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Enabling Tourism 5.0: How technological drivers can transform accessible tourism information systems

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ABSTRACT

It is undeniable that technology is changing accessible tourism conditions. This study aims to explore the transition from Tourism 4.0 to Tourism 5.0 by analyzing the possible impacts that technological drivers can have in terms of social responsibility components (accessibility) in tourism information systems. To achieve this goal, a two-stage methodology is used. First, a scoping literature review was conducted to identify technological drivers in the scope of digitalization. Then, a proposal is presented for integrating those drivers within an emergent mobile platform for accessible tourism: access@tour by action. This platform focuses on delivering information about accessible tourism conditions in an accessible way. Overall, results showed that when integrated with technological drivers such as virtual reality and artificial intelligence, access@tour by action can significantly enhance its capability to promote and ensure accessible tourism conditions. The synergy between these technologies and access@tour by action can facilitate real-time, personalized, and user-centered services, offering a more dynamic and tailored experience. This amalgamation not only paves the way for a more equitable tourism sector but also underscores the transformative potential of a digitally driven era in creating universally accessible tourism experiences.

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1. Introduction

Technological advancements in recent years have exerted a profound influence not only on individuals' lives but also on society as a whole [1]. The fifth industrial revolution (Industry 5.0) is now being used within the industrial sector to describe advancements as well as product developments in the domains of communication, transportation, and robotics [2], [3]. In this way, the industrial and service sectors have seen a significant transformation due to technological enhancements. Industry 5.0 has significantly impacted the transformation and brought a revolution in the tourism industry and will continue to do so in the future [4]. The hospitality sector was a pioneer in embracing new technology. Digitalization has influenced this industry over time, and in the post-COVID future, it is anticipated to have even more significant effects. Based on evolving consumer behavior and preferences, as well as greater usage of Industry 5.0 technology, the tourism industry will undergo significant transformation in the future [5].

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Given the rise of Industry 5.0, the concept of Tourism 4.0 is currently evolving into Tourism 5.0, starting to reveal unseen possibilities and perspectives in the field of tourism management and services [6]. While Tourism 4.0 mainly focuses on technology development [7], Tourism 5.0 intends to transform previously identified technology advancements and place the human being at the center of this innovation and transformation. The scope of Tourism 5.0 is connected to technological impacts on social sustainability [8], [9]. Essentially, technological drivers are key enablers [10] of Tourism 5.0, redefining the travel industry's boundaries by improving consumer experiences and service quality and transforming current technologies, such as tourism information systems [11]. Information is the key to ushering in the new digital era across tourism [12]. Therefore, it should come as no surprise that information technologies have a relevant role [13], particularly tourism information systems. Studying how technology in tourism interacts with society to promote social sustainability is the primary purpose of the Tourism 5.0 paradigm. Concerning social aspects, technology may be used to improve accessibility conditions. Therefore, accessible tourism and Tourism 5.0 go hand in hand [14]. However, studies on the Tourism 5.0 paradigm are still few in the literature, despite the innovation trend across tourism [15], [16]. Therefore, this paper intends to increase knowledge in this field by examining how Tourism 5.0 may contribute to the development of a more accessible tourism industry. In particular, this study's objective is to analyze the transformation of tourism information systems and understand how technological drivers can improve existing solutions regarding accessibility, thus addressing technological innovation within human components and enabling Tourism 5.0.

To achieve this goal, a two-step methodology is conducted. First, a scoping systematic literature review is performed to discover how technological drivers are changing tourism accessibility. Academic works were searched and analyzed to identify examples of technology's effects on accessible tourism. In the second part, we tried to understand the particular impact of these drivers on a specific accessible tourism information system, using the app access@tour by action as an example. This explorative study involves understanding how the platform can benefit from incorporating technological advancements in terms of accessibility and social sustainability. The access@tour by action is a mobile app developed to support information exchange within the accessible tourism market. The relationship between technological drivers and their integration into the access@tour by action app offers a comprehensive view of how technological advancements can bolster accessible tourism. Upon analyzing the main technological drivers, a think-aloud process was applied to understand possible impacts on accessibility. Subsequently, some validation of these impacts was sought in current tourism and technology literature. The research intended to bridge theoretical exploration with practical application, offering possible solutions for understanding how technological drivers can enhance accessibility in tourism and, therefore, promote Tourism 5.0.

2. Theoretical framework

2.1 Tourism 5.0

Industry 5.0 refers to the 5th Industrial Revolution, in which humans, robots, and intelligent machines work side-by-side [2]. It implies using technology to help humans work better and faster by leveraging advanced mechanics [17], [18]. Technological drivers have been around for quite some time and have been the crucial point of Industry 4.0, as carefully explained in the technology analysis model by Souza et al. [19] and the research conducted by Schwab [20]. Notwithstanding, Industry 5.0 aims to merge those technology capabilities with more human components, putting social components at the center of innovation [21]. The same principle may justify the transition from Tourism 4.0 to Tourism 5.0.

As technologies emerging from industry [22] were adopted in tourism services, it marked the start of Tourism 4.0 [7]. By integrating technological advancements, Tourism 4.0 connected various aspects of the tourism ecosystem in more efficient and innovative ways [23]. Furthermore, these technologies allow for smooth interaction and data exchange across numerous devices, platforms, and stakeholders, helping to create enriched and personalized tourism experiences [24], [25]. This innovation also provides significant opportunities to better understand tourist behavior, preferences, and needs, enabling responses with exceptional precision and customization, thereby transforming the dynamics of the tourism industry. However, while Tourism 4.0 mainly focuses on technology integration [7], a proper understanding of the Tourism 5.0 paradigm can only be achieved by exploring how tourism integrates not only with technology elements but also with society and sustainability components [26]. Combining human, sustainable,

and intelligent machines brings incredible opportunities to tourism [9]. Tourism 5.0 can be potentially defined as human-centered tourism [27] based on technological drivers, i.e., robotics, intelligent machines, and artificial intelligence [28].

Technological advances have changed how people travel, and the increasing digitalization trends promise more interactive and exciting experiences. Thus, some of the research carried out in Tourism 5.0 tends to be associated with a plethora of related concepts (e.g., Hospitality 5.0, Marketing 5.0, Digital Tourist). The Hospitality 5.0 concept states that because tourism and travel are highly dependent on technology today, the tourism industry must keep up with the new advances [29]. This gives the tourism industry another reason to advance its methodologies and strategies according to the growing technological demands, which may be related to Marketing 5.0 [30].

The "Digital Tourist" is a concept that intends to describe the modern-day tourist, who is increasingly interconnected and reliant on digital technologies throughout their travel journey [31]. Digital tourists utilize various digital platforms and services for planning, booking, navigating, experiencing, and sharing their travels, expecting integrated and personalized experiences enabled by intelligent technologies. Understanding the digital tourist is paramount for developing and delivering services that meet the ever-evolving expectations and preferences of tourists in the age of Tourism 5.0 [32]. Thus, it can be perceived that Tourism 5.0 refers to intelligent tourism that is responsible for an inhabitant's quality of life by reinventing tourism activities within society by using technological innovation [6], [33]. Thus, Tourism 5.0 can be enabled by addressing innovation on a crucial societal component of the tourism industry: accessibility.

2.2 Enabling Tourism 5.0 through promoting accessible tourism

As stated beforehand, social components are a significant factor in enabling Tourism 5.0 [8], [9]. Considering this, accessibility conditions are a prominent term to achieve a more sustainable and inclusive tourism industry. Accessible tourism refers to the availability of resources to make tourism accessible to all, especially people with disabilities and other special needs [34]. It includes access to information about the accessibility of tourism offers, transportation, and easy access to accessibility-related services. Although Tourism 4.0 has set the goal of making tourism more accessible [35], Tourism 5.0 is capable of further enhancing the accessibility of tourism offers, as innovation is directly centered on the human aspect [36]. This gives the accessible tourism market opportunities for more personalized and accessible services, with information technologies being a key factor.

Since tourism is hugely dependent on the availability of data, tourism information systems [37] are already established components, particularly in the scope of accessibility [38] and social sustainability [39]. Because the tourism industry has to keep pace with innovations and technologies, Tourism 5.0 is expected to change the dynamics of accessible tourism information systems. Smart tourism is evolving into super smart tourism as technological drivers redefine the travel industry's boundaries by improving consumer experiences and service quality and transforming current technologies, such as tourism information systems [11]. When traveling, people with special needs rely on this technology to get information about accessibility conditions available in hotels, tourist attractions, and transportation [40]. Moreover, technology such as sofbots [41] and, most recently, artificial intelligence [42] can help support individuals in the efficient execution of diverse activities, including those related to tourism [43], by fostering a more collaborative and harmonious human-machine interaction and whether automatic, planned, or proactive. This idea is thoroughly explored in a study by Vujičić et al. [44], which also advocates that the transition from Tourism 4.0 to Tourism 5.0 lies in promoting more ethical and human-centered approaches to technology through accessibility integration. Thus, Tourism 5.0, through its innovative and digital applications, has the capability of transforming tourism technology, including tourism information systems, making them even more accessible and inclusive [33]. Despite this, the literature about the relationship between Tourism 5.0 and accessible tourism is very scarce, with few studies [33], [43], [44] addressing this issue, especially concerning technology impacts. For that reason, it is essential to understand how a new digital era is transforming accessible tourism, in particular, accessible tourism information systems, and, as a consequence, enabling Tourism 5.0.

3. Methods

A two-stage methodology was used to analyze how technological drivers can improve existing accessible tourism solutions, thus enabling Tourism 5.0. First, a scoping literature review [45] was employed to investigate existing research on technological innovations

in accessible tourism. This type of review was chosen for its suitability in exploring vast research areas, identifying knowledge gaps, and summarizing findings from diverse sources without limiting the analysis to a certain extent. The review followed a theoretical reflection based on the technical drivers discussed by Schwab [20]: Internet of Things (IoT), Cyber-physical system (CPS), Radio frequency identification (RFID), Cloud technology, Big data, Additive production (3D printing), Augmented reality (AR), Virtual reality (VR), Robotics, and Artificial intelligence (AI). The review process was conducted over a period of ten weeks, from December 2023 to February 2024, ensuring sufficient time for comprehensive searches, screening, and analysis. The review focused on studies published within six years (2017–2023) to capture technological advancements and their applications in the context of accessible tourism. Older studies were excluded to maintain relevance to current trends and innovations within the scope of Tourism 4.0 and Tourism 5.0. The scientific academic databases Web of Science and Scopus were selected for their comprehensive collections of peer-reviewed research in technology and tourism disciplines. The search strings included keywords that reflected the intersection of technology, tourism, and accessibility. The generic string used was: **("technological driver" AND "tourism" AND "accessibility")**, with specific technologies (e.g., "Internet of Things," "Augmented reality") replacing "technological driver." Regarding inclusion criteria, studies were included if they met three criteria: (i) the study referred to the application of a specific technology driver in tourism; (ii) the study explored how the technology improved accessibility conditions; and (iii) the study was published in English. On the other hand, studies were excluded if they lacked a focus on accessibility or tourism or were purely theoretical without practical implications or applications. The selection process involved title and abstract screening, followed by a full-text review. The final review included 27 studies that met all inclusion criteria. These studies were critically analyzed to identify insights regarding the impacts of technological innovations across accessible tourism.

In the second stage of the study, a practical example is used to demonstrate the integration of technological drivers in accessible tourism. The example used is the platform access@tour by action [38], a mobile platform designed particularly for the accessible tourism market. The methodological approach involves analyzing the potential of each specified technological driver (e.g., AI, IoT, AR/VR) and aligning it with the requirements of accessible tourism stakeholders. Through a think-aloud process, ideas were extrapolated from the 27 studies that had previously been obtained, which resulted in a list of possible impacts of technological drivers in access@tour by action. The main objective of this stage is to provide a thorough insight into how technology can improve accessibility by demonstrating the specific ways the platform can benefit from technological integration. To ensure inclusivity and accessibility in tourism, the study emphasizes putting people at the center of technological innovation and transformation. Consequently, it was possible to explore the transition from Tourism 4.0 (technology-focused) to Tourism 5.0 (human-centered). Hence, the rationale for selecting this methodological approach lies in its ability to connect theoretical exploration with practical application, providing insights into the scope of Tourism 5.0. Moreover, the use of access@tour by action as an example is justified by several factors: (i) relevance to accessible tourism (showcase how technology can address unique challenges related to accessibility); (ii) human-centered approach (emphasis on user requirements, making it an appropriate tool for illustrating the transition to a more inclusive Tourism 5.0 paradigm); and (iii) integration potential (design and functionalities can be aligned with the identified technological drivers). In summary, the platform access@tour by action served as a testing ground for exploring the practical adaptability of these drivers, offering multifaceted perspectives on how technology can be tailored to improve tourism accessibility.

3.1 access@tour by action - an accessible tourism information system

The access@tour by action is a mobile app prototype developed as part of the ACTION research project [46]. Its main goal is to improve accessible tourism conditions by supporting information management in the context of the accessible tourism market. The platform is a model instance of how technology can be leveraged to integrate diverse stakeholders of the accessible tourism market as well as to share information about accessibility in an accessible manner. The platform was constructed using a user-centered design framework [47] and is still under development, but it has lots of potential for improving accessibility conditions.

For contextualizing the access@tour by action, it is essential to note that this information system works as an intelligent tourism platform that caters to the accessibility tourism market by providing accessible information about tourism offers. At the same time,

the platform can generate knowledge related to accessible tourism. These primary characteristics of access@tour by action are depicted in some platform interfaces in Figure 1. It should be pointed out that the system works essentially as a smartphone app but can also be accessed via the Web on other devices.

Essentially, access@tour by action allows information exchange between three types of stakeholders/users: (i) demand agents (tourists with special needs – e.g., the elderly and other people with functional limitations, informal caregivers, social organizations (formal caregivers)); (ii) supply agents (e.g., accommodation units, food & beverage units, transport and tourism animation enterprises, tour operators, travel agents, and public organizations); and (iii) institutions responsible for training in tourism environments (e.g. universities and other higher education institutions). A fully detailed presentation of access@tour by action is presented in the study by Teixeira et al. [48].

Recognizing how object-oriented elements are ingrained in digital ecosystems is crucial for Tourism 5.0. Human-automation symbiosis is emphasized in Tourism 5.0. However, the particularities of the accessible tourism market make this symbiosis problematic. Intuitive and accessible information systems for tourism must be developed within a user-centered design since only actual users (people with special needs) can express their particular accessibility requirements. Based on the findings by Stankov & Gretzel [26], by understanding technology's impact on technological platforms and addressing the human factor through further enhancing accessible tourism conditions, it is possible to understand how to enable Tourism 5.0

Accessible tourism provision and user-centered functionalities are the main principles behind access@tour by action. For that reason, the access@tour by action is an excellent example of how information systems are crucial to accessible tourism. Thus, this particular mobile platform is a great candidate for understanding all the potential that Tourism 5.0 can bring to the area of accessibility and social sustainability. The goal is to analyze how access@tour by action can evolve from a smart platform to a super smart platform. These key themes are illustrated briefly in Figure 2.

4 Results and discussion

4.1 Technological drivers enabling Tourism 5.0

A scoping literature review was conducted on the topic of Tourism 5.0 to elaborate an overview of different technological innovations (established and emergent) developing accessibility conditions in tourism. The results came with identifying leading technologies influencing accessible tourism and

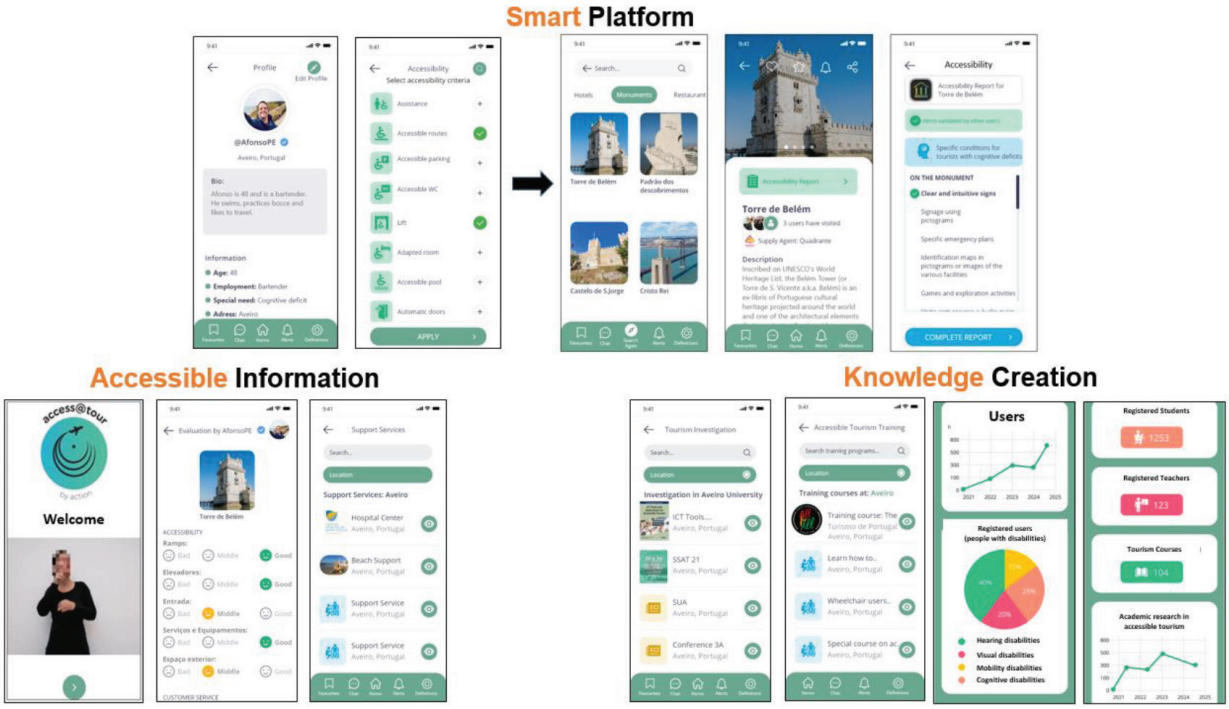

Figure 1. Interfaces illustrating some functionalities of the access@tour by action. Partially adapted from Teixeira et al. [48]

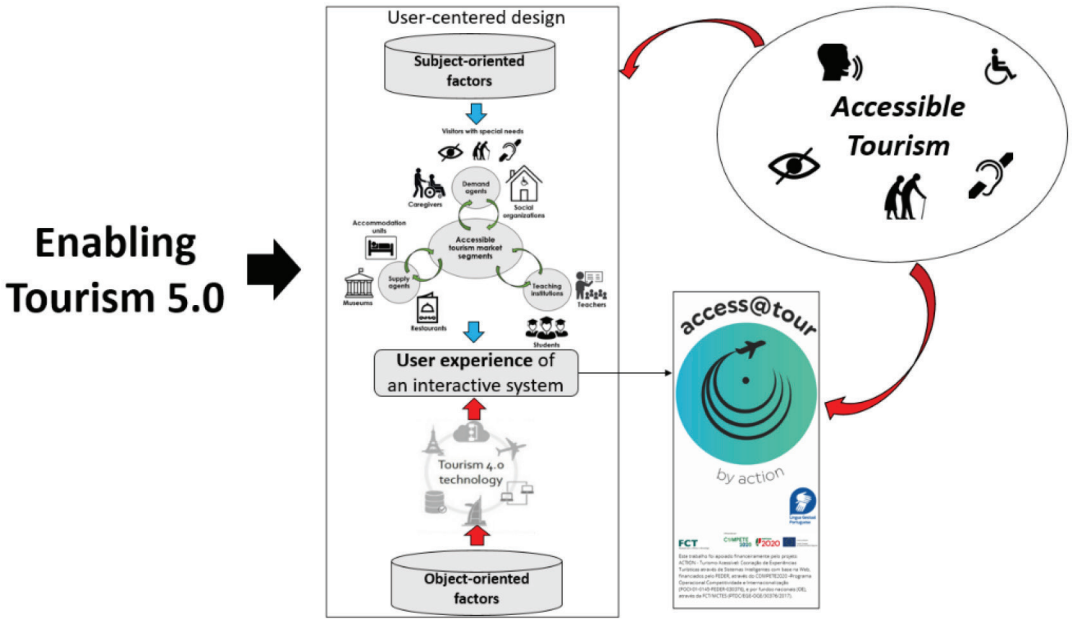

Figure 2. Enabling Tourism 5.0 with accessible tourism and the access@tour by action platform. Partially adapted from Stankov and Gretzel [26] and Teixeira et al. [48]

driving the new digital era. A particular example for each drive was attained to illustrate the impact on accessible tourism. Figure 3 summarizes the findings of the systematic literature review by describing technological drivers and their effects on accessible tourism. By enhancing the collection of real-time data on locations and events, CPS may make it possible to improve the services provided to visitors with special needs. It is feasible to guarantee safer and more effective travel by permitting simple modifications of spaces and corresponding resources, as shown in the example by Deka et al. [49]. Issues relating to a lack of accessibility-related information can be resolved by the information sharing that IOT permits [50]. In fact, saving and displaying visitors' unique demands in real-time becomes simple, which may provide more individualized and environmentally friendly travel options.

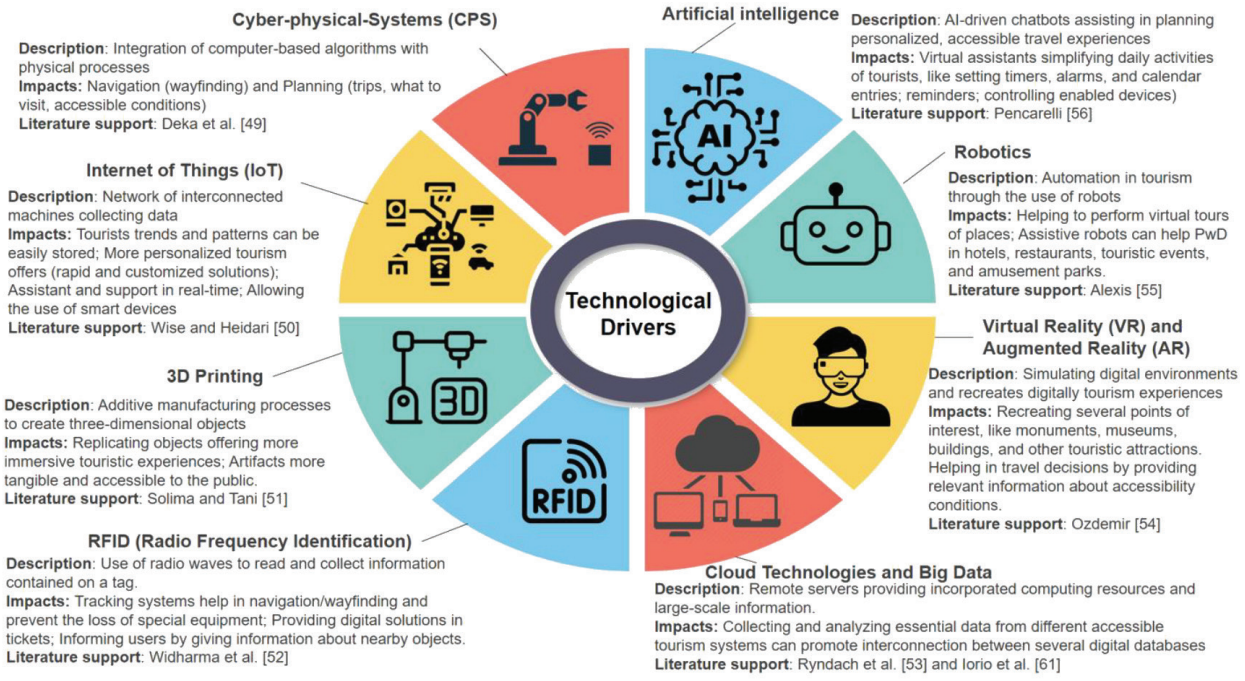

Figure 3. Established and emergent technologies and their impacts across accessible tourism

It might be assumed that the travel business does not make extensive use of 3D printing technologies. However, the ability to create replicas could significantly improve accessible experiences for visitors and aid in the preservation of historical buildings and institutions [51]. Through the improvement of contactless methods, as well as tracking and control systems, RFID is also beginning to transform the tourism industry [52]. This includes improving navigation and wayfinding, reducing equipment loss, and facilitating resource management. With these technologies, accessible information on resources and requirements in tourism can come from various sources. Thus, cloud technology and big data treatment can help with this new flow of information, distinguishing which information is most relevant. This is particularly crucial with regard to natural resources and accessibility of tourism activities [53].

Virtual and augmented reality offer unique experiences for the tourism industry. The simulation of digital worlds may significantly impact travel, which may lead to significant changes in accessible and, consequently, sustainable tourism experiences [54]. In that regard, adapting to the demands of travelers and utilizing sophisticated learning algorithms to help tourists with special needs are just a few of the potential uses for robotics [55]. Finally, AI has potential in the field of sustainable tourism because of its ability to learn from user interactions and continuously improve its products using Chatbots or virtual assistants that may provide prompt answers to users' inquiries regarding accessibility [56].

Table 1. Integration of technological drivers in access@tour by action

Technological driver	Possible impact on the characteristics of access@tour by action	Literature support
Cyber-physical systems (CPS)	Upgrade the access@tour by action interface to improve real-time data collection on accessible routes and destinations, making navigation and exploration more user-friendly, sustainable, and intuitive.	[49] [57] [58]
Internet of Things (IoT)	Add functionalities to the access@tour by action that facilitate seamless data sharing about accessible venues and services, enhancing user experience by providing relevant and immediate information on various resources.	[59] [50] [60]
Big data (analysis tools)	The access@tour by action platform could serve as a valuable tool by analyzing user behaviors and preferences across various collaborating entities. This would enable the app to refine its services and information, enhancing user engagement while fostering greater social responsibility and providing improved accessibility training.	[61] [62] [63] [64]
Robotics	The access@tour by action can start to offer connections through interfaces with robot guides that help tourists enjoy museums and art galleries, providing, for example, help to visit inaccessible exhibits.	[55] [65] [66]
3D printing	Upgrade the system of access@tour by action to aid in creating custom solutions or equipment for specific needs, which could be facilitated or recommended through the app based on user preferences and feedback.	[51] [67] [68]
Radio frequency identification (RFID)	Improve access@tour by action to allow user identification and access to services and locations, potentially allowing asset allocation (wheelchairs) to different venues and transport services highlighted in the app. Better management of resources by supply agents could allow more efficient choices.	[52] [69] [70]
Cloud technology	Enhance the performance of access@tour by action by programming a better understanding and interpretation of user needs, potentially providing more personalized and relevant suggestions and solutions for accessible tourism.	[53] [71] [72]
Virtual reality (VR) and Augmented reality (AR)	Integrate visual interfaces within the access@tour by action, allowing users to explore destinations and services virtually, aiding users in making informed decisions and preparing better for their trips.	[54] [73] [74]
Artificial intelligence (AI)	Upgrade the access@tour by action to integrate unique chatbots and virtual assistants. This integration should be programmed to systematically improve and refine learning from user interactions and feedback, enabling more intelligent accessibility solutions. This would result in more personalized tourism offers recommendations based on user preferences/requirements related to accessibility and social sustainability.	[11] [56] [53]

4.2 Enabling Tourism 5.0: How access@tour by action can benefit from established and emergent technologies

The relationship between technological drivers and their integration into the access@tour by action app offers a comprehensive view of how technological advancements can bolster accessible tourism. Upon analyzing the main technological drivers mentioned beforehand, a think-aloud process was applied to understand possible impacts on accessibility. It is essential to note that accessibility improvements can be achieved in terms of functionalities (what the app can do) and the accessibility of the app itself. Subsequently, some validation of these impacts was sought in current tourism and technology literature. Each technological driver presents distinct advantages that can significantly enhance the functionalities and user experience of the app, making it a more effective tool for promoting and ensuring accessibility in tourism. Table 1 provides extrapolated examples of addressing possible impacts using literature support from the previous scoping literature review.

5. Conclusion

The in-depth exploration of integrating technological drivers with accessible tourism, specifically with a case study on access@tour by action, revealed the significant potential of technology in establishing more accessibility. The technological drivers, such as 3D printing, CPS, Cloud technologies, IoT, Big data (analysis tools), Cognitive computing, VR, RFID, AR, and AI, provide unique improvements that can revamp the app's usability, adaptability, and information/communication spread. These connections have the power to improve and tailor user experiences, guaranteeing high levels of customization and real-time adaptation to meet the diverse demands of people with special needs and also having the capability to allow for more accessible tourism. Thus, the study advocates for leveraging technological advancements to foster inclusivity, enhance collaboration among key players, and establish sustainable practices in the tourism industry. By focusing on these goals, the study not only addresses current challenges in accessible tourism but also lays the groundwork for a future where tourism is universally inclusive, technologically advanced, and sustainable. This holistic approach guarantees that the tourism sector evolves to meet the needs of people with special needs while fostering socioeconomic development and innovation, enabling the Tourism 5.0 paradigm.

The research effectively combines theoretical exploration with practical insights, aligns with the goals of accessible tourism, and highlights the transformative potential of placing users at the center of technological innovation. This ensures the study provides both theoretical and practical contributions. Regarding theoretical contributions, by focusing on accessible tourism, the work expands the relatively underexplored academic research on integrating industry-related technologies in this domain. It also emphasizes the importance of considering the impacts of a new digital era by disclosing the role of technological drivers in accessible tourism. Moreover, the study adds to the theoretical frameworks of transitioning from Tourism 4.0 (technology-driven) to Tourism 5.0 (human-centered), emphasizing inclusivity, personalization, and innovation. Concerning practical contributions, the study provides insights for integrating the explored technologies into existing tourism platforms. With the application of findings to an actual tourism app, the research offers possible ideas for enabling Tourism 5.0, emphasizing inclusivity and personalization to enhance accessibility. Significant aspects include improving accessible information delivery for people with special needs, supporting policy and strategy development, and fostering stakeholder collaboration. These benefits can encourage the adoption of similar technologies in other tourism platforms to enhance accessibility functionalities. Finally, the obtained findings also promote sustainable innovation to ensure accessibility advances across the tourism industry, which can improve overall accessibility conditions and unlock the growing economic potential of the accessible tourism market.

The study has some limitations that need to be addressed in future works. This study provided only a particular view of how a specific platform can evolve to promote more accessibility. To better estimate the technological impacts of Tourism 5.0 on tourism platforms, it may be necessary to analyze platforms with other types of functionalities (e.g., wayfinding). Furthermore, consumers' desire and capacity for technological adaptation will determine the success of technology implementation. Because of this, integrating cutting-edge technology can be costly and difficult to achieve. Finally, it would be essential to listen to the opinions of several stakeholders (e.g., people with special needs, supply agents, and decision-makers) regarding which technologies should be integrated and with what goals. These stakeholders need to be part of accessible technology development processes. Otherwise, the core value of Tourism 5.0 will be neglected.

By focusing on access@tour by action, the study delivers a real-world perspective on how technology can transform accessible tourism, ensuring a user-centered, inclusive approach that fosters innovation within Tourism 5.0. The incorporation of emerging technologies in accessible tourism apps like access@tour by action has the potential to transform the experience for travelers in terms of accessibility and social sustainability. However, the journey does not end with integration; it demands continuous refinement and research to overcome limitations and evolve with the dynamic technological landscape. By embracing technological advancements and integrating them thoughtfully, we can make strides towards more inclusive/accessible tourism, thus also achieving genuinely sustainable tourism.

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