/10630732.2011.601117

Card, J. A., Cole, S. T., & Humphrey, A. H. (2006). A comparison of the Accessibility and Attitudinal Barriers Model: Travel providers and travelers with physical disabilities. *Asia Pacific Journal of Tourism Research*. https://doi.org/10.1080/10941660600727566

Cerrudo, C. (2014). An Emerging US (and World) Threat: Cities Wide Open to Cyber Attacks. *IEEE Communications Surveys & Tutorials*, *16*(4), 1933–1954. https://doi.org/10.1109/COMST.2014.2320093

Chareyron, G., Da-Rugna, J., & Raimbault, T. (2014). Big data: A new challenge for tourism," *2014 IEEE International Conference on Big Data (Big Data)*, Washington, DC, 2014, pp. 5-7. https://doi.org/10.1109/BigData.2014.7004475

Cheung, C. W., Tsang, T. I., & Wong, K. H. (2017). Robot Avatar: A Virtual Tourism Robot for People with Disabilities. *International Journal of Computer Theory and Engineering*, *9*(3), 229–234. https://doi.org/10.7763/ijcte.2017.v9.1143

Choi, T. Y., & Chu, R. (2001). Determinants of hotel guests' satisfaction and repeat patronage in the Hong Kong hotel industry. *International Journal of Hospitality Management*. https://doi.org/10.1016/S0278-4319(01)00006-8

Clarke, R. H., Twede, D., Tazelaar, J. R., & Boyer, K. K. (2006). Radio frequency identification (RFID) performance: The effect of tag orientation and package contents. *Packaging Technology and Science*. https://doi.org/10.1002/pts.714

Clayton, T., Sadun, R., Farooqui, S., Gale, G., Leaver, M., VanReenen, A. J., … Ritchie, F. (2005). IT investment, ICT use and UK firm productivity. *ONS, London*, (January). Retrieved from http://collection.europarchive.org/tna/20060715135119/http://www.statistics.gov.uk/articles/nojournal/ICTReportAug05a.pdf

Cohen, B (2012). The smart city wheel. Retrieved March 1, 2019, from http://www.faena.com/aleph/articles/tags/what-makes-up-a-smart-city/

Connell, B., Jones, M., Mace, R., Mueller, J., Mullick, A., Ostroff, E., … Vanderheiden, G. (1997). The Principles of Universal Design should be cited as follows: "The Center for Universal Design (1997). The Principles of Universal Design, Version 2.0. Raleigh, NC: North Carolina State University."

Crandall, E. R. (2018). Industry 1.0 to 4.0: The Evolution of Smart Factories | APICS Magazine. Retrieved March 2, 2019, from http://www.apics.org/apics-for-individuals/apics-magazine-home/magazine-detail-page/2017/09/20/industry-1.0-to-4.0-the-evolution-of-smart-factories

CTILG. (2019). Hands to Discover. Retrieved May 1, 2019, from www.handstodiscover.com

Daniels, M. J., Drogin Rodgers, E. B., & Wiggins, B. P. (2005). "Travel Tales": An interpretive analysis of constraints and negotiations to pleasure travel as experienced by persons with physical disabilities. *Tourism Management*. https://doi.org/10.1016/j.tourman.2004.06.010

Dantas, J. (2013). *Inovação e Marketing em Serviços*. Lidel.

Darcy, S. (2011). Developing sustainable approaches to accessible accommodation information provision: a foundation for strategic knowledge management. *Tourism Recreation Research ISSN: 36*(2), 141–157. https://doi.org/10.1080/02508281.2011.11081315

Darcy, S., & Dickson, T. (2009). A whole-of-life approach to tourism: the case for accessible tourism experiences. *Journal of Hospitality and Tourism Management*, *16*(1), 32–44. https://doi.org/10.1375/jhtm.16.1.32

Daruwalla, P., & Darcy, S. (2005). Personal and societal attitudes to disability. *Annals of Tourism Research*. https://doi.org/10.1016/j.annals.2004.10.008

Darvishy, A., Hutter, H., Früh, P., Horvath, A., & Berner, D. (2008). Personal mobile assistant for air passengers with disabilities (PMA). In *11th International Conference Computers Helping People (ICCHP)* (pp. 1129–1134). Linz, Austria: Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-70540-6_169

De Filippi, P., & Mccarthy, S. (2012). Cloud Computing : Centralization and Data Sovereignty. *European Journal Of Law and Technology*, *3*(2). Retrieved from http://ejlt.org/article/view/101/234

DEO (Department of Education, Massachusetts) (2005) Disability definitions and related links. Retrieved January 20, 2019, from http://www.doe.mass.edu/sped/definitions.html.

Dias, D., Lima, F., Dias, E. (2016). Tourism management and automation : RFID applications in Brazilian maritime cruises. International Journal of Internet of Things and Web Services, 1, 43–49. Retrieved from https://www.iaras.org/iaras/filedownloads/ijitws/2016/022-0006.pdf

Disabled People's Association, (DPA). (2015). Glossary of Disability Terminology. Retrieved from https://www.dpa.org.sg/wp-content/uploads/2015/10/DPA-Disability-Glossary-FINAL.pdf

Dohler, M., Vilajosana, I., Vilajosana, X., & Llosa, J. (2011). Smart Cities: An Action Plan. In *Barcelona Smart Cities Congress*. https://doi.org/10.1016/j.ymeth.2008.06.007

Dovidio, J. F., Pagotto, L., & Hebl, M. R. (2011). Implicit attitudes and discrimination against people with physical disabilities. In *Disability and Aging Discrimination: Perspectives in Law and Psychology*. https://doi.org/10.1007/978-1-4419-6293-5_9

Eichhorn, V., Miller, G., Michopoulou, E., & Buhalis, D. (2008). Enabling access to tourism through information schemes? *Annals of Tourism Research*, *35*(1), 189–210. https://doi.org/10.1016/j.annals.2007.07.005

El-gohary, H. (2014). E-Marketing-A literature Review from a Small Businesses perspective E-Marketing - A literature Review from a Small Businesses perspective, (May).

Emrouzeh, M. P., Dewar, K., Fleet, G., & Bourgeois, Y. (2017). Implementing ICT for Tourists with Disabilities. *Proceedings of the 2017 International Conference on E-Education, E-Business and E-Technology*, (6), 50–53. https://doi.org/10.1145/3141151.3141152

ENAT. (2019). Retrieved May 2, 2019, from www.accessibletourism.org

Esser, S. K., Andreopoulos, A., Appuswamy, R., Datta, P., Barch, D., Amir, A., … Modha, D. S. (2011). Cognitive Computing Systems : Algorithms and Applications for Networks of Neurosynaptic Cores, (December).

eTips. (2019). ETIPS TRAVEL APPS. Retrieved February 26, 2019, from https://etips.com/#augmented-reality

European Commission (2014). Economic Impact and Travel Patterns of Accessible Tourism in Europe – Final Report.

European Parliament. (2014). Mapping Smart Cities in EU. Retrieved from http://www.europarl.europa.eu/RegData/etudes/etudes/join/2014/507480/IPOL-ITRE_ET(2014)507480_EN.pdf

European Parliamentary Research Service. (2018). Assistive technologies for people with disabilities IN-DEPTH ANALYSIS Science and Technology Options Assessment. Retrieved from http://www.europarl.europa.eu/RegData/etudes/IDAN/2018/603218/EPRS_IDA(2018)603218_EN.pdf

Eusébio, C., Carneiro, M. J., Kastenholz, E., & Alvelos, H. (2016). The impact of social tourism for seniors on the economic development of tourism destinations. *European Journal of Tourism Research*.

Eusébio, C., Carneiro, M. J., Kastenholz, E., & Alvelos, H. (2017). Social tourism programs for the senior market: a benefit segmentation analysis. *Journal of Tourism and Cultural Change*. https://doi.org/10.1080/14766825.2015.1117093

Evstropyeva, O. V., Zabortseva, T. I., & Korytny, L. M. (2018). Ecological barriers to tourism development (a case study of the Baikal region). *IOP Conference Series: Earth and Environmental Science*, *190*(1). https://doi.org/10.1088/1755-1315/190/1/012006

Fall, C. L., Quevillon, F., Blouin, M., Latour, S., Campeau-Lecours, A., Gosselin, C., & Gosselin, B. (2018). A Multimodal Adaptive Wireless Control Interface for People with Upper-Body Disabilities. *IEEE Transactions on Biomedical Circuits and Systems*, *12*(3), 564–575. https://doi.org/10.1109/TBCAS.2018.2810256

Figueiredo, E., Eusébio, C., & Kastenholz, E. (2012). How Diverse are Tourists with Disabilities? A Pilot Study on Accessible Leisure Tourism Experiences in Portugal. *International Journal of Tourism Research*. https://doi.org/10.1002/jtr.1913

Fleischer, A., & Pizam, A. (2002). Tourism constraints among Israeli seniors. *Annals of Tourism Research*. https://doi.org/10.1016/S0160-7383(01)00026-3

Food and Agriculture Organisation (FAO). (2017). *Information and Communication Technology (ICT) in Agriculture: A Report to the G20 Agricultural Deputies*.

Fuchs, M., Höpken, W., & Lexhagen, M. (2014). Big data analytics for knowledge generation in tourism destinations - A case from Sweden. *Journal of Destination Marketing and Management*, *3*(4), 198–209. https://doi.org/10.1016/j.jdmm.2014.08.002

Furnham, A. (1984). Tourism and culture shock. *Annals of Tourism Research*. https://doi.org/10.1016/0160-7383(84)90095-1

Giffinger, R., & Fertner, C. (2007). City-ranking of European medium-sized cities. *Centre of Regional*, 1–12.

Girardin, F., Blat, J., Calabrese, F., Dal Fiore, F., & Ratti, C. (2008). Digital footprinting: Uncovering tourists with user-generated content. *IEEE Pervasive Computing*. https://doi.org/10.1109/MPRV.2008.71

Gnoth, J. (2002). Tourism motivation and expectation formation. *Annals of Tourism Research*. https://doi.org/10.1016/s0160-7383(97)80002-3

GODFREY, K. (2018). Most visited cities in the world 2018 - does London make the list? *Express UK*. Retrieved from https://www.express.co.uk/travel/articles/1022766/most-visited-city-in-the-world-2018-london-dubai-new-york

Gresham, F. M., Sugai, G., & Horner, R. H. (2001). Interpreting outcomes of social skills training for students with high-incidence disabilities. *Exceptional Children*. https://doi.org/10.1177/001440290106700303

Gretzel, U., Sigala, M., Xiang, Z., & Koo, C. (2015). Smart tourism: foundations and developments. *Electronic Markets*, *25*(3), 179–188. https://doi.org/10.1007/s12525-015-0196-8

Guo, Y., Liu, H., & Chai, Y. (2014). The embedding convergence of smart cities and tourism internet of things in China: An advanced perspective. *Advances in Hospitality and Tourism Research (AHTR), 2*(1), 54–69. Retrieved from http://dergipark.gov.tr/download/article-file/372557

Haddara, M., & Elragal, A. (2015). The Readiness of ERP Systems for the Factory of the Future. In *Procedia Computer Science*. https://doi.org/10.1016/j.procs.2015.08.598

Han, D. I., Jung, T., & Gibson, A. (2014). Dublin AR: Implementing Augmented Reality in Tourism. In *Information and Communication Technologies in Tourism 2014*. https://doi.org/10.1007/978-3-319-03973-2_37

Hanseth, O., & Bygstad, B. (2015). Flexible generification: ICT standardization strategies and service innovation in health care. *European Journal of Information Systems*, *24*(6), 645–663. https://doi.org/10.1057/ejis.2015.1

Haworth, A., & Williams, P. (2012). Using QR codes to aid accessibility in a museum. *Journal of Assistive Technologies*, *6*(4), 285–291. https://doi.org/10.1108/17549451211285771

Heiskanen, E., Halme, M., Jalas, M., Kärnä, A., & Lovio, R. (2001). *Dematerialization: The Potential of ICT and Services*. Retrieved from https://core.ac.uk/download/pdf/16390705.pdf

Hoy, M. B. (2018). Alexa, Siri, Cortana, and More: An Introduction to Voice Assistants. *Medical Reference Services Quarterly*. https://doi.org/10.1080/02763869.2018.1404391

Huang, S. H., Liu, P., Mokasdar, A., & Hou, L. (2013). Additive manufacturing and its societal impact: A literature review. *International Journal of Advanced Manufacturing Technology*. https://doi.org/10.1007/s00170-012-4558-5

Huang, X. kai, Yuan, J. zheng, & Shi, M. yu. (2012). Condition and Key Issues Analysis on the Smarter Tourism Construction in China. In *Communications in Computer and Information Science*. https://doi.org/10.1007/978-3-642-35286-7_56

IBM. (2015a). What is Cloud Computing? https://doi.org/10.1007/978-3-642-13067-0_35

IBM. (2015b). Computing , cognition and the future of knowing. How humans and machines are forging a new age of understanding. Retrieved January 25, 2019, from http://www.kutayzorlu.com/wp-content/uploads/2017/08/Computing_Cognition_WhitePaper.pdf

IBM. (2016). What is M2M technology? Retrieved February 22, 2019, from https://www.ibm.com/blogs/internet-of-things/what-is-m2m-technology/

IBM. (2017). Vacation with IBM Watson and discover a whole new world. Retrieved March 12, 2019, from https://www.ibm.com/blogs/client-voices/vacation-ibm-watson-discover-new-world/

ICT. (2019) In Cambridge dictionary. Retrieved from https://dictionary.cambridge.org/pt/dicionario/ingles/ict?q=ICT

Irestig, M., & Timpka, T. (2008). Politics and technology in health information systems development: A discourse analysis of conflicts addressed in a systems design group. *Journal of Biomedical Informatics*. https://doi.org/10.1016/j.jbi.2007.05.009

Ivanov, S., Webster, C., & Berezina, K. (2017). Adoption of robots and service automation by tourism and hospitality companies. *Turismo & Desenvolvimento*, *27*(28), 1501–1517. Retrieved from https://www.researchgate.net/publication/322635104

Ivanović, S., Milojica, V., & Roblek, V. (2017). A Holistic Approach to Innovations in Tourism. *International Conference on Economic and Social Studies (ICESoS'16)*, (September), 367–380.

Jancenelle, Vivien, Storrud-Barnes, Susan, Javalgi, R. (2017). Augmented reality, virtual reality and 3D printing for the co-creation of value for the visitor experience at cultural heritage places. *Management Research Review*, *40*(3), 352–367. https://doi.org/https://doi.org/10.1108/MRR-01-2016-0019 Downloaded

Jansen, A. (2012). The understanding of ICTs in public sector and its impact on governance. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *7443 LNCS*, 174–186. https://doi.org/10.1007/978-3-642-33489-4_15

Jaremen, D. (2016). Advantages from ICTS usage in hotel industry. *Czech Journal of Social Sciences, Business and Economics*, *5*(3), 6–17. https://doi.org/10.24984/cjssbe.2016.5.3.1

Jasperneite, J. (2013). Was hinter Begriffen wie Industrie 4.0 steckt. *Internet Und Automation*. Retrieved December 20, 2018, from https://www.computer-automation.de/steuerungsebene/steuern-regeln/artikel/93559/

Jazdi, N. (2014). Cyber-physical systems in the context of Industry 4.0. In *Proceedings of 2014 IEEE International Conference on Automation, Quality and Testing, Robotics, AQTR 2014*. https://doi.org/10.1109/AQTR.2014.6857843

Jovicic, D. Z. (2019). From the traditional understanding of tourism destination to the smart tourism destination. *Current Issues in Tourism*, *22*(3), 276–282. https://doi.org/10.1080/13683500.2017.1313203

Jung, T., tom Dieck, M. C., Lee, H., & Chung, N. (2016). Effects of Virtual Reality and Augmented Reality on Visitor Experiences in Museum. In *Information and Communication Technologies in Tourism 2016*. https://doi.org/10.1007/978-3-319-28231-2_45

Jurčić, I., Umachandran, K., Della Corte, V., Del Gaudio, G., Aravind, V., Ferdinand-James, D. (2018). Industry 4.0: Unleashing Its Future Smart Services.

Kannan, S. M., Suri, K., Cadavid, J., Barosan, I., Brand, M. Van Den, Alferez, M., & Gerard, S. (2017). Towards industry 4.0: Gap analysis between current automotive MES and industry standards using model-based requirement engineering. In *Proceedings - 2017 IEEE International Conference on Software Architecture Workshops, ICSAW 2017: Side Track Proceedings*. https://doi.org/10.1109/ICSAW.2017.53

Kastenholz, E., Eusébio, C., Figueiredo, E., & Lima, J. (2012). Accessibility as competitive advantage of a tourism destination: The case of Lousã. *Advances in Culture, Tourism and Hospitality Research*, *6*, 369–385. https://doi.org/10.1108/S1871-3173(2012)0000006023

Kastner, W., Neugschwandtner, G., Soucek, S., & Newman, H. M. (2005). Communication systems for building automation and control. In *Proceedings of the IEEE*. https://doi.org/10.1109/JPROC.2005.849726

Kaur, K., & Kaur, R. (2016). Internet of Things to promote Tourism : An insight into Smart Tourism. *International Journal of Recent Trends in Engineering and Research*. Retrieved from https://www.ijrter.com/papers/volume-2/issue-4/internet-of-things-to-promote-tourism-an-insight-into-smart-tourism.pdf

Kittay, E. F. (2011), The Ethics of Care, Dependence, and Disability*. Ratio Juris, 24: 49-58. https://doi.org/10.1111/j.1467-9337.2010.00473.x

Klein, S., Avery, M., Adams, G., Pollard, S., & Simske, S. (2014). From scan to print: 3D printing as a means for replication. In *NIP & Digital Fabrication Conference*.

Klironomos, I., Antona, M., Basdekis, I., & Stephanidis, C. (2006). White Paper: Promoting Design for All and e-Accessibility in Europe. *Universal Access in the Information Society*, *5*(1), 105–119. https://doi.org/10.1007/s10209-006-0021-4

Konkel, M., Leung, V., Ullmer, B., & Hu, C. (2004). Tagaboo: a collaborative children's game based upon wearable RFID technology. *Personal and Ubiquitous Computing*. https://doi.org/10.1007/s00779-004-0302-y

Koo, C., Gretzel, U., Hunter, W. C., & Chung, N. (2015). The Role of IT in Tourism. *Asia Pasific Journal of Information System*, *25*(1), 99–104. https://doi.org/http://dx.doi.org/10.14329/apjis.2015.25.1.099

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

Kovar, J., Mouralova, K., Ksica, F., Kroupa, J., Andrs, O., & Hadas, Z. (2016). Virtual Reality in Context of Industry 4.0. *Proceedings of the 2016 17Th International Conference on Mechatronics - Mechatronika (Me) 2016*.

Kraus, L., Lauer, E., Coleman, R., & Houtenville, A. (2018). *2017 Disability Statistics Annual Report*. *University of New Hampshire*. https://doi.org/10.1007/s001380050037

Krevelen, D. W. F. van, & Poelman, R. (2010). A Survey of Augmented Reality Technologies, Applications and Limitations. *The International Journal of Virtual Reality*. https://doi.org/10.1155/2011/721827

Lee, J., Kao, H. A., & Yang, S. (2014). Service innovation and smart analytics for Industry 4.0 and big data environment. *Procedia CIRP*, *16*, 3–8. https://doi.org/10.1016/j.procir.2014.02.001

Lee, S., Jeon, S., & Kim, D. (2011). The impact of tour quality and tourist satisfaction on tourist loyalty: The case of Chinese tourists in Korea. *Tourism Management*, *32*(5), 1115–1124. https://doi.org/10.1016/j.tourman.2010.09.016

Lee, S., Yoon, D., & Ghosh, A. (2008). Intelligent parking lot application using wireless sensor networks. In *2008 International Symposium on Collaborative Technologies and Systems, CTS'08*. https://doi.org/10.1109/CTS.2008.4543911

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

Li, Y., Hu, C., Huang, C., & Duan, L. (2017). The concept of smart tourism in the context of tourism information services. *Tourism Management*, *58*, 293–300. https://doi.org/10.1016/j.tourman.2016.03.014

Liu, Z., Sokhn, M., Calvé, A., & Schegg, R. (2016). City Eye: Accessibility for all. In *9th International Conference on Theory and Practice of Electronic Governance (ICEGOV2016)* (pp. 350–351). Montevideo, Uruguay.

Lu, S. C. Y., Shpitalni, M., & Gadh, R. (1999). Virtual and augmented reality technologies for product realization. *CIRP Annals - Manufacturing Technology*. https://doi.org/10.1016/S0007-8506(07)63229-6

Magliulo, A. (2016). Cyber Security and Tourism Competitiveness. *European Journal of Tourism, Hospitality and Recreation*, *7*(2), 128–134. https://doi.org/10.1515/ejthr-2016-0015

Maisonneuve, N., Stevens, M., Niessen, M. E., Hanappe, P., Steels, L., & Maria, E. (2009). Citizen Noise Pollution Monitoring. *The Proceedings of the 10th International Digital Government Research Conference*.

Majumdar, S. (2015). Emerging Trends in ICT for Education & Training. *Unevoc.Unesco.Org*, 1–13. Retrieved from http://www.unevoc.unesco.org/fileadmin/up/emergingtrendsinictforeducationandtraining.pdf

Mammadov, R. (2012). The Importance of Transportation in Tourism Sector. *7th Silk Road International Conference "Challenges and Opportunities of Sustainable Economic Development in Eurasian Countries."*

Marquardt, K. (2017). Smart services – characteristics, challenges, opportunities and business models. *Proceedings of the International Conference on Business Excellence*, *11*(1). https://doi.org/10.1515/picbe-2017-0084

McKercher, B. (2008). A citation analysis of tourism scholars. *Tourism Management*. https://doi.org/10.1016/j.tourman.2008.03.003

Mckillop, H. (2013). Sustainable Archaeological Tourism of the Underwater Maya Project by 3D Technology, Anthmpology News (May/ June), 12–13. Retrieved from http://www.ga.lsu.edu/hmckill/publications/2013%20McKillop%20and%20Sills%20Anth%20News.pdf

McKinsey Digital. (2015). Industry 4.0 How to navigate digitalization of the manufacturing sector. Retrieved January 25, 2019, from, http://www.forschungsnetzwerk.at/downloadpub/mck_industry_40_report.pdf

McKinsey Digital. (2016). Industry 4.0 After the initial hype Where manufacturers are finding value and how they can best capture it. Retrieved January 25, 2019, from, https://www.mckinsey.com/~/media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/getting%20the%20most%20out%20of%20industry%204%200/mckinsey_industry_40_2016.ashx

McKinsey & Company. (2015). Manufacturing's next act June 2015. Retrieved December 10, 2018, from https://www.mckinsey.com/business-functions/operations/our-insights/manufacturings-next-act

Meade, T. W., Dyer, S., Browne, W., & Frank, A. O. (1995). Randomised comparison of chiropractic and hospital outpatient management for low back pain: Results from extended follow up. *BMJ*. https://doi.org/10.1136/bmj.311.7001.349

Michopoulou, E., & Buhalis, D. (2013). Information provision for challenging markets: the case of the accessibility requiring market in the context of tourism. *Information & Management*, *50*(5), 229–239. https://doi.org/10.1016/j.im.2013.04.001

Milicchio, F., & Prosperi, M. (2016). Accessible tourism for the deaf via mobile apps. In *9th ACM International Conference on PErvasive Technologies Related to Assistive Environments - PETRA '16* (pp. 1–7). New York, New York, USA: ACM Press. https://doi.org/10.1145/2910674.2910694

Moavenzadeh, J. (World E. F., & Maar, L. (Accenture). (2018). The Known Traveller: Unlocking the potential of digital identity for secure and seamless travel. *World Economic Forum*, (January). Retrieved from http://www3.weforum.org/docs/WEF_The_Known_Traveller_Digital_Identity_Concept.pdf

Mobile technology. (2019) In Cambridge dictionary. Retrieved from https://dictionary.cambridge.org/pt/dicionario/ingles/mobile-technology

Mohd Isa. (2011). Assessing the Usability and Accessibility of Malaysia E-Government Website. *American Journal of Economics and Business Administration*. https://doi.org/10.3844/ajebasp.2011.40.46

Mrugalska, B., & Wyrwicka, M. K. (2017). Towards Lean Production in Industry 4.0. In *Procedia Engineering*. https://doi.org/10.1016/j.proeng.2017.03.135

Münster, D., & Münster, U. (2012). Consuming the Forest in an Environment of Crisis: Nature Tourism, Forest Conservation and Neoliberal Agriculture in South India. *Development and Change*. https://doi.org/10.1111/j.1467-7660.2012.01754.x

Nath, B., Reynolds, F., & Want R., "RFID Technology and Applications," in IEEE Pervasive Computing, vol. 5, no. 1, pp. 22-24, Jan.-March 2006. https://doi.org/10.1109/MPRV.2006.13

Ndou, V., & Passiante, G. (2005). Value Creation in Tourism Network Systems. *Information and Communication Technologies in Tourism 2005*, 440–451. https://doi.org/10.1007/3-211-27283-6_40

Neuhofer, B., Buhalis, D., & Ladkin, A. (2012). Conceptualising technology enhanced destination experiences. *Journal of Destination Marketing and Management*. https://doi.org/10.1016/j.jdmm.2012.08.001

Newman, D. (2018). Top 6 Digital Transformation Trends in Hospitality and Tourism. Retrieved February 27, 2019, from https://www.forbes.com/sites/danielnewman/2018/01/02/top-6-digital-transformation-trends-in-hospitality-and-tourism/#23f6ddb267df

Nunes, M. L., Pereira, A. C., & Alves, A. C. (2017). Smart products development approaches for Industry 4.0. *Procedia Manufacturing*. https://doi.org/10.1016/j.promfg.2017.09.035

Öztayşi, B., Baysan, S., & Akpinar, F. (2009). Radio frequency identification (RFID) in hospitality. *Technovation*, *29*(9), 618–624. https://doi.org/10.1016/j.technovation.2009.05.014

Ozturk, Y., Yayli, A., & Yesiltas, M. (2008). Is the Turkish tourism industry ready for a disabled customer's market?. The views of hotel and travel agency managers. *Tourism Management*. https://doi.org/10.1016/j.tourman.2007.03.011

Pala, Z., & Inanç, N. (2007). Smart parking applications using RFID technology. *2007 1st Annual RFID Eurasia*, (May), 2007–2010. https://doi.org/10.1109/RFIDEURASIA.2007.4368108

Papa, R. (2014). SMART CITY CHALLENGES : PLANNING FOR SMART CITIES. DEALING WITH NEW URBAN CHALLENGES. *TeMAJournal of Land Use, Mobility and Environment*.

Paper, B. W., Zysman, J., Feldman, S., Murray, J., Nielsen, N. C., Kushida, K. E., … Press, I. O. S. (2011). Services with Everything : The ICT-Enabled Digital Transformation of Services 1 Copyright 2010 by the Authors Governance : The Digital Transformation of Services . ‖ in Innovations in Public.

Parida, V., Sjödin, D., & Reim, W. (2019). Reviewing literature on digitalization, business model innovation, and sustainable industry: Past achievements and future promises. *Sustainability (Switzerland)*. https://doi.org/10.3390/su11020391

Peceny, U. S., Urbančič, J., Mokorel, S., Kuralt, V., & Ilijaš, T. (2019). Tourism 4.0: Challenges in Marketing a Paradigm Shift. *Intech Open*, *2*, 64. https://doi.org/10.5772/32009

Persson, H., Åhman, H., Yngling, A. A., & Gulliksen, J. (2015). Universal design, inclusive design, accessible design, design for all: different concepts—one goal? On the concept of accessibility—historical, methodological and philosophical aspects. *Universal Access in the Information Society*, *14*(4), 505–526. https://doi.org/10.1007/s10209-014-0358-z

Popiel, M. (2016). Barriers in Undertaking Tourist Activity by Disabled People, (3), 103–110.

Portales, R. C. (2015). Removing "invisible" barriers: opening paths towards the future of accessible tourism. *Journal of Tourism Futures*, *1*(3), 269–284. https://doi.org/10.1108/JTF-04-2015-0018

PREDIF. (2019). Retrieved May 2, 2019, from www.predif.org

Pühretmair, F. (2004). It's time to make eTourism accessible. *Computers Helping People with Special Needs*, 272–279. https://doi.org/10.1007/978-3-540-27817-7_41

Pühretmair, F., & Wöß, W. (2008). A flexible concept to establish accessibility information in tourism web-pages. In *11th International Conference Computers Helping People (ICCHP)* (pp. 981–988). Linz, Austria: Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-540-70540-6_147

Put-van den Beemt, W., & Smith, R. (2016). Smart tourism tools: linking technology to the touristic resources of a city. *Smart Tourism Congress Barcelona*, 1–12. Retrieved from https://www.cett.es/fitxers/campushtml/MiniWebs/122/papers/PUT_SMITH.pdf

Radosav, D., Karuovic, D., Markoski, B., & Ivankovic, Z. (2011). Guidelines on accessible web portal design. In *12th International Symposium on Computational Intelligence and Informatics (CINTI)* (pp. 297–302). Budapeste, Hungary: IEEE. https://doi.org/10.1109/CINTI.2011.6108518

Ribeiro, F., Silva, A., Barbosa, F., Silva, A., & Metrôlho, J. (2018). Mobile applications for accessible tourism: overview, challenges and a proposed platform. *Information Technology & Tourism*, *19*(1–4), 29–59. https://doi.org/10.1007/s40558-018-0110-2

Rogers, J., & Spavriero, S. (2011). Same tune, different words: The creative destruction of the music. *Observatorio*, *5*(4), 1–30.

Rouse, M. (2014). ICT (information and communications technology, or technologies). Retrieved January 23, 2019, from https://searchcio.techtarget.com/definition/ICT-information-and-communications-technology-or-technologies

Rumetshofer, H., & Woss, W. (2005). Semantic maps and meta-data enhancing e-accessibility in tourism information systems. In *16th International Workshop on Database and Expert Systems Applications (DEXA'05)* (pp. 881–885). IEEE. https://doi.org/10.1109/DEXA.2005.176

Russo, C. (2015). The digital transformation could add EUR 1.25 trillion to Europe's industrial value creation by 2025 – or diminish it by EUR 605 billion. Retrieved December 08, 2018, from https://www.rolandberger.com/en/Media/The-digital-transformation-could-add-EUR-1.25-trillion-to-Europe's-industrial-va.html

Rüßmann, M., Lorenz, M., Gerbert, P., Waldner, M., Justus, J., Engel, P., & Harnisch, M. (2015). Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries. *Boston Consulting*. https://doi.org/10.1007/s12599-014-0334-4

Saturno, M., Pertel, V. M., Deschamps, F., De, F. R., & Loures, E. R. (2018). Proposal of an Automation Solutions Architecture for Industry 4. *0. LogForum*, *14*(2), 185–195. https://doi.org/10.17270/J.LOG.2018.266

Schlüter, F. F., Hetterscheid, E., & Henke, M. (2017). A Simulation-Based Evaluation Approach for Digitalization Scenarios in Smart SupplyChain Risk Management. *Journal of Industrial Engineering and Management Science*, *2017*(1), 179–206. https://doi.org/10.13052/jiems2446-1822.2017.009

Schwab, K. (2016). *The Fourth Industrial Revolution*. LEVOIR.

Sedlar, U., Kos, A., Pustisek, M., Bester, J., Pogacnik, M., Mali, L., & Stojmenova Duh, E. (2018). Tackling the Challenges of ICT Innovation and Talents for Industry 4.0. *Transactions on Internet Research*, *14*(1).

Sevilla, J., Herrera, G., Martínez, B., & Alcantud, F. (2007). Web accessibility for individuals with cognitive deficits. *ACM Transactions on Computer-Human Interaction*, *14*(3), 12-es. https://doi.org/10.1145/1279700.1279702

Shahid, M., & Tasneem, K. A. (2017). Impact of Avoiding Non-functional Requirements in Software Development Stage. *American Journal of Information Science and Computer Engineering*.

Shi, Y. (2006). The accessibility of Queensland visitor information centers' websites. *Tourism Management*, *27*(5), 829–841. https://doi.org/10.1016/j.tourman.2005.05.012

Short, D. B. (2016). Use of 3D Printing by Museums: Educational Exhibits, Artifact Education, and Artifact Restoration. *3D Printing and Additive Manufacturing*. https://doi.org/10.1089/3dp.2015.0030

Siepmann, D., & Graef, N. (2016). Industrie 4.0 – Grundlagen und Gesamtzusammenhang. In *Einführung und Umsetzung von Industrie 4.0*. https://doi.org/10.1007/978-3-662-48505-7_2

siosLife. (2019). Retrieved May 1, 2019, from www.sioslife.com

Smith, R. W. (1987). Leisure of disable tourists. Barriers to participation. Annals of Tourism Research, Vol 14, pp, 376-389. https://doi.org/10.1016/0160-7383(87)90109-5

Smyth, C., & Crabtree, M. (2012). The Use of RFID Technology At Pedestrian Crossings To ASSIST DISABLED USERS: ON-STREET TRIAL RESULTS. Rerived from https://www.starconference.org.uk/star/2012/SmythCrabtree.pdf

Snyman, J. A. (2002). *The needs of tourists with disabilities. Potchefstroom University for Christian Higher Education, Potchefstroom*. Retrieved from https://repository.nwu.ac.za/handle/10394/6527

Soteriades, M. (2012). Tourism destination marketing: Approaches improving effectiveness and efficiency. *Journal of Hospitality and Tourism Technology*. https://doi.org/10.1108/17579881211248781

Standen, P. J., & Brown, D. J. (2005). Virtual Reality in the Rehabilitation of People with Intellectual Disabilities: Review. *CyberPsychology & Behavior*. https://doi.org/10.1089/cpb.2005.8.272

Story, M. F. (1998). Maximizing Usability: The Principles of Universal Design. *Assistive Technology*, *10*(1), 4–12. https://doi.org/10.1080/10400435.1998.10131955

Stumbo, N. J., & Pegg, S. (2005). Travelers and Tourists With Disabilities : a Matter of Priorities and Loyalties. *Tourism Review International*. https://doi.org/10.3727/154427205774791537

Tantawy, A., Kim, W. G., & Pyo, S. (2005). Evaluation of Hotels to Accommodate Disabled Visitors. *Journal of Quality Assurance in Hospitality & Tourism*. https://doi.org/10.1300/J162v05n01_07

TechTarget. (2014). ICT (information and communications technology, or technologies). Retrieved January 20, 2019, from https://searchcio.techtarget.com/definition/ICT-information-and-communications-technology-or-technologies

Teixeira, A., Ferreira, F., Almeida, N., Silva, S., Rosa, A. F., Pereira, J. C., & Vieira, D. (2017). Design and development of Medication Assistant: older adults centered design to go beyond simple medication reminders. *Universal Access in the Information Society*, *16*(3), 545–560. https://doi.org/10.1007/s10209-016-0487-7

Teixeira, L., Ferreira, C., & Santos, B. S. (2012). User-centered requirements engineering in health information systems: A study in the hemophilia field. *Computer Methods and Programs in Biomedicine*, *106*(3), 160–174. https://doi.org/10.1016/j.cmpb.2010.10.007

Tobergte, D. R., & Curtis, S. (2013). *Einführung und Umsetzung von Industrie 4.0 - Grundlagen, Vorgehensmodell und Use Cases aus der Praxis*. *Journal of Chemical Information and Modeling* (Vol. 53). https://doi.org/10.1017/CBO9781107415324.004

Tourism for All. (2019). Retrieved May 3, 2019, from www.tourism-for-all.com

Tourismus für Alle Deutschland. (2019). Reisen für Alle. Retrieved May 2, 2019, from www.reisen-fuer-alle.de

Tran, V. (2011). The Impact of ICT Developments on the Music Industry. Retrieved February 23, 2019, from https://tphoangviet.wordpress.com/2011/03/16/the-impact-of-ict-developments-on-the-music-industry-2001-–-2009/

Tsai, C. Y., & Chung, S. H. (2012). A personalized route recommendation service for theme parks using RFID information and tourist behavior. *Decision Support Systems*, *52*(2), 514–527. https://doi.org/10.1016/j.dss.2011.10.013

Tsai, J. Y., Kelley, P., Cranor, L. F., & Sadeh, N. (2009). Location-sharing technologies: Privacy risks and controls. *Isjlp*, (2002). https://doi.org/10.3868/s050-004-015-0003-8

Turismo de Portugal. (2019). Tourism for all. Retrieved May 6, 2019, from http://www.turismodeportugal.pt

Turner, R. (2017). *The Economic Impact of Travel*. Retrieved from https://www.wttc.org/-/media/files/reports/economic-impact-research/regions-2017/world2017.pdf

United Nations. (2006). *The UN convention on the rights of persons with disabilities*. Retrieved from https://www.un.org/disabilities/documents/convention/convoptprot-e.pdf

UNWTO. (1980). Manila Declaration on World Tourism. *The World Tourism Conference*. Retrieved from https://www.univeur.org/cuebc/downloads/PDF%20carte/65.%20Manila.PDF

UNWTO. (2009). Understanding Tourism: Basic Glossary. *World Tourism Organization*. http://cf.cdn.unwto.org/sites/all/files/docpdf/glossaryenrev.pdf

UNWTO. (2017). *Tourism and the Sustainable Development Goals – Journey to 2030*. https://doi.org/10.18111/9789284419401

Vaidya, S., Ambad, P., & Bhosle, S. (2018). Industry 4.0 - A Glimpse. *Procedia Manufacturing*, *20*, 233–238. https://doi.org/10.1016/j.promfg.2018.02.034

Vargo, S. L., & Lusch, R. F. (2004). Evolving to a New Dominant Logic for Marketing. *Journal of Marketing*. https://doi.org/10.1509/jmkg.68.1.1.24036

VDMA. (2016). Guideline Industrie 4.0: Guiding principles for the implementation of Industrie 4.0 in small and medium sized businesses. *Plattform Industrie 4.0*. https://doi.org/978-8163-0687-0

Vila, T. D., González, L. A., & Darcy, S. (2018) Accessible tourism online resources: a Northern European perspective, Scandinavian Journal of Hospitality and Tourism, 19:2, 140-156, https://doi.org/10.1080/15022250.2018.1478325

Virtual Assistant. (2019) In Cambridge dictionary. Retrieved from https://dictionary.cambridge.org/pt/dicionario/ingles/virtual-assistant

Virtual Reality. (2019) In Oxford dictionary. Retrieved from https://en.oxforddictionaries.com/definition/virtual_reality

W3C. (2016a). Techniques for WCAG 2.0. Retrieved from https://www.w3.org/TR/WCAG-TECHS/

W3C. (2016b). Understanding WCAG 2.0. Retrieved from https://www.w3.org/TR/UNDERSTANDING-WCAG20/

W3C. (2018a). How to Meet WCAG 2 (Quick Reference). Retrieved from https://www.w3.org/WAI/WCAG21/quickref/

W3C. (2018b). Web Content Accessibility Guidelines (WCAG) 2.1.

W3C. (2019). Web Accessibility Evaluation Tools List. Retrieved from https://www.w3.org/WAI/ER/tools/

Walters, P., & Davies, K. (2010). 3D printing for artists: research and creative practice. *Rapport*.

Wang, D., Li, X., & Li, Y. (2013). China's "smart tourism destination" initiative: A taste of the service-dominant logic. *Journal of Destination Marketing and Management*. https://doi.org/10.1016/j.jdmm.2013.05.004

Wang, D., Xiang, Z., & Fesenmaier, D. R. (2016). Smartphone Use in Everyday Life and Travel. *Journal of Travel Research*. https://doi.org/10.1177/0047287514535847

Wang, L., Law, R., Guillet, B. D., Hung, K., & Fong, D. K. C. (2015). Impact of hotel website quality on online booking intentions: ETrust as a mediator. *International Journal of Hospitality Management*. https://doi.org/10.1016/j.ijhm.2015.03.012

Wang, W., Wu, Y., Yuan, C., Xiong, H., & Liu, W. (2017). Use of social media in uncovering information services for people with disabilities in China. *The International Review of Research in Open and Distributed Learning*, *18*(1), 65–83. https://doi.org/10.19173/irrodl.v18i1.2621

Waschke, S. (2004). *Labeling im Barrierefreien Tourismus in Deutschland – Vergleichende Analyse auf Basis Europäischer Beispiele. Thesis. Universität Lüneburg*. Universität Lüneburg.

Washburn, D., Sindhu, U., Balaouras, S., Dines, R. A., Hayes, N. M., & Nelson, L. E. (2010). Understand smart city initiative. https://doi.org/10.1029/2004RS003041

Wetzel, E., & Barten, C. (2016). Smart Technologies in Tourism. *International Tourism Student Conference*, (April). Retrieved from https://opendataincubator.eu/files/2016/06/Smart-Technologies-in-Tourism.pdf

Wolter, M. I., Mönnig, A., Hummel, M., Weber, E., Zika, G., Helmrich, R., … Neuber-Pohl, C. (2015). Industrie 4.0 und die Folgen für Arbeitsmarkt und Wirtschaft: Szenario-Rechnungen im Rahmen der BIBB-IAB-Qualifikations- und Berufsfeldprojektionen. *IAB-Forschungsbericht*, *8*, 68. https://doi.org/10.1007/s10273-011-1262-2

Wooden, A. (2017). How New Smart Cities Hope to Attract Smart Tourists. Retrieved February 25, 2019, from https://www.intel.co.uk/content/www/uk/en/it-management/cloud-analytic-hub/tourism-in-smart-cities.html

World Economic Forum, & Accenture. (2017). Digital Transformation Initiative Aviation, Travel and Tourism Industry In collaboration with Accenture Contents, (January). Retrieved from http://reports.weforum.org/digital-transformation

World Health Organisation. (1993). International Classification of impairments, disabilities and handicaps (ICIDH), (May 1976).

World Health Organization. (2011). World Report on Disability - Summary. *World Report on Disability 2011*, (WHO/NMH/VIP/11.01), 1–23. https://doi.org/http://www.who.int/disabilities/world_report/2011/report/en/

World Tourism Organization. (1991). Resolution adopted by the General Assembly on 21 December 1990. 45/216. Population and development. *Population Newsletter / Issued by the Population Division of the Department of Economic and Social Affairs, United Nations*, (51), 21–23.

World Tourism Organization. (2001). Global Code of Ethics for Tourism. Resolution adopted by the WTO General Assembly 21 December 2001. Retrieved from http://cf.cdn.unwto.org/sites/all/files/docpdf/gcetbrochureglobalcodeen.pdf

World Travel & Tourism Council. (2015). Seven ways technology is changing the travel industry. Retrieved February 27, 2019, from https://medium.com/@WTTC/seven-ways-technology-is-changing-the-travel-industry-85cff79c1ece

World Travel & Tourism Council. (2018). *Economic Impact 2018*. *Travel and Tourism*. Retrieved from https://www.wttc.org/-/media/files/reports/economic-impact-research/cities-2018/city-travel--tourism-impact-2018final.pdf

Xiang, Z., Magnini, V. P., & Fesenmaier, D. R. (2015). Information technology and consumer behavior in travel and tourism: Insights from travel planning using the internet. *Journal of Retailing and Consumer Services*. https://doi.org/10.1016/j.jretconser.2014.08.005

Xiang, Z., Schwartz, Z., Gerdes, J. H., & Uysal, M. (2015). What can big data and text analytics tell us about hotel guest experience and satisfaction? *International Journal of Hospitality Management*. https://doi.org/10.1016/j.ijhm.2014.10.013

Yi, M. Y., & Hwang, Y. (2003). Predicting the use of web-based information systems: Self-efficacy, enjoyment, learning goal orientation, and the technology acceptance model. *International Journal of Human Computer Studies*. https://doi.org/10.1016/S1071-5819(03)00114-9

Yunpeng, L. I., HU, C., Chao, H., & Liqiong, D. (2014). The Concept of Smart Tourism under the Context of Tourism Information Service. (English). *Tourism Tribune / Lvyou Xuekan*, *29*(5), 106–115. http://doi.org/10.3969/j.issn.1002-5006.2014.05.0111

Zajadacz, A. (2014). Sources of tourist information used by deaf people. Case study: the polish deaf community. *Current Issues in Tourism*, *17*(5), 434–454. https://doi.org/10.1080/13683500.2012.725713

Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M. (2014). Internet of things for smart cities. *IEEE Internet of Things Journal*, *1*(1), 22–32. https://doi.org/10.1109/JIOT.2014.2306328

Zeni, N., Kiyavitskaya, N., Barbera, S., Oztaysi, B., & Mich, L. (2009). RFID-Based Action Tracking for Measuring the Impact of Cultural Events on Tourism. In *Information and Communication Technologies in Tourism 2009*. https://doi.org/10.1007/978-3-211-93971-0_19

Zhou, Y. J., Hyvonen, S. L., & Louise, S. (2004). *Functional Requirements and Non-Functional Requirements: A Survey*.

Zyda, M. (2005). From visual simulation to virtual reality to games. https://doi.org/10.1109/MC.2005.297

Attachments

Attachment 1: Problems in WCAG 2.0 Success criteria Identified with TAW

Success criteria – Conformance level	Problems Detected	Min	Max	Mean	Std. Des.
1.1.1 Non-text Content –A	5467	0	229	15,89	22,346
1.2.1 Audio and Video Only – A	4	0	2	0,01	0,152
1.2.2 Captions – A	0	0	0	0	0
1.2.3 Audio Description or Media – A	0	0	0	0	0
1.2.4 Captions (live) – AA	0	0	0	0	0
1.2.5 Audio Description – AA	0	0	0	0	0
1.2.6 Sign Language – AAA	0	0	0	0	0
1.2.7 Extended Audio Description – AA	0	0	0	0	0
1.2.8 Media Alternative – AAA	0	0	0	0	0
1.2.9 Audio Only – AAA	0	0	0	0	0
1.3.1 Info and Relationships – A	5045	0	1021	14,66	56,647
1.3.2 Meaningful Sequence – A	0	0	0	0	0
1.3.3 Sensory Characteristics – A	0	0	0	0	0
1.4.1 Use of Colour – A	0	0	0	0	0
1.4.2 Audio Control – A	0	0	0	0	0
1.4.3 Contrast – AA	0	0	0	0	0
1.4.4 Resize Text – AA	0	0	0	0	0
1.4.5 Images of Text – AA	0	0	0	0	0
1.4.6 Contrast – AAA	0	0	0	0	0
1.4.7 Low or No Background Audio- AAA	0	0	0	0	0
1.4.8 Visual Presentation – AAA	0	0	0	0	0
1.4.9 Images of Text (no exception) – AAA	0	0	0	0	0
2.1.1 Keyboard – A	0	0	0	0	0
2.1.2. No Keyboard Trap – A	0	0	0	0	0
2.1.3 Keyboard (no exception) – AAA	472	0	51	1,37	4,994
2.2.1 Timing Adjustable – A	2	0	1	0,01	0,076
2.2.2 Pause, Stop, Hide – A	0	0	0	0	0
2.2.3 No Timing - AAA	0	0	0	0	0
2.2.4 Interruptions – AAA	5	0	3	0,01	0,178
2.2.5 Re-authenticating – AAA	0	0	0	0	0
2.3.1 Three Flashes /Below Threshold – A	0	0	0	0	0
2.3.2 Three Flashes – AAA	0	0	0	0	0
2.4.1 Bypass Blocks – A	2	0	2	0,01	0,108
2.4.2 Page Titled – A	7	0	1	0,02	0,141
2.4.3 Focus Order – A	45	0	33	0,13	1,816
2.4.4 Link Purpose – A	3132	0	93	9,07	11,886
2.4.5 Multiple Ways – AA	0	0	0	0	0
2.4.6 Heading and Labels – AA	0	0	0	0	0
2.4.7 Focus Visible – AA	0	0	0	0	0

Contiues in next page

Success criteria – Conformance level	Problems Destected	Min	Max	Mean	Std. Des.
2.4.8 Location – AAA	20	0	20	0,06	1,078
2.4.9 Link Purpose – AAA	1679	0	79	4,87	11,141
2.4.10 Section Headings – AAA	1734	0	1007	5,03	54,288
3.1.1 Language of Page – A	160	0	3	0,46	0,533
3.1.2 Language of Parts – AA	0	0	0	0	0
3.1.3 Unusual Words – AAA	0	0	0	0	0
3.1.4 Abbreviations – AAA	0	0	0	0	0
3.1.5 Reading Level – AAA	0	0	0	0	0
3.1.6 Pronunciation – AAA	0	0	0	0	0
3.2.1 On Focus – A	6	0	6	0,02	0,323
3.2.2 On Input – A	101	0	3	0,29	0,655
3.2.3 Consistent Navigation – AA	0	0	0	0	0
3.2.4 Consistent Identification – AA	0	0	0	0	0
3.2.5 Change on Request – AAA	2	0	1	0,01	0,076
3.3.1 Error Identification – A	2	0	2	0,01	0,108
3.3.2 Labels or Instructions – A	2165	0	104	6,29	10,289
3.3.3 Error Suggestion – AA	0	0	0	0	0
3.3.4 Error Prevention (Legal) – AA	0	0	0	0	0
3.3.5 Help – AAA	0	0	0	0	0
3.3.6 Error Prevention (All) – AAA	0	0	0	0	0
4.1.1 Parsing – A	4785	0	190	13,87	27,613
4.1.2 Name, Role, Value – A	2407	0	104	6,70	10,422

Attachment 2: Warnings in WCAG 2.0 Success criteria Identified with TAW

Success criteria – Conformance level	Warnings Detected	Min	Max	Mean	Std. Des.
1.1.1 Non-text Content –A	6682	0	163	19,32	20,147
1.2.1 Audio and Video Only – A	80	0	47	0,23	2,712
1.2.2 Captions – A	18	0	6	0,05	0,474
1.2.3 Audio Description or Media – A	17	0	6	0,05	0,471
1.2.4 Captions (live) – AA	17	0	6	0,05	0,471
1.2.5 Audio Description – AA	17	0	6	0,05	0,471
1.2.6 Sign Language – AAA	17	0	6	0,05	0,471
1.2.7 Extended Audio Description – AA	17	0	6	0,05	0,471
1.2.8 Media Alternative – AAA	17	0	6	0,05	0,471
1.2.9 Audio Only – AAA	17	0	6	0,05	0,471
1.3.1 Info and Relationships – A	5581	0	233	16,20	23,719
1.3.2 Meaningful Sequence – A	7526	0	315	21,85	37,340
1.3.3 Sensory Characteristics – A	0	0	0	0,00	0,000
1.4.1 Use of Colour – A	0	0	0	0,00	0,000
1.4.2 Audio Control – A	17	0	6	0,05	0,471
1.4.3 Contrast – AA	103	0	14	0,30	1,107
1.4.4 Resize Text – AA	12540	0	1976	36,36	116,401
1.4.5 Images of Text – AA	60	0	17	0,17	1,259

Continues in the next page

Success criteria – Conformance level	Warnings Detected	Min	Max	Mean	Std. Des.
1.4.6 Contrast – AAA	0	0	0	0,00	0,000
1.4.7 Low or No Background Audio- AAA	17	0	6	0,05	0,471
1.4.8 Visual Presentation – AAA	0	0	0	0,00	0,000
1.4.9 Images of Text (no exception) – AAA	0	0	0	0,00	0,000
2.1.1 Keyboard – A	474	0	51	1,38	4,994
2.1.2. No Keyboard Trap – A	0	0	0	0,00	0,000
2.1.3 Keyboard (no exception) – AAA	0	0	0	0,00	0,000
2.2.1 Timing Adjustable – A	0	0	0	0,00	0,000
2.2.2 Pause, Stop, Hide – A	0	0	0	0,00	0,000
2.2.3 No Timing - AAA	0	0	0	0,00	0,000
2.2.4 Interruptions – AAA	0	0	0	0,00	0,000
2.2.5 Re-authenticating – AAA	0	0	0	0,00	0,000
2.3.1 Three Flashes /Below Threshold – A	0	0	0	0,00	0,000
2.3.2 Three Flashes – AAA	0	0	0	0,00	0,000
2.4.1 Bypass Blocks – A	1800	0	1007	5,23	54,404
2.4.2 Page Titled – A	349	0	16	1,01	0,829
2.4.3 Focus Order – A	2053	0	100	5,97	11,561
2.4.4 Link Purpose – A	1703	0	79	4,94	11,170
2.4.5 Multiple Ways – AA	21	0	8	0,06	0,610
2.4.6 Heading and Labels – AA	6790	0	1290	19,72	71,454
2.4.7 Focus Visible – AA	185	0	16	0,54	1,365
2.4.8 Location – AAA	2	0	2	0,01	0,108
2.4.9 Link Purpose – AAA	0	0	0	0,00	0,000
2.4.10 Section Headings – AAA	4	0	2	0,01	0,152
3.1.1 Language of Page – A	0	0	0	0,00	0,000
3.1.2 Language of Parts – AA	0	0	0	0,00	0,000
3.1.3 Unusual Words – AAA	0	0	0	0,00	0,000
3.1.4 Abbreviations – AAA	0	0	0	0,00	0,000
3.1.5 Reading Level – AAA	0	0	0	0,00	0,000
3.1.6 Pronunciation – AAA	0	0	0	0,00	0,000
3.2.1 On Focus – A	0	0	0	0,00	0,000
3.2.2 On Input – A	0	0	0	0,00	0,000
3.2.3 Consistent Navigation – AA	0	0	0	0,00	0,000
3.2.4 Consistent Identification – AA	1	0	1	0,00	0,054
3.2.5 Change on Request – AAA	3148	0	124	9,10	15,091
3.3.1 Error Identification – A	770	0	10	2,24	2,255
3.3.2 Labels or Instructions – A	21	0	1	0,06	0,240
3.3.3 Error Suggestion – AA	385	0	5	1,12	1,128
3.3.4 Error Prevention (Legal) – AA	1152	0	15	3,35	3,388
3.3.5 Help – AAA	384	0	5	1,12	1,129
3.3.6 Error Prevention (All) – AAA	384	0	5	1,12	1,129
4.1.1 Parsing – A	27729	0	1457	78,81	158,944
4.1.2 Name, Role, Value – A	0	0	0	0,00	0,000