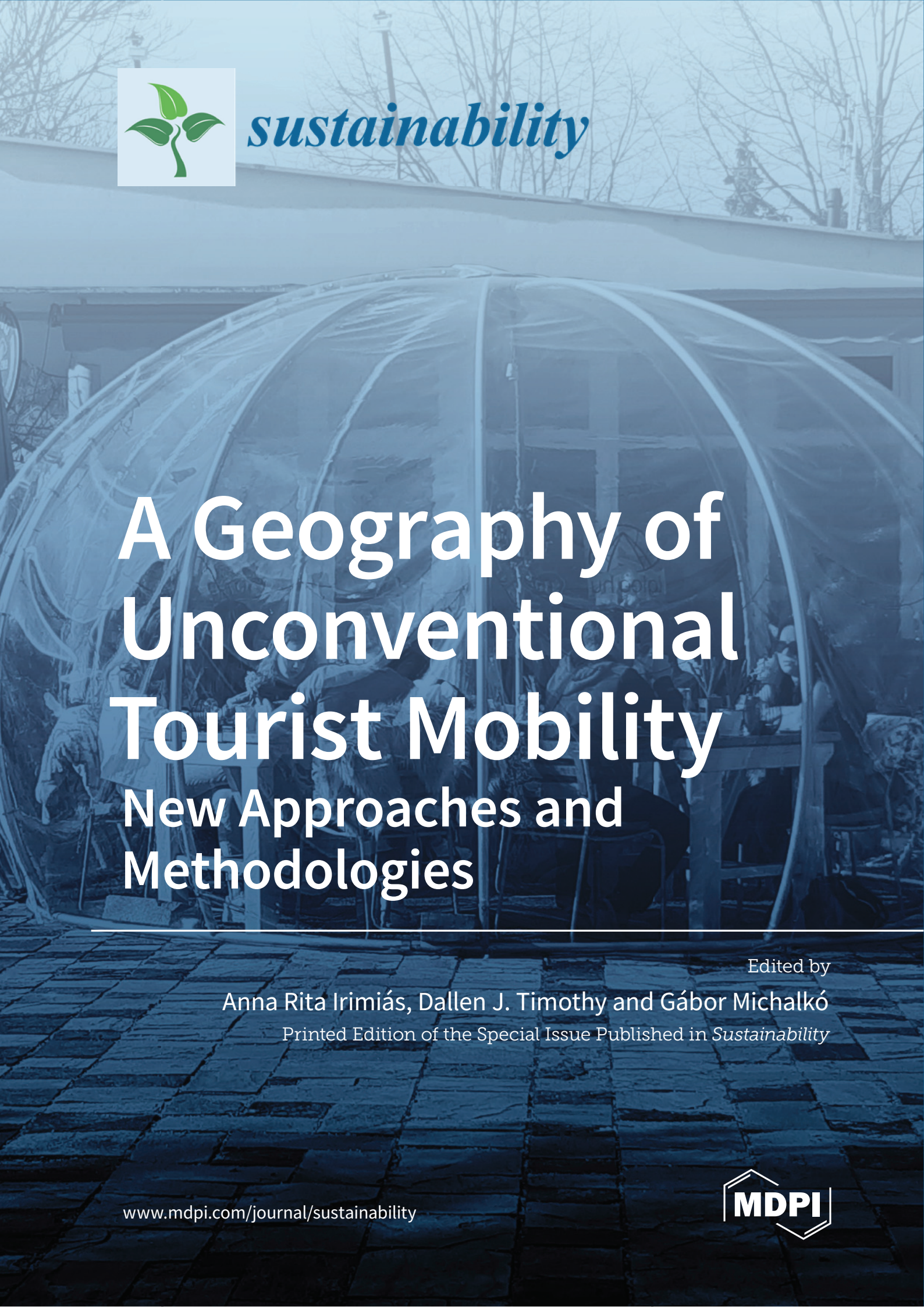

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A Geography of Unconventional Tourist Mobility

New Approaches and Methodologies

Edited by

Anna Rita Irimiás, Dallen J. Timothy and Gábor Michalkó

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Cover image courtesy of Gábor Michalkó

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Editorial

Is Unconventional the New Normal in Tourism?

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The phenomenon of tourism, driven by individuals' desire to experience something new, different, or otherly, has seen significant changes. In this ongoing process, new tourist segments with specific motivations and behaviors have emerged [1,2]. As MacCannell (2018:6) argues, the tourist is "a figure worthy of all the attention we might give it to understand what is going on around us". In this light, contemporary tourism has become a reflection of a symbiotic relationship between travel and its social functions. In recent decades, participation in tourism has almost become a lifestyle of its own: I travel, therefore I am!

In the 21st century, international tourism increased from 700 million to 1.5 billion between 2000 and 2019. In the post-pandemic travel climate, numbers have continued to rise. Well-known tourism destinations and attractions continue to draw an impressive number of tourists, and the rise in popularity of minor or previously 'hidden' destinations is unquestionable. Through globalization processes, increased access to information, increased standards of living over the past two decades, and social media and other internet-based technology, these formerly hidden attractions and less visited destinations are now able to draw tourists from all over the world. In parallel, the pluralization of the tourism industry means that the supply side has experienced an impressive geographical expansion. Every corner of the world has now become a tourist destination and, due to the democratization of tourism, tourism demand has grown significantly. The mere concept of the 'tourist experience' has also widened. Today, practically anything related to a journey can be interpreted as a tourist experience [3]. Thus, alongside the range of experiences designed and managed by destinations, 'prosumer' tourists create, live, and communicate about their travel experiences on social media [4].

Prior to the COVID-19 pandemic, tourism had already permeated all spaces of experience, reaching every country, region, and corner of the globe [5]. In recent decades, the meanings, implications, and roles of tourism have also expanded significantly [6,7] from a purely leisure and pleasure-driven mobility to any sort of overnight travel away from home for almost any reason at all. People's strong desire to travel during the pandemic contributed to the current acceleration of tourism mobility we now witness everywhere. The contributions to this Special Issue focus on unconventional tourism mobilities. This concept refers to trips that are uncounted, or statistically invisible, because they involve same-day travel, utilize informal or illegal accommodations, or manifest in other ways that are not typically enumerated in tourism statistics. The activities undertaken and the experiences sought are less relevant to this phenomenon than the fact that they are 'invisible' to national and global statisticians and gatekeepers.

In fact, unconventional tourism is an umbrella term that covers most kinds of unregistered or unaccounted tourist mobilities (e.g., stays at second homes, same-day return visits, illegal home rentals, or visiting friends and relatives), some of which might not appear to

be 'tourism' but should be seen as such in certain localities and under certain conditions (e.g., petty traders and utilitarian shoppers) [8]. Given the growth of unregistered tourist flows and unaccounted leisure (or utilitarian) mobilities, there is a need in tourism studies to apply innovative research methods and to reconceptualize the meanings of tourism in different geographical and social contexts. It is expected that people's craving for travel in the post-pandemic era [9] will open up new spatial and temporal tourism experiences and behaviors in which unconventional tourism has played an important role. To better understand this phenomenon and to evaluate the development of new approaches to travel and behavioral spatialities, new ways of thinking, new theoretical constructs, and new methodologies are needed. This Special Issue offers contributions that explore unconventional tourism mobilities as described in all their forms, focusing on the geographical patterns, processes and hidden aspects of unconventional tourism.

The opening paper of the Special Issue offers a theoretical pillar for a better understanding of unconventional tourist mobility (Contribution 1). The article highlights that tourism flows that are not statistically measurable are equally as important as those registered at official accommodations for the impacts they generate in the tourism destination. It analyzes the nature of invisible tourism, highlighting the specificities of uncounted trips of many kinds. Its authors—the guest editors of the Special Issue—call for additional research on unconventional tourism mobilities and recommend developing methodologies that will help us gain a deeper understanding of the phenomenon.

In this light, the first part of the theme issue brings together innovative methods for exploring unconventional tourist mobility. Making the invisible flows of tourism visible is no easy task, perhaps most akin to criminal investigations, as researchers exploit the clues left by tourists rather than tangible and accountable data provided by border crossings or lodging records. Mobile Positioning Data (MPD) contains billions of pieces of information generated by tourists' mobile phones, which can be used to understand tourist flows and the duration of their stays (Contribution 2). Understanding tourists' spending outside of accommodation services by using online cash registers (OCR), based on a combination of their movements and consumption patterns, reveals a hitherto lesser-known aspect of transit travel (Contribution 3). Likewise, geotags of photos uploaded on social media reveal the increasing popularity of so-called secondary destinations (Contribution 4). Although databases other than official statistics are extremely difficult to access and have a number of limitations, they nonetheless provide valuable information on unconventional or unmeasured tourism.

The challenges of making tourism sustainable are numerous. Although unconventional tourism mobility is often invisible to destination management organizations, its social and environmental impacts are evident. Prior to the COVID-19 pandemic, many popular tourist cities struggled with overtourism. As part of the solution, fuzzy linear programming can be used to identify the challenges of overtourism and determine the optimal number of tourists for a given city at any given time (Contribution 5). To manage cities' tourism carrying capacity, alternative routes and experiences are recommended. Contribution 6 considers the tourist trend to visit heretofore nearly neglected urban green spaces such as historical cemeteries. The use of autonomous vehicles (AVs) in cities has several benefits, including making urban mobility green and sustainable. Travelling by AVs itself can become a unique tourist experience and can make tourism more accessible for people with disabilities, as demonstrated by Contribution 7. The implementation of sustainable development principles requires responsible behavior both by the service provider and the tourist.

As already noted, the COVID-19 pandemic effected an unprecedented decline in tourism businesses. To survive, service providers put all their creative energies into making improvements and innovation, with safety as a priority. Spa towns, for example, in addition to their traditional market segments (senior tourists), began targeting families with young children, and they had to reconceptualize their offerings (Contribution 8). In tourism innovation, the need and desire for safety have induced numerous info-communication

developments, such as the DIS:CO (design communication)-based application. This innovative application offers personalized, real-time feedback on tourists' health conditions and helps to build trust between consumers and service providers (Contribution 9). Unconventional tourism in the Metaverse is a phenomenon yet to be explored and understood. Contribution 10 provides an overview of the main tendencies in the domains of tourism and food and the consequences for research applications. According to the authors, the Metaverse can become an important tool for promoting and advancing tourism research and to foster virtual and digital collaboration among service providers, academia, and tourists.

Innovative product developments have played a key role in supporting unconventional tourist mobility. In making cycling tourism more experiential, a symbiosis of body (optimal physical exertion) and soul (effective personal development) was created on Hainan Island, China (Contribution 11). The increasingly intensive development of knowledge societies has also generated new products in the global tourism industry. Thus, the case study of the Chinese university city of Guangzhou can be of considerable help to destinations wishing to engage in scientific tourism in order to create their own evaluation matrix (Contribution 12).

The aim of this Special Issue is to raise awareness of unconventional, invisible, and uncounted forms of tourism—concepts not readily found in mainstream tourism research but which are extremely important, especially in certain destinations, such as borderlands, peripheral regions, and urban areas. The contributions in this theme issue illustrate that not all tourism is measurable, or even definable, in every context. Thus, human mobilities, more broadly as unconventional tourism, should become more prominent in tourism studies and in other disciplines that are concerned with human mobility and the use of space for leisure or utilitarian purposes.

List of Contributions

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3 Tóth, G.; Kincses Á. (In)Visible Tourism According to Online Cash Registers in Hungary, 2018–2020
4 Kádár, B.; Gede, M. The Measurable Predominance of Weekend Trips in Established Tourism Regions–The Case of Visitors from Budapest at Waterside Destinations
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6 Sallay, Á.; Mikházi, Zs.; Gecséné Tar, I.; Takács, K. Cemeteries as a Part of Green Infrastructure and Tourism
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9 Megyeri, G.; Boros, K.; Fekete, B. A Theoretical Concept of an Innovative and Sustainable Product Based on an Unconventional Approach to Design Development
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11 Lin, M.; Xu, H. Subjective Bodily Experiences of Island Cyclists in Different Contexts: The Case of Hainan Island, China

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Author Contributions: Conceptualization—G.M., A.I., D.J.T.; Writing—original draft preparation, A.I., G.M., D.J.T.; Writing—review and editing, D.J.T., G.M., A.I. All authors have read and agreed to the published version of the manuscript.

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Hypothesis

Unconventional Tourist Mobility: A Geography-Oriented Theoretical Framework

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Abstract: Prior to the COVID-19 pandemic, tourism had permeated all spaces of experience, reaching nearly every country, region, community, and corner of the globe. In recent decades, the meanings, implications, and roles of tourism have also expanded significantly. This article focuses on unconventional tourism mobilities, including same-day visits, which are an important but often neglected part of the tourism system, constantly challenging both scholars and tourism industry stakeholders. Unconventional tourism is an umbrella term that covers most kinds of unregistered or unaccounted tourist mobilities, some of which might not appear to be 'tourism' but should be in certain localities and under certain conditions. Given the growth of unregistered tourist flows and unaccounted leisure (or utilitarian) mobilities, there is a need in tourism studies to apply innovative research methods and to reconceptualize the meanings of tourism in different geographical and social contexts. It is expected that people's desire to travel in the post-pandemic era will educe new spatial and temporal travel experiences and behaviours in which unconventional tourisms will play an important role. To better understand this phenomenon and to evaluate the development of new approaches to travel and behavioural spatialities, new ways of thinking, new theoretical constructs, and new methodologies are needed. This article seeks to explore certain hidden or invisible tourism mobilities, focusing on the geographical patterns, processes, and hidden aspects of unconventional tourism.

Keywords: unregistered tourism; unconventional tourism; unaccounted tourism; short-haul travel; same-day travel; cross-border mobility; VFR tourism; sharing economy; shopping tourism

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1. Introduction

The COVID-19 pandemic led to a drastic decline in world tourism [1]. According to World Tourism Organization (UNWTO) data [2], there was an 87% drop in international tourism demand in 2020 and a 56% drop in 2021 compared to 2019, which was a record high year. The crisis in the global tourism industry provides an opportunity to assess the development of tourism in the 21st century and to carefully plan for its revitalisation [3]. The spread of the pandemic closely correlates with the lifestyle of our time and with travelling becoming an ordinary practice [4]. Intensive tourist mobility contributed to the spread of the coronavirus to almost all countries on Earth in the first three months of 2020 [5]. In 2019, the UNWTO [2] recorded 1.5 billion international tourist arrivals, double the number of arrivals in 2000. Multiple changes underlie the dynamic growth of tourism over the last two decades; understanding these mechanisms will help construct post-pandemic scenarios and realise the vision of sustainable tourism [6]. The COVID-19 pandemic has brought unprecedented silence to popular tourist destinations around the world. Deserted streets, empty terraces, and closed restaurants, cafes and bars—a doomsday atmosphere

was realised by globetrotters in previously crowded neighbourhoods. The waves of the COVID-19 pandemic have raised hopes for greater sustainable uses of places but have also shown the downside of the temporal collapse of the experience economy and experience society [7]. The extent of lockdowns, quarantines, and travel restrictions differed by country and region, but the reduction of environmental pressures was greatest where both long-term and same-day tourist mobility had previously been present [8]. In the resurrected mobilities of the post-pandemic period, innovative solutions will likely emerge to help promote and support sustainable destination management [9].

The impressive statistics produced by the UNWTO are primarily representative of measured and recognized tourist flows, not of invisible mobilities that also fit under the auspices of tourism [10]. For example, domestic same-day travel, cross-border and transit same-day trips, and overnight stays outside registered accommodations, including the use of second homes, courtesy lodging, and informal accommodations, are for the most part outside the scope of official tourism statistics [11]. 'Invisible tourism' estimates and periodic surveys are done in some countries, but there are no databases for international comparisons [12], yet this is a salient part of the tourism system worldwide.

The European Parliament and the Council of Europe adopted regulations concerning European tourism statistics in 2011 [13], clearly stating that (5) "The changing nature of tourism behaviour since the entry into force of Council Directive 95/57/EC of 23 November 1995 on the collection of statistical information in the field of tourism, with the growing importance of short trips and same-day visits contributing substantially in many regions or countries to the income from tourism, the increasing importance of non-rented accommodation or accommodation in smaller establishments, and the growing impact of the Internet on the booking behaviour of tourists and on the tourism industry, means that the production of tourism statistics should be adapted."

The European Commission has required Eurostat, the statistical office of the European Union, to draw up a methodological manual that must be regularly updated. However, even the political will to make invisible tourism visible has failed to produce tangible results. The UNWTO and the World Travel and Tourism Council (WTTC) estimate that domestic tourism is several times larger than international demand but, due to data collection gaps, few numbers are available for scientific analysis of this segment [14].

Unconventional (or invisible, or hidden) tourism mobility refers to trips involving the use of accommodation outside of regular statistical data collection and trips of less than 24 h in duration (Figure 1). Unconventional tourism mobility as conceived here differs from conventional tourism in essentially two ways: the nature of the accommodation used and the short length of stay. Unconventional tourism is, therefore, statistically invisible, but the characteristics of travel consumer behaviour are relatively well captured and essentially the same as conventionally measured tourism. In a given destination, the same tourist activity can be carried out in both unconventional and conventional modalities (e.g., a day visit to a ski resort or a beach holiday in a second home property provided free of charge by friends) [15]. Unconventional tourism mobility thus overlaps with conventional tourism mobility, in both space and time, and managing the two phenomena together poses significant challenges for planners, developers and managers.

The phenomena associated with unconventional tourism mobility have been known to tourism researchers for decades, yet they remain under-researched due to the estimated volume, assumed impacts, and the difficulty in drawing parameters for analysis. The lack of a conceptual framework to explore unconventional tourism mobilities has been an additional obstacle to the discussion of the phenomenon. However, profound changes in the nature of tourism (in particular overtourism) have drawn attention to the economic, social and scientific potential of unconventional tourism mobility [16]. There is also a growing recognition that hidden tourism is symbiotic with the trends that are driving its broader uptake so the need for invisible tourism to operate smoothly has implications for the formation of trends, and in some cases the trends themselves can be interpreted as unconventional tourism (e.g., CouchSurfing) [17].

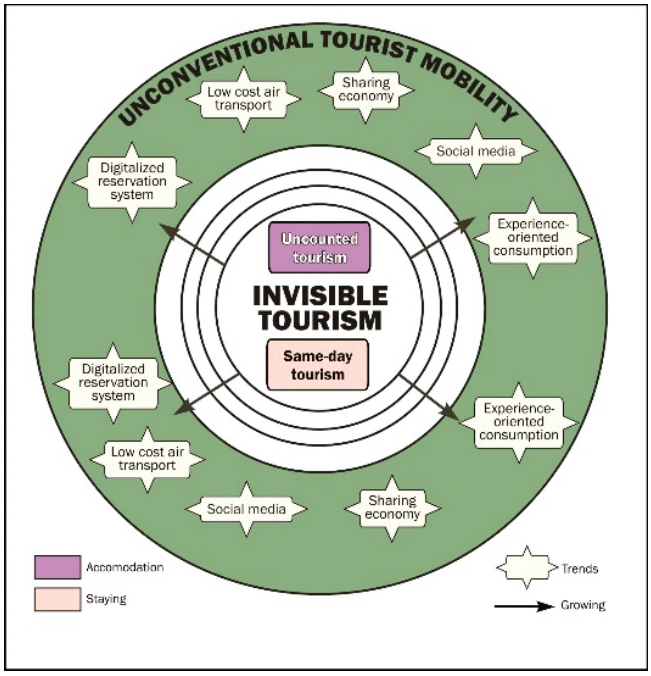

Figure 1. Model of unconventional tourist mobility. Source: authors' conceptualization (design: Livia Kaiser).

It is difficult to draw boundaries that mark the changing nature of tourism and to determine the period which has now generated and increased the need for a complex exploration of unconventional tourism mobility. The emergence and market penetration of low-cost airlines [18]; the widespread use of the internet and online retail spaces that facilitate the purchase of most tourism services [19]; the ability to share travel experiences instantaneously on social media [20]; the diffusion of the sharing economy [21]; the fact that consumption is not only a means of satisfying needs but also a means of accumulating experiences and avoiding boredom [22] all have played a significant role in this process.

If we look at the above processes in their historical context, the turn of the 20th and 21st centuries is when the very nature of tourism changed on a global scale, affecting almost all segments of society and generating measurable results in national economies. Conventional market processes in tourism have been joined by unconventional ones driven by several business and technological innovations. First, the alternative to expensive, convenient, and privileged air travel has become cheap and democratised air travel [23]. Second, online booking systems have made it possible to bypass travel agents and ticket offices when purchasing travel products, even with immediate validity [24]. Third, experience narratives have become real-time, spreading across the web through visuals, posts, hashtags, comments and 'likes' on Facebook and Instagram platforms, and transforming marketing communication [25]. Fourth, because of Airbnb, private homes have become commercial places to stay and attract tourists in droves with the promise of 'living like a local' [26]. Finally, historically popular tourist destinations have become victims of overtourism, and simultaneously, many previously unknown geographical locations have entered the world tourism marketplace, offering an almost inexhaustible pool of experiences [27].

In Europe, unconventional tourist mobility has also been catalysed by policy changes, such as the expansion of the European Union, facilitating the free movement of people, and the expansion of the Schengen Zone, which abolished most border controls, thereby contributing to the reduction of the unpleasantness often associated with border crossings [28]. In a market dominated by planned trips, mostly related to the possibility of taking some time off work, the share of spontaneous impulse trips generated by internet-based marketing communications has also increased [29]. Discount airfares that facilitate even one-day return trips have in many cases led to hyper-fast consumption of a desti-

nation/product/service without necessitating overnight accommodations [30]. Changes in the world of work and learning, especially due to the advance in digital technology, have created opportunities for blurring the boundaries between the private and the official spheres and between leisure and work. The use of second homes as home offices and 'workations' (work during vacation) both broaden the conceptual framework of unconventional tourism mobility [31].

As the issue of spatiality is a primary concern in understanding the characteristics of unconventional tourism mobility, geography and related disciplines have a major responsibility to address our gaps in knowledge. The challenge is two-fold: to strengthen the theoretical background on the one hand and the methodological arsenal on the other. The theoretical framework can be built up through a critical literature review on different issues linked to unconventional tourism mobility, while the methodological framework needs to be improved through an evaluation of the procedures used in previous studies. The primary objective of this paper is to outline the theoretical concept of unconventional tourism mobility by analysing and evaluating the literature on the common set of trends leading to invisible tourism and overtourism. Emphasis is placed on the geographic aspects of mobility and on the methodology, which can support the recognition of invisible tourism.

2. Invisible Tourism

Tourism statistics and databases facilitate the systematic monitoring of tourism phenomena and processes [32]. In principle, official statistical data have been collected at border crossings and from lodging establishment records [33,34]. Data from these sources support the UNWTO's assertation that tourists are people who spend at least one night away from home. In certain countries, border and/or accommodation statistics are complemented by surveys using different methodologies [35,36]. The global tourism statistics published annually by the UNWTO [2], which are representative of international tourism flows and comparable over space and time, are a combination of the above data collection methods. Given the statistical definition of a tourist and typical data source points, tourism statistics are not suitable for monitoring tourism mobility of less than 24 h in duration and travel that does not entail the use of registered accommodation—together termed here 'invisible tourism', 'unconventional tourism', or 'hidden tourism'. Statistically, invisible tourism generates tourist flows that affect the socioeconomic, sociocultural and natural environments in the destination [37], even if it is not counted directly. Although no official statistical data are collected on invisible tourism, service providers' statistics, onsite surveys and estimates (e.g., number of tickets sold, one-day city card sales, and parking receipts) are collected for different purposes [38]. Because the methodologies in data collection differ significantly, it is almost impossible to compare data.

2.1. Unobserved Tourism

De Cantis et al. [39] define unobserved tourism as visits where tourists stay in a destination for more than 24 h and spend the night in unofficial establishments or in official establishments but are deliberately not registered by the host (mainly due to tax evasion) (Figure 2). The former is also called unmeasured tourism, the latter underground tourism. Based on their studies in Sicily, De Cantis and Ferrante [11] found that the number of tourists staying on the island is almost the same in official and in unofficial establishments, but they did not attempt to estimate the number of visitors concealed by the managers of official establishments. Unobserved tourism stays of at least one night generate a noticeable turnover in the destination [40]. On the one hand, this translates into increased revenues from the use of non-accommodation tourism services, and, on the other hand, it undermines the principle of sustainability [41]. Parocco et al. [42] point out that both unobserved and short-haul tourism pose serious challenges to data-driven planning.

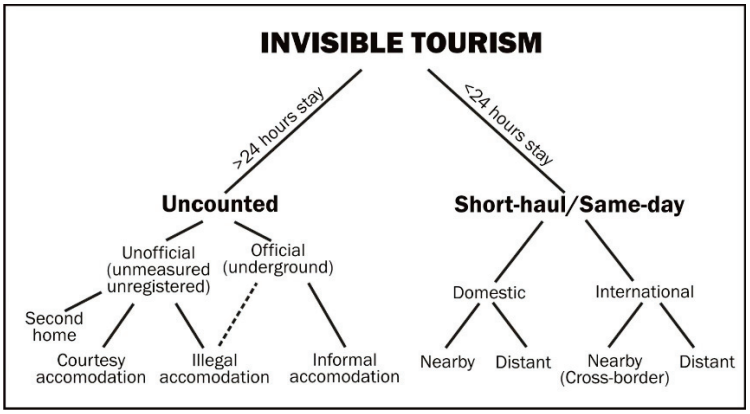

Figure 2. Model of invisible tourism. Source: authors' conceptualization (design: Livia Kaiser).

Within unobserved tourism, a distinction is made between unofficial and official tourism. Unofficial accommodations include second homes for owners' use or for family members, the total or partial letting of owned or rented property to distant relatives or friends on a courtesy basis, and illegal accommodations operated specifically for business purposes but completely hidden from the authorities. One of the characteristics of second homes is that they are usually specifically intended for leisure purposes, whether they are located in prominent or secluded tourist destinations, and thus increase the demand for local or regional tourist services despite their stay not being recorded in any database [43]. The full or partial letting of owned or rented property on a courtesy basis is most often carried out in the context of VFR tourism [44]. In these cases, the owner or tenant offers guests the temporary use of a dedicated space (e.g., guest room) without payment or offers overnight accommodation in other parts of the property without registration (e.g., in the living room, garage, garden tent). A key feature of VFR tourism is that the guest and the host usually spend as much time together as possible, and so a significant proportion of meals are also served in the host's household. Although VFR tourism is not necessarily linked to tourist destinations, the guests often use tourist services as leisure activities, in which hosts also are involved [45]. Some prominent tourist destinations specifically control and sanction the use of properties (including second homes) disguised as VFR tourism. The CouchSurfing movement is an organised form of accommodation by courtesy, a reduced form of home-swapping, where members of an online community stay overnight in each other's homes during their travels, with no statistical reporting obligations on the part of the host [46]. Illegal accommodation—accommodation that is operated without a licence or a declaration of the existence of the accommodation—can occur anywhere in the world, but is more likely to be found in regions where income concealment is an integral part of everyday life [47]. Spending nights outdoors 'under the sky', such as sleeping in tents, sleeping bags, caravans, or cars, should also be considered under the umbrella of non-official accommodation [48].

Official accommodations become part of unobserved tourism when managers conceal from authorities some of their income, mainly for tax evasion purposes [49]. By doing so, they operate informally, either seasonally or for a certain proportion of the actual turnover. For example, they offer their services legally, with official permits (subject to registration), but the recorded bed-nights do not match reality.

A very specific type of informal accommodation is represented by sea- or river cruise ships with several hundred or thousands of passengers on board, which stay parked at least one night in a destination's harbour. These stays are not included in official destination statistics, and cruise passengers are considered day-trippers [50].

Likewise, hotels which once operated legally but have had their licences withdrawn or surrendered, have retained their marketing and/or sales channels, and still receive guests at certain intervals, operate on the conceptual borderline between formal and informal accommodations. This also includes operators who run several different types of

accommodation (hotel-apartment or camping-bungalow/caravan) but conceal the turnover generated in one or the other.

2.2. Same-Day Tourism

Travel within 24 h without an overnight stay is part of the broader phenomenon of short-haul tourism [51,52]. Official statistical counts of same-day visitors, or day-trippers, can only be made at border posts, where government controls are enacted and travel documents presented (e.g., passports, visas, vaccination documents) as a condition for entry into the country. Same-day tourism takes place both internationally and domestically, with the length of the journeys (in time and distance) typically being rather short, both subject to a return to the place of origin within 24 h, or more precisely without an overnight stay (Figure 2). The length of the trip and the return journey essentially depend on the means of transport used [53]. Despite the fact that day trips are popularly perceived as trips to areas near one's residence, there are also trips of less than 24 h to destinations hundreds or even thousands of kilometres from the place of origin, thanks to efficient air travel and high-speed rail. Although climatic conditions can influence short-haul tourism, their seasonal effect is somewhat lower, as water-based holidays, which attract large crowds and require long hot summer periods, or ski tourism, which is linked to cold, wet winter weather, are by definition peripheral to day trips.

The archetypes of same-day tourism in international contexts are cross-border shopping tourism, health tourism, VFR tourism and business tourism. Shopping tourists travel to purchase goods and certain repair and maintenance services available on the other side of a national border, motivated by lower prices, better quality, a greater product selection, a more attractive sales environment, the purchase of certain goods not available at the point of origin, and faster, more efficient service [54]. Day-trip international health tourism involves the use of services that are either linked to health insurance or self-financed [55]. Health care providers in Mexican municipalities bordering the US are visited by Americans seeking less-expensive care and Mexican citizens living in the US without adequate health insurance [56]. In Hungary's border region with Austria, day visits by Austrian health tourists are driven by Hungarian dental services, which are both low-cost and high-quality by international standards [57]. In border regions where history has divided families and communities that had lived together for generations, international day visits to relatives are a common travel activity [58]. While business tourism usually assumes a stay of at least one night with premium services, brief visits of less than 24 h to offices or worksites relatively close but in another country are common, especially where good transport links make day-tripping easy [59].

In the case of short-haul, domestic tourism, it would be difficult to highlight archetypal tourism products similar to international ones. However, it can be noted that the most common activities during domestic day trips are visits to natural environments offering a wide variety of recreational activities, visits to iconic sites of cultural and heritage tourism, gastronomic strongholds, sport events, amusement parks, and visits to relatives and friends [60,61]. The distance scale of domestic trips shorter than 24 h depends to a large extent on the size of the country's territory, because the length of a trip within a country's borders is incomparably different in a microstate than it is in a very large country [62,63]. It is also related to the available transport infrastructure. Where domestic flights are available, it is obviously possible to cover a return trip over much greater distances within 24 h than in regions where only land connections are available (although high-speed rail may be an alternative to air transport) [64].

3. Geographical Factors and Methodological Challenges

Time and distance are closely connected and are among the most important attributes of tourism mobility; thus, understanding the geographical factors of unconventional tourism is important [65–67]. Tourism entails changing one's environment, seeking experiences, and using services. This supposes, according to traditional understandings,

that tourism-motivated consumption is tied to at least one night away from the place of residence, at a registered lodging service [68]. Although unconventional tourism mobility is not a new phenomenon, there is a need for its statistical recording, scientific examination and more conscious management [69]. The tourism trends of the 21st century contribute, on one hand, to the increased demand for shorter journeys, providing more intensive experiences and, on the other hand, to the horizontal and vertical extension of tourism space [70]. The fact that early-morning and late-night flights have become fashionable means that tourism destinations are accessible within a one-day round trip, evoking the need to re-define tourism in certain situations [23]. If destinations that have previously been almost unknown among international tourists now appear on airline route maps and in marketing campaigns, and within a destination, parts of a city located away from the traditional tourist zones are garnering more tourist attention, then the appearance of new tourism geographies defined by unconventional mobility becomes more evident [71,72]. The increasing desire (generated largely by social media) for life satisfaction through travel (a need once outlined by Maslow), the rapid expansion of transportation in both techniques and technologies, and the rational use of shared accommodation, including second homes and courtesy accommodation, have led to such high numbers of invisible tourists that characteristics of change in consumer behaviour in time and space are almost impossible to examine [73].

The wide range of methodological tools at researchers' disposal can potentially help develop databases that extend over and above simple border-crossing and accommodations statistics. The exploration of, and better acquaintance with, the macro- and micro-changes of unconventional tourism can contribute both to a deeper understanding of certain phenomena, as well as to their effects and management. Representative surveys undertaken from time to time among foreign tourists in a country and among domestic tourists in their own homelands can help refine and triangulate statistical data collected at border crossings and lodging establishments, as they also explore the volume, characteristics and geographical extent of unconventional tourism [74,75]. These surveys are extremely costly and their databases are incomplete, even from the point of view of macro-changes. Surveys dealing with travel of less than 24 h are typically done at a very local or regional level. Thus, they are rarely representative of broader populations and are less comparable, but the results may be adequate to evaluate unknown or hidden factors of tourism consumption in a given destination [76,77]. Research undertaken by a local authority or destination management organisation can provide opportunities to assess the micro-mobility of tourists within the community by having visitors list the sites visited or show them on a map [78]. Even before the spread of digital cameras and smartphones, photo elicitation studies and photograph content analyses enabled researchers to understand tourists' consumer behaviours, especially the extent of their mobility in the destination. For the most part, there were two consistent methods. One was the use of tourists' personal photographs; the other was asking tourists to take pictures using disposable cameras provided by the researcher [79]. Digital photography provided a breakthrough in two main ways. First, film cameras were no longer necessary and the digital images were easier to store and analyse. Secondly, the exact location and time of the photograph could be digitally stamped with the help of GPS coordinates [80]. Digital photographs energized the use of social media and online photo-sharing platforms. Because of this technology, using 'geotags' (certain cartographic algorithms), it became possible to assemble databases to better understand the spatialities of tourism regions [81,82].

Exploring unconventional tourism mobility is possible through regular, countrywide quota sampling surveys among international and domestic tourists, paralleled with the tourism demand of the relevant communities and/or regions at the same time. The costs of such a massive endeavour would likely be returned with a greater understanding of tourism satellite accounts and in the results of efforts to stimulate the economy. However, such surveys would not produce an exact picture of the spatial and temporal characteristics of macro- and micro-sized changes in tourism mobility [83], but they might produce some

level of actionable data. Using mobile cellular data from smartphones might be part of the solution [84]. Cellular transmission towers are located relatively near one another and record mobile phone use within their radius, constantly producing large databases daily [85]. Using big data technology and current analytical tools with programmed algorithms, tourists' mobility, including the locations visited and lengths of stay can be determined. Although the use of mobile phone data to explore unconventional tourism mobilities is still in a nascent phase, it has a great deal of potential for making invisible tourism more visible.

4. Conclusions

A common characteristic of economic and social development is the movement from unconventional to conventional. What was unconventional at one time becomes conventional later through processes of change and normalization. This cycle is also apparent in tourism, although the period of change to conventional from unconventional appears to be getting shorter [86]. In the history of tourism, technical and technological innovations are the most notable milestones that have effected the most change in travel patterns and tourist attitudes. For example, in 1841, Europe's first tour operator, Thomas Cook, started his global enterprise, which continues to operate today, built upon Stephenson's Rocket, an early steam locomotive. In 1958, the first Boeing jet airliner, the 707 model, initiated a breakthrough in intercontinental and transoceanic flights. At the turn of the 21st century, massive advances in information and communications technology pervaded everyday life in the Global North and Global South and ushered in the latest chapter of tourism history. The underlying ethos of tourism—seeking experiences, visiting other environments, and utilizing services, were common in all three periods of history and have remained the essence of tourism.

The unconventional features of tourism discussed in this paper are not new or previously unheard of; overnighting in non-registered accommodations or same-day journeys have long been acknowledged as part of the tourism system, but their volume and diversity have increased as a result of trends endemic to the first decades of the 21st century. As acknowledged earlier, unconventional tourism is defined largely by the non-use of registered lodging and a short length of stay, which does not necessarily fit the UNWTO's official definition of a tourist or tourism. Thus, it may be relegated to the margins of tourism by national or supranational authorities because of its 'invisibility' and position outside the normative scope of statistically measurable tourism.

Our attempt to introduce the concept of unconventional or invisible tourism mobility aims to advance the following: (1) to produce a succinct and simple conceptual umbrella to discuss the unobservable (and unmeasurable) mobilities and same-day tourism; (2) to extend and differentiate the scope of these phenomena; (3) to explore the potential for more systematically analysing these hidden manifestations of tourism in the face of a 'data desert'. Geography plays an important role in the conceptualization of unconventional tourism mobility, particularly as regards place, distance, and temporality, yet the spatial and chronological features of unconventional tourism have so far received little academic attention. Geographers have a special responsibility to explore patterns of horizontal and vertical mobility, as well as the length of stay associated with them. Scholars should not be content with the limited information and data available. Rather, new and creative methods need to be developed to create databases that can help researchers better understand otherwise 'unmeasurable' manifestations of tourism. Digital photographs, including those posted by internet users, are a potentially lucrative source of data, especially because they are digitally stamped with GPS coordinates. Likewise, mobile and cellular data generated by smartphones might be alternative sources of tourism statistics, especially in light of the scarcity of data otherwise. Studying unconventional and invisible tourism mobilities serves to create a deeper and more sophisticated understanding of new turns in 21st-century tourism and contributes to the development of data-driven tourism management. It also creates a more holistic view of tourism in its broadest sense, rather than what is normally

measured and accounted for, and has the potential to support the concept of sustainable development as communities and industry leaders begin to recognize the potential socioeconomic and sociocultural contributions of alternative tourisms that traditionally have been unaccounted and overlooked.

The perspectives on forgotten tourism or unconventional tourism at the centre of this article have inspired previous research. Representatives from many disciplines have recognized the research potential on the topic, including management, urban studies, landscape architecture, statistics, and environmental science, yet it remains tangential to the thrust of mainstream tourism research. Our hope is that the concept of unconventional tourism will become more accepted among researchers, with the potential to generate additional international research. The most important task for the future is to develop, in cooperation with statistics offices and tourism management representatives (governmental decision makers), a comprehensive monitoring system that will be more inclusive in providing credible, comparable and regular data on the real and more holistic processes of tourism.

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The Measurable Predominance of Weekend Trips in Established Tourism Regions—The Case of Visitors from Budapest at Waterside Destinations

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Abstract: Short trips to weekend destinations are less researched than more conventional forms of tourism involving longer trips and overnight stays, because quantitative data are hard to procure on the behavior of such weekend tourists. As a result, the effects of these day trips on secondary destinations cannot be measured, yet weekend tourism does contribute to the economic sustainability of many tourism regions. In this study, we analyzed geotagged photography uploaded to Flickr.com in the Budapest metropolitan area, the Danube Bend north of the Hungarian capital, and the Northern Balaton Region. Analysis of the spatio-temporal activity of photographers revealed Flickr users who live in the analyzed regions or in foreign countries, identifying the locals, weekend visitors from Budapest, those from other Hungarian regions, and foreign tourists. The predominance of visitors from Budapest was measured in both of the water-side destinations, and the spatial patterns of such visitors were more dispersed than the more concentrated spatial patterns of foreign tourists. These results show how day-trippers spread out the economic effects of tourism to much wider geographic areas than conventional tourists. Therefore, more focus should be directed toward these previously invisible forms of visits among the scientific community, policy makers, and the tourism industry.

Keywords: visitor behavior; tracking tourists; Flickr; day trips; weekend destination

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1. Introduction

Since the Grand Tours of the 18th century, discourse on tourism has focused mainly on faraway trips and long vacations, where the differences between ordinary and outstanding experiences were evident [1]. This focus was needed in scientific research to formulate clear theories, but at the same time, it was also essential for the tourism industry in order to develop its offers and infrastructures. However, parallel with the development of conventional tourism, society also developed less visible forms of leisure travel: excursions and short weekend trips to nearby natural areas, waterfronts, or cultural destinations. Most of these trips do not use any form of paid accommodation. Some visitors make only day trips, others have their own holiday houses or family properties to use for a weekend. Still, these nonconventional tourists do participate in the visitor economy, eating out, visiting cultural destinations and national parks, and using local recreational services and transport. Their contribution is especially important in places out of the reach of mass tourism, where restaurants and services make a visible turnover without being accessible for international tourists [2,3]. Many businesses offering tourism-related services or any services building on the experience economy outside the large urban and tourism centers are fundamentally sustained by such short-term visitors, not having a large local consumer base. These businesses must build their services on local authenticity [4] and offer experiences competitive with those in mainstream destinations using innovative methods [5,6]. Successful strategies

are mostly based on the transformation of local values into experiences, including local food and specific rural landscapes [7,8]. However, the sustainability of this segment of the experience economy in rural tourism regions relies on consumers whose activity cannot be measured with traditional methods in tourism statistics.

New methods must be developed in order to quantify the contribution of day-trippers and weekend visitors to rural tourism regions, as these groups do not use transport types (air travel and organized tours) and accommodation from where the main statistical data for tourism come from [9]. In the past few decades, tourism researchers and the operators and developers of the tourism industry started to realize how nonconventional tourism with short visits is an important factor, and therefore, destination marketing is focusing more and more on such visitors nowadays. New trends in tourism—especially the changes imposed by the COVID-19 crisis [10–12]—direct much more attention to local travel and short weekend visits, and new data sources are needed in order to establish solid research methods in this field [13–15].

The biggest social changes in the past decade have been linked to the spread of social media. Tourism systems are also deeply affected since the main platforms of destination branding became those where users share their experiences and influence other users in their travel choices. Millions of selfies, perpetually re-composed landscapes and cityscapes, food photos, and detail photos of attractive subjects have flooded the popular photo sharing services. Using photo sharing services has become an integral part of tourism, having a major impact on shaping the destination systems. While in the twentieth century, "Kodak Moments" were the highlights of once-in-a-lifetime vacation trips [16], today, an "Instagram moment" can be found anywhere [17], so proximity tourists do not even have to travel far to post about any leisure activity that can be popular on social media. The motivation for sharing anything on social media is very much the same as the motivation for travel photography since the beginning: tourism consumption (as social media presence) can only be fulfilled if evidence is produced of the experience and shared with others [1]. Since Kodak introduced its interchangeable film camera in 1888, photography has become the main accompaniment to travel [18]—a real holiday produced pictural memories in family albums [19,20]. The development of technology has expanded the activities of photography to even more areas. Digital photography, GPS positioning, internet access, and through it, social content generated by individuals (and companies) have become the mediums that have completely transformed the consumption and processing of tourist experiences in a few years. In addition, unlike family photo albums, these mediums can be accessed and researched from anywhere; there is currently no other accessible method for mapping the statistically "invisible" tourism of weekend trips.

Urry formulated the role of photography in tourism [1], also building on the works of Hall [21] and MacCannell [22]. The circle of representation for tourist destination images described by Jenkins [23] is more relevant than ever: according to this model, a desired image of a destination is formed by the tourist before the visit from pictures conveyed to him/her by marketing or other means, and when finding this image, the tourist also takes a photo of it during the trip and shares it on the (social) media used, thus strengthening the already-formed image of the destination for others. However, through the digital and social media revolution, imaging and sharing have become so widespread that there is a competition to publish new, unique, and attractive images, which have brought previously undiscovered sites into the public consciousness, but because of the functioning of the above circle, they have also become known and desired destinations [17,24]. Today, significant research focuses on how social media affects the perception and development of tourist destinations [25–28]. Such research confirms that UGC (user-generated content) on social media fundamentally influences the perception of a destination, and has a great marketing value especially for smaller, specialized businesses, mainly serving short visits [29]. Thus, these media and the short messages and visual content circulating on them promote the fragmentation of large tourism infrastructures and the viability of smaller-scale services at the local level.

Some social media platforms partially manage their service on the geographical position of photography uploaded. The "geotags" of images uploaded to sites such as Flickr.com (https://flickr.com/, accessed on 8 February 2022) allow for a new kind of research on the spatial behavior of tourists [30–32]. On Flickr, there are more than 1,000,000 photographs uploaded with a geotag only from the area of Hungary. This quantity of specific spatio-temporal data enabled the research of unconventional tourism in the two most popular rural tourism regions in Hungary, where the majority of visits comprise weekend and one-day trips, and also the activities of holiday home owners.

In this study, the spatial patterns of different tourist types are mapped for the rural tourism regions of the Hungarian Danube Bend and the Northern Balaton Region, revealing the activities of the previously invisible day-trippers and holiday home owners. Special attention was paid to the residents of the Budapest Metropolitan Area, as according to our hypothesis, most of the visitors to the two analyzed regions come from Budapest. Budapest is the main tourist hub of Hungary for international tourism; most international visitors to the two analyzed areas arrive to Budapest first, and they possibly spend time in the capital, too. Budapest had 4,578,000 tourist arrivals in 2019 [33], the last full year prior to the COVID-19 crisis, and 86.1% of these were international arrivals, with only 13.8% being Hungarians. Such detailed statistics do not exist for the two analyzed regions, because international tourists usually stay in hotels in the capital city of Budapest, taking day trips to the Danube Bend, or go for a lakeside holiday to the shores of Lake Balaton. Residents of Budapest also take day trips to the Danube Bend, and most Hungarians have had vacations on the shores of Balaton Lake, from where day trips to the villages and destinations in the Balaton Uplands National Park are popular. The proportion of weekend houses and holiday homes in these areas is extremely high; therefore, many Hungarians make short visits from their own or rented vacation house.

In the following section, we present a methodology to collect data on the tourism activities of day-trippers and weekend visitors from Flickr.com, comparing the different data analysis methods to separate the space usage patterns of different user groups. In the results section, we present previously unmeasurable findings on the origin and space usage of visitors to the two regions. We demonstrate the predominance of visitors from the capital city, the role of weekend visits, and the seasonality of tourism in such waterside rural destinations, summarizing the contribution of such findings to the field in the discussion and conclusion section.

2. Materials and Methods

The patterns of the tourist space use of the Danube Bend and the Balaton Uplands in the Northern Balaton Region have been mapped using the database of Flickr, which is still operating with an open API. Among the available social media databases, the one of Flickr.com is most commonly used by researchers [34–36]. Flickr research is beneficial not only because of its quantification, but this social media has users from the most diverse age and social groups, and this portal is most aimed at sharing images taken during tourist visits [37,38]. While only a quarter of Flickr images are geotagged with precise geographical coordinates, it was still possible to analyze more than half a million photos, using almost 100,000 for the study of the two regions. In fact, all photos with geotags in the Budapest agglomeration (including the Danube Bend) and around Lake Balaton were downloaded. This large dataset can combine the quantitative advantages of the huge number of social media users [37] with the geographical accuracy of GNSS technology [39,40]. Based on the work of Kádár and Gede [30,41], the method used analyzes spatial and temporal data obtained from the API of Flickr.com, grouping users who create the images into various categories based on spatio-temporal behavior patterns and the user data provided. The subject, quantity, and frequency of geotagged photos uploaded by users on Flickr reveals whether the person is a tourist or a local resident in the given area, retrieving the frequency of visits to determine whether someone lives locally or has only arrived for a short time. Based on the categorization of users, it is also possible to map which ones are

the main tourist attractions in a given city and which places are mainly visited by local residents [30,42].

First, users who could be residents of the Budapest area were identified. For each user, the time tags for their geotagged images were examined in the Budapest agglomeration area. The Budapest agglomeration data (together with the data of the Danube Bend) were downloaded on 31 March 2020, resulting in 682,312 geotagged photos of 19,284 Flickr users. The photos of each user were grouped into time intervals in a way that the longest time gaps between photos in the same interval are less than 60 days. Users were called 'local' if they have an interval at least 30 days long or have at least 4 intervals. Locals in this case were residents from the Budapest Metropolitan region, and such users kept this attribute also in the analysis of the Northern Balaton Region (where another group of 'locals' was identified). It is possible to accurately identify the visiting patterns of the above user groups at various points of a given tourist region even with an accuracy of up to 10 m, due to the accuracy of the geotags provided by GNSS. After analyzing the Budapest agglomeration database, the samples of the Danube Bend were also analyzed based on data from 37,720 photos. The 'local' group was kept intact for this area, as determining who is 'local' from the Danube Bend area and who is from Budapest proved to be inaccurate as most of the residents of the towns of the Danube Bend commute for work to Budapest, and therefore, the photographing patterns of Budapest visitors and locals visiting Budapest showed very similar patterns. Keeping 'locals' as every user from the larger Budapest area, 'tourists' were further broken down into sub-groups. If all their photos were in one interval, the tourist was on his/her first visit to Budapest and the Danube Bend. If this interval was less than 5 days, then the user was placed in the group of tourists who made a short visit, and if it was longer, in the group of long-visit tourists. Some tourists' photos fall into two or three intervals; they were placed in the group of returning visitors. The 7 most popular clusters, which are the most touristy communities in the Danube Bend area, were highlighted, quantifying visitor numbers in each of the following sub-groups:

- Users living in the Budapest area.
- First-time tourists on a short trip.
- First-time tourists on a longer trip.
- Returning visitors to the area.

Further analysis of Flickr data could identify additional categories of visitors. In addition to visit space–time patterns, user data and profile analysis gave more information about the origin of visitors, but due to the manual inspection of all user profiles, this was a much slower process. In this study, we developed a methodology to check each user profile for affiliation information on a smaller sample in the Danube Bend; therefore, we selected the data from Szentendre and the Skanzen (open air ethnographic museum) nearby. Flickr has a tag for the nationality and the hometown of the user, but not every user fills out this information. Therefore, a manual check of users had to be performed, discarding those from the dataset whose affiliation to a country could not be verified. Out of the 809 users found in this area, 396 users had user profiles with enough data about their town of origin. A total of 8343 photos were analyzed after discarding those where the origin of the user was not possible to determinate. Four groups could be separated for the users of such photos:

- Locals who live in Szentendre.
- Foreign tourists with a foreign profile.
- Domestic first-time visitors.
- Returning domestic visitors who returned to Szentendre in different time intervals.

For patterns of the Balaton Uplands, the two previous methodologies were combined. Flickr metadata of the entire Balaton region were downloaded on 31 March 2020, resulting in a total of 60,535 photos. After separating 'locals' who most probably live in the area from 'tourists' using the methodology described above, a relevant 'tourist' sub-group was instantly formed by comparing the dataset of the Budapest agglomeration area with the Balaton dataset. This resulted in the tag 'tourist from Budapest', but for the next sub-groups

of other Hungarian visitors and foreign tourists, a second step of analysis was needed with the verification of the nationality. After taking out the images of users without a secure affiliation, as well as all users who uploaded fewer than 5 images in the Balaton region, 57,974 geo-positioned photos were examined from 1432 users. In this way, the following groups could be isolated in the Balaton region:

- Visitors from Budapest (and its agglomeration).
- International tourists.
- Hungarian tourists (outside the capital).
- Locals from the Balaton region.

The focus of the study was the Balaton Uplands area, so the geotags were separated into 20 clusters which are the main communities in this region, measuring the visitor numbers in these clusters.

In the Balaton region, we also identified Flickr users staying in non-paying accommodation, typically holiday homes. This was achieved by separately analyzing the activity patterns of users who uploaded photos taken in at least two different time periods within a 50-m radius in a recreational area around Balaton—these are built-up areas where there are no residential buildings, only holiday homes. It was therefore necessary to qualitatively analyze all repeating photographs in such recreational areas: the content of these images typically depict a home environment, i.e., family, interior, private gardens, and related subjects. Only if such attributes were true users were assigned the 'holiday home owner' tag, and their activities outside their accommodation could be separately analyzed in both the northern and southern shore of Lake Balaton for comparison.

3. Results

3.1. Weekend Tourism in the Danube Bend

Analyzing all photos from the Budapest Metropolitan Area and using this database to narrow down the geographical territory to the towns of the Danube Bend made it possible to determinate the role of this region inside the tourism system of Budapest and also in relation to the residents of the larger region itself. Only 13.6% of the 19,284 users uploading geotagged photography in the area of the Budapest Metropolitan Area were locals; the rest of the users were in one of the groups of tourists (Table 1). The largest group was the first-time short trip visitors, with 57.9% of all users being in this category, and most of these are international tourists, according to official statistics [33].

A total of 1648 users (8.5% of all in the Budapest Metropolitan Area) left digital traces in the Danube Bend region. The majority of these users are not international tourists, but visitors from the Budapest region itself (55.5%). The residents of the seven analyzed areas of the Danube Bend are also represented among the 914 users from the greater Budapest area, but it was not methodologically possible to separate them, as their movement patterns are also intensive in the capital city, where many of these residents work. However, the results of the next section in this paper further analyzing the Flickr users in Szentendre clearly show how locals are outnumbered by visitors from Budapest.

Table 1. Flickr users taking photos in the Budapest Metropolitan Area and in the communities of the Danube Bend sorted into different user groups of locals and tourists.

	Locals from the Budapest Metro. Area			Tourists											Sum	
				All			First Time on Short Visit			Returning More Times			First Time on Long Visit				
	photos	*users*	photos /user	photos	*users*	photos /user	photos	*users*	photos /user	photos	*users*	photos /user	photos	*users*	photos /user	photos	*users*
Budapest Metropolitan	326,356	*2628*	124	355,963	*16,656*	21	194,410	*11,170*	17	45,512	*2871*	16	116,041	*2615*	44	682,319	*19,284*
%in Budapest		*13.6%*			*86.4%*			*57.9%*			*14.9%*			*13.6%*			*100.0%*
Danube Bend count	12,150	*914*	13	5952	*734*	8	2467	*422*	6	975	*180*	5	2510	*132*	19	18,102	*1648*
%in Danube Bend	67.1%	*55.5%*		32.9%	*44.5%*		13.6%	*25.6%*		5.4%	*10.9%*		13.9%	*8.0%*		100.0%	*100.0%*
%in Budapest	3.7%	*34.8%*		1.7%	*4.4%*		1.3%	*3.8%*		2.1%	*6.3%*		2.2%	*5.0%*		2.7%	*8.5%*
Visegrád count	4572	*262*	17	1391	*213*	7	668	*114*	6	334	*63*	5	389	*36*	11	5963	*475*
%in Visegrád	76.7%	*55.2%*		23.3%	*44.8%*		11.2%	*24.0%*		5.6%	*13.3%*		6.5%	*7.6%*		100.0%	*100.0%*
%in Budapest		*10.0%*			*1.3%*			*1.0%*			*2.2%*			*1.4%*		0.9%	*2.5%*
Szentendre count	4048	*341*	12	3582	*383*	9	1413	*234*	6	443	*76*	6	1726	*73*	24	7630	*724*
%in Szentendre	53.1%	*47.1%*		46.9%	*52.9%*		18.5%	*32.3%*		5.8%	*10.5%*		22.6%	*10.1%*		100.0%	*100.0%*
%in Budapest		*13.0%*			*2.3%*			*2.1%*			*2.6%*			*2.8%*		1.1%	*3.8%*
Skanzen count	1319	*55*	24	466	*30*	16	111	*16*	7	31	*7*	4	324	*7*	46	1785	*85*
%in Skanzen	73.9%	*64.7%*		26.1%	*35.3%*		6.2%	*18.8%*		1.7%	*8.2%*		18.2%	*8.2%*		100.0%	*100.0%*
%in Budapest		*2.1%*			*0.2%*			*0.1%*			*0.2%*			*0.3%*		0.3%	*0.4%*
Nagymaros count	922	*90*	10	197	*41*	5	131	*23*	6	44	*12*	4	22	*6*	4	1119	*131*
%in Nagymaros	82.4%	*68.7%*		17.6%	*31.3%*		11.7%	*17.6%*		3.9%	*9.2%*		2.0%	*4.6%*		100.0%	*100.0%*
%in Budapest		*3.4%*			*0.2%*			*0.2%*			*0.4%*			*0.2%*		0.2%	*0.7%*
Dunabogdány-Kisoroszi	656	*88*	7	156	*34*	5	60	*18*	3	87	*12*	7	9	*4*	2	812	*122*
%in Dunabogdány-Kiso.	80.8%	*72.1%*		19.2%	*27.9%*		7.4%	*14.8%*		10.7%	*9.8%*		1.1%	*3.3%*		100.0%	*100.0%*
%in Budapest		*3.3%*			*0.2%*			*0.2%*			*0.4%*			*0.2%*		0.1%	*0.6%*
Leányfalu count	347	*35*	10	86	*22*	4	47	*8*	6	29	*9*	3	10	*5*	2	433	*57*
%in Leányfalu	80.1%	*61.4%*		19.9%	*38.6%*		10.9%	*14.0%*		6.7%	*15.8%*		2.3%	*8.8%*		100.0%	*100.0%*
%in Budapest		*1.3%*			*0.1%*			*0.1%*			*0.3%*			*0.2%*		0.1%	*0.3%*
Tahitótfalu count	286	*43*	7	74	*11*	7	37	*9*	4	7	*1*	7	30	*1*	30	360	*54*
%in Tahitótfalu	79.4%	*79.6%*		20.6%	*20.4%*		10.3%	*16.7%*		1.9%	*1.9%*		8.3%	*1.9%*		100.0%	*100.0%*
%in Budapest		*1.6%*			*0.1%*			*0.1%*			*0.0%*			*0.0%*		0.1%	*0.3%*

Seven separate areas grouped around the settlements of the Danube Bend were visualized on diagrams juxtaposed on the map of the exact location of photos uploaded by first-time visitors and by locals from Budapest Metropolitan Area (Figure 1). It is evident from the spatial patterns of these user groups that first-time visitors (mainly foreign tourists) visit only the most important destinations and never explore the region for minor attractions. Visitors from the Budapest areas (including locals) take a lot more photographs in this tourism region than any tourist groups (double, on average), except long-term tourists staying for more than 5 days. The most tourists outside Budapest visit Szentendre, where 52.9% of users are tourists, but only 2.3% of all tourists visiting Budapest area go to Szentendre. Accepting the correlation between the number of Flickr users in the 'tourist' category group and the actual annual arrivals of tourists, Szentendre should have to 105,000 visitors from outside Budapest in 2019. The second most visited town is Visegrád, and 44.8% of users are tourists from outside Budapest, accounting for 1.3% of all tourists to Budapest (approx. 58,500 arrivals). The smaller destinations along the Danube have many more local users from Budapest and the region; on average, only 30% are 'tourists' from elsewhere. Moreover, 79.6% of photographers in Tahitótfalu are either locals or from Budapest.

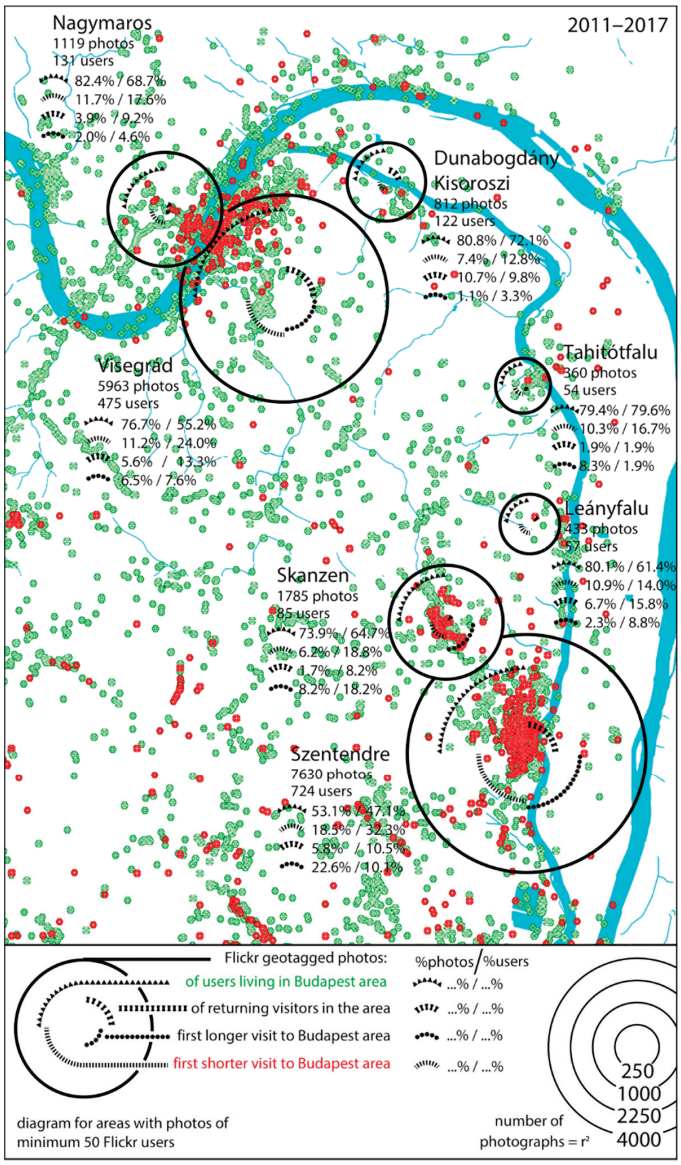

Figure 1. Visitors to the Danube Bend and Szentendre based on geotagged photos uploaded to Flickr (red dots represent photos from mostly foreign tourists who come to the Budapest region only once for a short time, green dots represent the photos from users living in Budapest or its agglomeration).

Some 34.8% of Flickr users living in the Budapest Metropolitan Area did visit the Danube Bend; 13% went to Szentendre and 10% to Visegrád. Those visiting the Budapest area for at least the second time went more frequently to the Danube Bend than those on a first visit to this metropolitan area. Approximately 3.8% of first-time visitors went to the Danube Bend area, 5.0% of longer-staying tourists and 6.3% of returning tourists.

It is possible to examine the temporal distribution of these groups of photographers in the Danube Bend area, both for the different months of the year (Figure 2) and the different days of the week (Figure 3). The figures display the percentage of total users of the groups taking photos in the given time periods. Although the general trend is that fewer users took photos during the winter months, locals and visitors from Budapest also visited the region in this season. For most of the groups, the months of May, August, and October were the most popular. The exception is the group of returning tourists, whose number constantly increases until September and then decreases until the February minimum. First-time visitors (also those on longer trips) follow similar patterns, and their sum of percentages through the 12 months is exactly 100%, showing how every first-time tourist visited the area just once. This is 108% for returning tourists, meaning that very few of these returning tourists also return to the Danube Bend. The sum is 239% for locals and visitors from Budapest, showing how users from this group took photos in two or three different seasons during their activity. This number is probably much higher for locals and stays around two for those from Budapest, but it is still safe to state that an average visitor from Budapest returned to the region at least twice during the past decade.

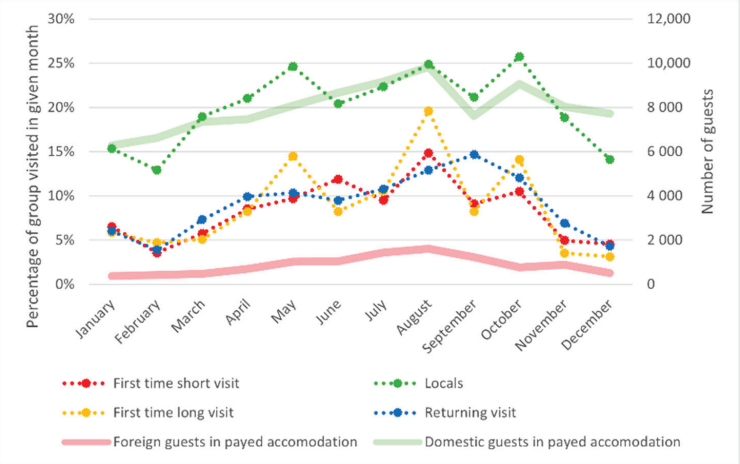

Figure 2. Temporal distribution of photographers in the Danube Bend region through the months of the year compared with official statistics of yearly average tourists in paid accommodation (Visegrád and Szentendre) between 2008 and 2019 [43].

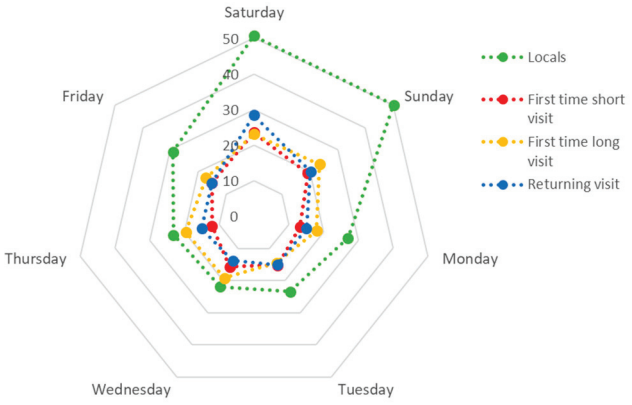

Figure 3. Temporal distribution of photographers in the Danube Bend region through the days of the week (% of users from the user groups who visited the area on the days of the week).

It is possible to compare the number of users with the official statistics of tourists in paid forms of accommodation in this region. The distribution along seasons correlates well in the case of domestic tourists. However, foreigners stay much less often in hotels here than domestic visitors, as most of these foreign visitors come to Budapest, stay there, and visit the Danube Bend only for a day trip.

Examining the number of users over the days of the week, the peaks are on Saturdays and Sundays. These peaks are especially outstanding in the case of visitors from Budapest, while tourists outside the capital area tend to visit in a more balanced distribution. Those visiting the capital city area on a longer trip were present in larger numbers also on Monday, Wednesday, and Thursday apart from the weekend. The average number of visits is much higher for locals and visitors from Budapest—a user from this group visited the Danube Bend for an average of 4.92 days, either living there or returning more times from Budapest during the past decade. Returning tourists spent 1.28 days, while first-time tourists on trips longer than 5 days spent an average of 1.41 days; therefore, more users from this group stayed overnight. In contrast, first-time visitors on short trips spent only 1.14 days here, meaning that very few of these visitors spent a night in the area. As stated before, most of the international tourists arriving to the region are in this group, taking only day trips to the region.

3.2. More Detailed Territorial Analysis around the Town of Szentendre

In this analysis, the verification of the behavior of foreign tourists and locals living in Szentendre was the focus, and the following users were identified:

- 10 locals who live in Szentendre;
- 175 international tourists with a foreign profile;
- 113 domestic first-time visitors; and
- 98 returning domestic visitors who returned to Szentendre in different time intervals.

In Szentendre, five spatial clusters were identified, all of which had more than 200 photos taken (Figure 4). The most visited cluster was the historical city and its riverbank, where 5290 photos were taken, of which 8.1% were taken by locals, the majority of the photos of this user group (54.7%). Most of the photos in the center were taken by foreigners (58.4%), and 83.3% of their photographing activities were concentrated here. Moreover, 53.1% of the photos by first-time Hungarian visitors and 38.9% of the photos by returning Hungarian visitors were taken in the center, making this area the tourism center of Szentendre. The second most visited cluster was the area of Szentendre Skanzen with 1182 photos, 13.6% of which were taken by foreigners, 28.3% by Hungarian tourists, and only 5.9% by returning visitors. Szentendre has a holiday area on the Danube, the Papp Island campsite, where 90.5% of the photos were taken by returning Hungarian visitors. Returning visitors were also the majority taking part in Pilis Park Forest excursions. In the Sztaravoda creek valley, the proportion of their photos was 91%, and in the Bükkös creek valley, it was 60.4%. The few local users were understandably significant in numbers (31.1%) at the mostly residential and holiday home areas around the center of Szentendre, where 39% of photos belonged to returning Hungarian visitors who were on holiday in Szentendre's holiday area or visiting the more out-of-town parts of the Danube (e.g., Postás beach). This detailed visitor analysis of Szentendre shows that foreign tourists mostly visited the historical city center only, with few of them reaching the Skanzen. Hungarian visitors had similar visit patterns, except for returning tourists, who visited Szentendre more regularly. They are hikers who followed the hiking trails of the Pilis Park Forest, holiday home owners who spent time in their weekend house in Szentendre, and returning visitors who were regularly on vacation on Papp Island or other sections of the Danube. All of the user groups spent at least a third of their time in the city center, so restaurants and services here were also used by weekend tourists not registered in the official statistics.

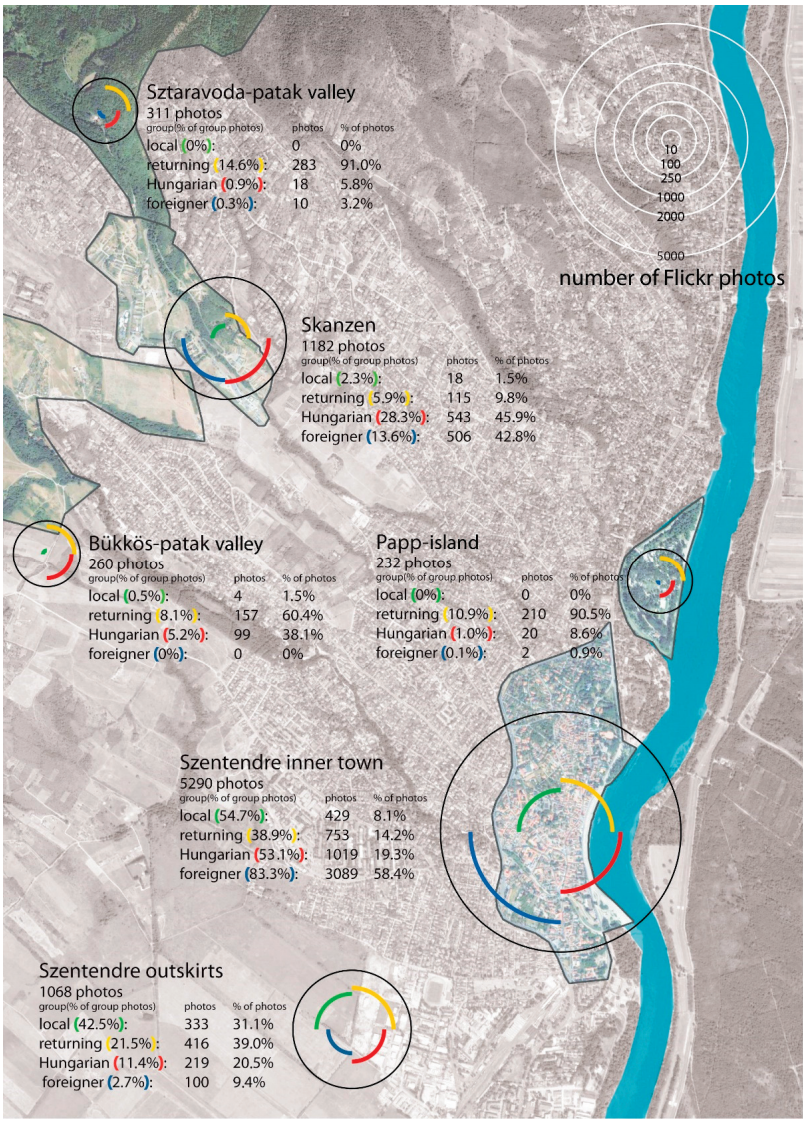

Figure 4. Number of photographs taken by different Flickr user groups in Szentendre, indicating the space usage of users living in Szentendre in green, regularly returning domestic tourists in yellow, first-time visiting domestic tourists in red, and international tourists in blue.

3.3. Visitors of the Northern Balaton Region and Their Movements Based on Flickr Images

The Balaton region is a much larger area than the Danube Bend, but due to the rigorous methodology discarding all users without a defined nationality, almost the same number of users was analyzed in the two regions. For the Balaton region, we found:

- 385 users (with 11,692 photos) clearly identified as foreigners who do not live in the country, as opposed to the 1046 Hungarian users;
- 106 users who could clearly be identified by their profile as inhabitants of the wider Balaton area, taking 5288 photos;
- 646 users active in this area classed as locals in the Budapest Metropolitan Area study, who took 32,297 photos; and
- 294 Hungarian users who were not from around Balaton or from Budapest, who took 8651 photos.

In addition, among the users from Budapest, 30 holiday home owners were identified who took more than five photos and stayed in non-commercial holiday homes around Lake Balaton, taking many more photos than other user groups, a total of 4055.

At first, it was surprising that only 7.4% of Flickr users who take photos around the Balaton Uplands are locals, while 45% are from Budapest. According to the data of the Hungarian Central Statistical Office [43], 262,293 people lived in the settlements of the Balaton recreation area in 2013. The Budapest Metropolitan Area had 2,541,835 inhabitants, while the rest of Hungary had 7,104,670 inhabitants. Therefore, correlated to the local inhabitants (106 users, 1/2474 inhabitants have Flickr activities = 100%), all users of Budapest have an activity level of 62.9% around Balaton (646), while other Hungarians (294) have an activity level of only 10.2%. In fact, if all domestic user groups had the same activity levels as locals, 1027 users from Budapest and 2871 Hungarian users outside Budapest should have been present in this area. The number of visitors from Budapest is very high, suggesting that more than half of all inhabitants from Budapest visited the Balaton region in a decade (given the timeframe of the Flickr dataset), while in the meantime, only 10% of other Hungarians did so. The data proved that Lake Balaton is primarily a recreation area of the capital city, even though it is located 100 to 200 km away from Budapest. International tourism was present in the region, but only 26.9% of users were foreigners. In addition, while the average foreign visitor took 30 photos, almost the same as the average Hungarian visitor (29 photos), guests from Budapest took almost 50 pictures, just as many per person as locals. This suggests that while a Hungarian tourist visiting Lake Balaton only visited once on average during the investigated period, visitors from Budapest spent much more time there, or reached Lake Balaton several times. The spatio-temporal patterns of visitors from Budapest are almost identical to those of locals in this region.

The temporal distribution of visitors in the Balaton region is observable in Figures 5 and 6. Instead of the absolute numbers, the percentage of the total number of users belonging to the different groups is shown because it reveals more clearly the different behavior of these groups. The highest numbers are during the two months of the beach season (July and August). The exception was the group of locals, whose numbers had two maximums in May and in October and were much more distributed around the year. The changes during the days of the week were similar to the ones in the Danube Bend region. Locals and foreigners were more balanced throughout the week: locals were in place all year around, while international tourists visited the lake once a year for a complete holiday week, as opposed to visitors from Budapest coming more times during the weekends. It is interesting again to compare the yearly distribution with official statistics. Flickr data of foreigners correlate well with international tourists staying in paid accommodation around Balaton Lake, and the same is true for domestic tourism. One interesting fact is that the statistical numbers correlate well in the summer season, while in all other months of the year, Flickr data show a great surplus of Hungarian visitors compared to domestic tourists in paid forms of accommodation. In fact, day trips and weekend visits to the area are frequent in autumn and spring, while in the summer, domestic tourists come for more time, using more hotels and campsites.

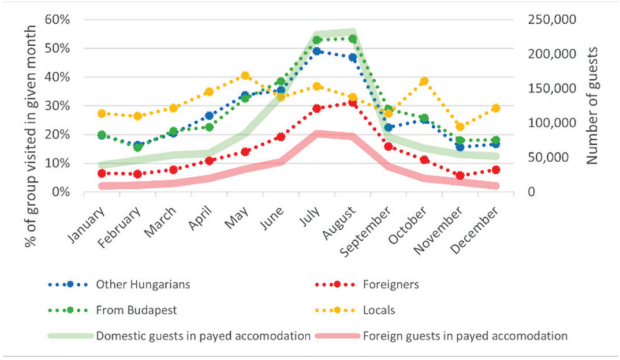

Figure 5. Monthly change in the number of Flickr users in the Balaton region compared with official statistics of yearly average tourists in paid accommodation between 2008 and 2019 [43].

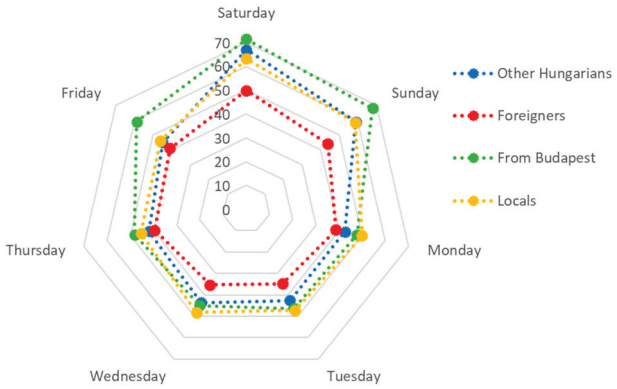

Figure 6. Change in the number of Flickr users through the days of the week in the Balaton region.

Part of the dataset in the Northern Balaton Region was aggregated into 20 microregions, as shown in Figure 7, highlighting the places photographed by Budapest users.

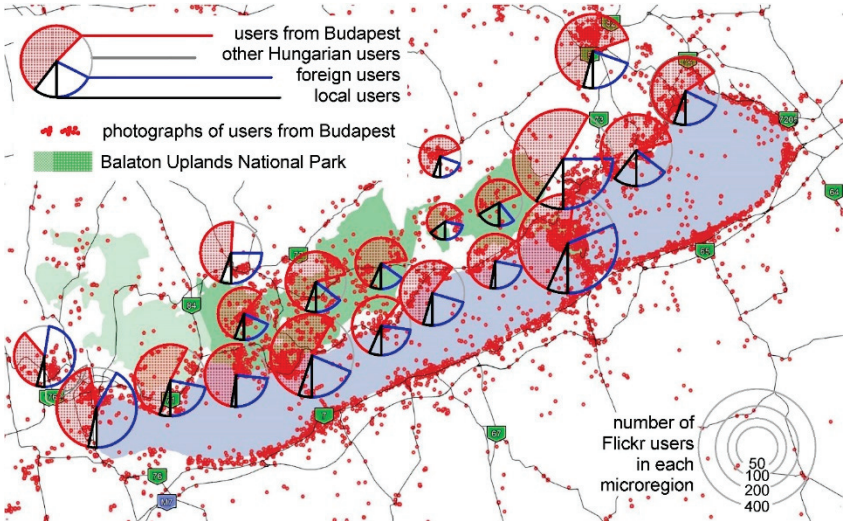

Figure 7. Map of the distribution of the photos by users from Budapest in the Northern Balaton Region, with diagrams showing the number and proportion of photographers in all the user groups identified.

Based on their Flickr photos, foreigners usually visit the settlements of the shores of Lake Balaton, where the beaches and ports can be found. In the Balaton Uplands, they visit the famous tourist destinations Veszprém (19.32% of all users), Balatonfüred (25.03%), Tihany (31.27%), Badacsony (18.78%), Szigliget (23.28%), and especially Keszthely (41.12%) and Hévíz (49.18%). Hévíz is the only settlement in the Balaton region where there are more international tourists than domestic tourists (46.7%). The place most neglected by foreign users is the most 'local' one: in the Pécsely Basin, 16.7% of Flickr users are locals, 51.7% are from Budapest, and only 11.67% are international tourists. Budapest users took photos in almost every settlement in the Balaton Uplands, with their share being between 50% and 60%, except where there are more foreigners, such as Keszthely (43.15%) and around Hévíz (39.34%), Tapolca (46.15%), Tihany (47.17%), and Balatonfüred (49.70%). Visitors from Budapest are highest in proportion in the Káli Basin: 66.27% of the users in Köveskál and Kővágóörs (international: 15.7%), and 65.09% in Szentbékkálla and Káptalantóti (international: 14.2%). The results show how the Northern Balaton region is prevalently the holiday area of the residents of the Budapest Metropolitan Area.

3.4. Tourist Consumption of Holiday Home Owners in Lake Balaton Based on Their Photos

The methodology identifying returning photographers in holiday home areas made it possible to analyze the tourist space usage of 20 residents of Budapest staying in private holiday homes on the northern shores of the lake, and 10 such users on the southern shores. The 4055 photos of these 30 users (135 on average) show that holiday home owners as a group use the region for tourism purposes most intensively (Figure 8). Every Flickr user staying in a holiday home in the Balaton area took photos in the shore strip of Lake Balaton: on beaches, piers, ferries, or promenades close to the water (53.93% of all photos). At the same time, 30.28% of the users also took photos in parts of the Balaton Uplands farther from the shore (at least 500 m from the water). Among the pictures of those staying in holiday homes on the north shore, 35% were taken in the Balaton Uplands, while half of these users did not take any photos on the south coast. In contrast, 90% of those staying on the south shore took photos in the north: 43.31% of their pictures were taken there (compared to 63.07% of those from the north) and 22% of the photos were taken in parts of the Balaton Uplands farther from the lake. Most of the holiday home owners travel all around the lake and the Balaton Uplands, visiting many secondary destinations where international tourists rarely arrive. Based on this dataset, it can be stated that a great number of holiday home owners around Lake Balaton travel around the region and the Uplands frequently instead of just staying in their holiday homes close to the beach. Even though this group is not included in the statistics, they have a much stronger presence and, presumably, consumption than many registered tourists.

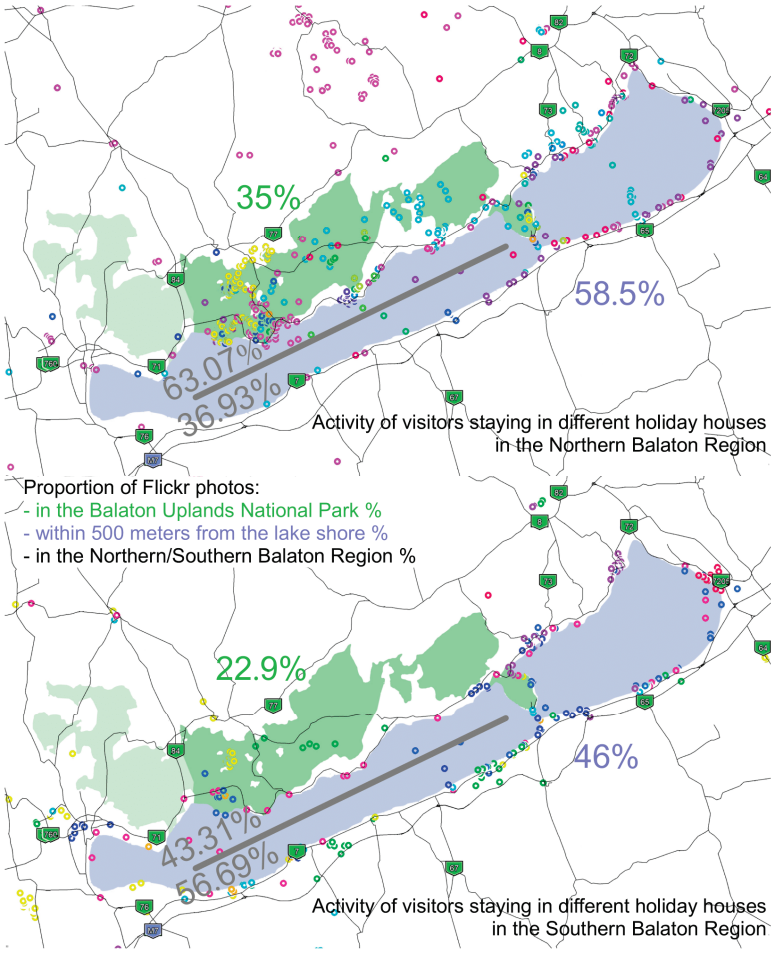

Figure 8. The movement of visitors (holidaymakers) staying in holiday homes around Lake Balaton, separately breaking down those who use holiday homes on the north shore and on the south coast.

4. Discussion and Conclusions

Geotagged photography retrieved from a social media site provided new data enabling us to have a more precise measurement of unconventional forms of tourism: day trips and weekend visits not using paid forms of accommodation. No other datasets equally available in multiple regions can describe the pattern of day trips and domestic tourism with such accuracy, but the selection of social media available for research is becoming more difficult [44]. Due to the protection of personal data, only data that are anonymized or that have been made freely available to users can be used for research, closing out large portions of social media usage. Moreover, even anonymized data are of value in the digital economy, so unlike the first services, having an open API (Application Programming Interface), today's social media data are kept in a closed system by the large service providers (Google, Facebook...) and cannot be researched [45]. For this reason, Twitter, which is not widespread in Hungary, and Flickr, which is used in Hungary, are used by most researchers for geo-positioned datasets [34,38,46]. Using Flickr has its limitations, not delivering statistically accurate data for all age and social groups. Kádár and Gede showed how Flickr is the most inclusive social media site for all age groups, meaning that older age groups are still under-represented but more active than on other photo sharing sites [30]. The higher photo sharing activity of tourists compared to locals in their domestic environments must also be taken into consideration. The experience of visiting a new environment is the main motivation for photo sharing [1], and therefore, visitors are always over-represented in such datasets. This study used Flickr data from before the outbreak of the COVID-19 pandemic, and the same datasets likely could not be used to measure the changing patterns in tourism consumption after the current crisis, as the declining userbase of this data source will provide less representative data.

However, we could deliver evidence on the predominance of domestic visitors in secondary tourism regions from before the COVID-19 crisis, when international tourism was still at its peak in Hungary and worldwide. The results partially explain why these rural destinations did not experience almost any decline in popularity during COVID-19 [47], unlike in Budapest, where most of the tourism facilities had serious difficulties [48,49].

The study bought evidence from tourism regions near watersides (Danube and Balaton), where beach tourism, nature tourism, and cultural tourism are all available, and some small- and medium-sized cities are the main tourist hubs. In the analyzed period, the main attractions and most branded destinations in these regions had a high proportion of international tourists (58.4% of all photography in the city center of Szentendre and 49.2% in Hévíz). However, at a regional level, only less than a quarter of all photography in both the Danube Bend and the Northern Balaton Region were taken by foreigners, and more than 80% only visited the primary attractions. The secondary attractions—sites farther away from important attractions, but with valuable landscapes, cultural attractions, and hospitality services—were mostly visited only by photographers from Hungary. Official statistics of paid accommodation also show the predominance of domestic tourists, and data from Flickr clearly showed correlation with such statistics (Figures 2 and 5). There is a great difference between the Danube Bend in the agglomeration area of Budapest and the Balaton region. Around the Balaton region, international tourists use paid forms of accommodation, and their numbers around the year correlate well with statistical data from these accommodation facilities. In fact, these statistics show that domestic tourists are underrepresented in the autumn, winter, and spring months, the times of year when many domestic tourists take day trips to the Balaton Uplands without using accommodation, or stay only for a night on the weekend. The Danube Bend shows reversed tendencies. Foreign tourists are almost completely missing from official statistics, as they book hotels in Budapest and only make day trips to this part of the Danube. Domestic tourists prefer not to go to Budapest, but stay in hotels in Visegrád or another town of the Danube Bend, but many visitors from Budapest also enjoy the thermal hotels of Visegrád. While in the Balaton region, the day trips and weekend visits invisible for statistics were taken mostly by residents of Budapest, in the Danube Bend, foreigners were also active day-trippers.

The most important finding from this dataset is that even if only one-fourth of the Hungarian population lives in the metropolitan area of the capital, well above 50% of all Flickr users active in both areas came from Budapest (in Nagymaros 68.7%, in the Kali Basin 65.5%). The visitors from Budapest—unlike international tourists—took photos of all primary and secondary destinations, and the least accessible ones in the two regions. The most active tourists in the Balaton region were the holiday home owners. The analysis of the spatial behavior of 30 such Flickr users reinforced previous findings about the role of this form of tourism [14]. Holiday home owners took 135 photos on average compared to the 50 of normal visitors from Budapest and 30 of other tourists; therefore, it can be assumed that this group extensively uses the paid services of the Balaton region such as restaurants, wine bars, and leisure services, and even more intensively in the Balaton Uplands, where even those based south of the lake prefer to take day trips. The exact proportion of holiday home owners compared to those staying in paying accommodation cannot be estimated from this analysis, but it can be stated with certainty that those staying in their own holiday homes contribute to the tourism economy much more than was measurable. The same is true for all day-trippers and weekend visitors—the present study reinforced similar studies with alternative methods on their tourism consumption [2,15].

The analysis of the photo sharing activities of Flickr users did not only reveal which domestic visitor groups visited the two waterside tourism regions the most, but also highlighted the role of social media and online image sharing in the function and sustainability of the economies and tourism systems in such destinations. Image taking and sharing became a main driving force in the experience economy, and local destinations can be competitive with global attractions if they offer authentic experiences users want to capture and share on social media. Studies of this phenomenon are important to understand the basis of economic sustainability of local tourism-related businesses outside of large destinations. The success of these local tourism regions contributes to the environmental sustainability of tourism as well; if local destinations can give memorable tourism experiences to domestic visitors, such visitors will have less motivation to seek out long-distance travel destinations, thereby reducing the environmental footprint of travel.

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(In)Visible Tourism According to Online Cash Registers in Hungary, 2018–2020

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Abstract: The aim of this paper is to share innovations and some key lessons learned in the use of non-traditional data sources to improve data quality and enable more accurate and efficient data use in the field of tourism. Research on visitor traffic is based on classical statistical measures, but it may be worth expanding it with alternative data sources, such as databases based on online cash register (OCR) data. These data can be particularly useful for analysing tourism-related consumption habits in a given area. The study introduces the "invisible", tourism-related, non-accommodation spending characteristics of transit traffic in Hungary, the possibilities of its analysis and spatial aspects, using online cash register data (includes all retail sales in Hungary, except for motorcycle purchases), and additionally, we identify the most affected municipalities which are invisible for traditional data sources. The results show that invisible tourism, linked to transit traffic, has significant economic potential. The analysis of this new type of database will provide a more accurate and faster picture of consumption associated with hidden tourism, which can be an important input for economic and marketing development.

Keywords: invisible tourism; transiting; transit traffic; geospatial information; Hungary

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1. Introduction

Hungary is a transit country, not only for freight but also for passengers. About one third of foreigners entering Hungary each year only pass through the country. This is explained by Hungary's central location in East-Central Europe, its proximity to seven countries and its access to the European road network. Transit does not necessarily occur in a hermetically sealed corridor—such as motorways across national borders—almost isolated of the socio-economic environment, but often becomes part of it. The nature of the transit implies stops, longer or shorter breaks for the driver and passengers, meals and refuelling of the vehicle, which take place both in motorway car parks with appropriate infrastructures and in the living areas of the local population within residential areas.

Classic survey-based data sources are available for the travel activity of foreigners not involved in freight transport, so we have a relatively reliable picture of the macro-level characteristics of transit flows. According to data from the Hungarian Central Statistical Office, the share of transit passengers arriving in Hungary increased from 33% in 2017 to 34% in 2020. Their number exceeded 20 million in 2019, before the COVID-19 pandemic, and decreased to 11 million in 2020. Spending by transit passengers accounted for 6% of total spending in 2017, increasing to 9% by 2020. Spending was HUF 116 billion in 2017, rising to HUF 174 billion in 2019, and then decreased to just over HUF 104 billion in 2020. The indicators speak for themselves: traffic of this magnitude is capable of generating changes at the micro-level, with social, economic and physical impacts [1] on the life of the municipalities concerned. However, in order to examine these effects, it is essential to define the municipalities involved in transit traffic, i.e., to identify the towns and villages where the demand of transit passengers is realised.

2. Materials and Methods

2.1. Online Cash Register Data in Hungary

The challenges faced by statistics in the 21st century are manifold. We are surrounded by systems that are becoming substantially more and more complex. With the emergence of new phenomena (e.g., globalisation, global demographic trends or sustainable development) and complex realities that need to be meaningfully and timely captured by statistics, new types of data have also been emerging, offering opportunities to improve the relevance of statistics.

Fortunately, there is currently an abundance of data sources: questionnaire-based statistical data, census data, big data, smart data, machine data, administrative data, privately held data, etc. In many cases, statistical domains are based on traditional data sources that are reaching their limits with respect to timeliness, relevance and compliance.

For the purpose of reducing the abuses committed during the retail trade turnover, the government of Hungary decided to introduce an online connection of cash registers with the National Tax Authority in October 2014. According to the OECD [2], electronic cash registers are used (among others) in Argentina, Austria, Belgium, the Czech Republic, Hungary, Italy, the Netherlands, Portugal, Russia and Sweden. As such, cash machines involved in the online cash register system send online retail chain sales information to the National Tax Authority. This means that data concerning the sales of retail stores can be accessed in real time from the NTCA (National Tax and Customs Administration) database. Immediately after the purchase of goods or services, invoice details are automatically sent online to the National Tax and Customs Administration. The Hungarian Central Statistical Office receives this in full. The database contains the OCR number, the date of commissioning, the period of validity, the tax number of the company, the name and address of the business, the economic activity of the company, the number and turnover value of invoices, cancellation and returns for the given period.

In this paper, we use OCR data from 2018, 2019 and 2020 to illustrate methodological approaches that map out the crystallisation points of transit traffic in Hungary. While the study primarily aims to capture the phenomenon of transit at the municipal level, we draw attention to the fact that the impacts are economy-wide in their multiplier effect.

The OCR data are available up-to-date, with the added advantage of being disaggregated by economic activity and geographical location. The advantage of online cash registers is that tax authorities can determine the amount of tax payable more accurately and quickly based on the data they receive, and if they see suspicious traffic data, they will be able to filter out fraudsters in a matter of seconds. The system developed from a tax point of view also provides much more accurate data for analysis, so we used this data source. According to the OECD [2], the use of online cash registers has the following advantages: better tax compliance, protection of fair competition, reduction of compliance burdens, and enhanced consumer protection. The other advantage of OCR is that we have quasi-real-time information about retail processes, the time to market is much faster than the classic questionnaire survey, and it reduces the statistical reporting burden on businesses.

The disadvantage of OCR data is that due to possible failures of the cash machines, NTCA will not receive data for another 11 months, so the first data transmission cannot be considered as final information. However, the differences between data sets are now negligible.

For the purpose of this study, we consider tourism-related expenditures based on the international recommendations (https://unstats.un.org/unsd/publication/Seriesm/SeriesM_83rev1e.pdf) (accessed on 5 January 2022) presented in Appendix A Table A1.

Transiting is a relatively rarely analysed part of tourism, despite the unquestionable importance of connectivity in tourism systems [3]. One of the reasons for this, according to certain opinions, is that transit is partly seen as a low revenue generator and partly as a necessary inconvenience for tourists [4].

2.2. Theoretical Background

Although transit is a phenomenon that affects many countries in Europe, the study of this kind of mobility is not part of mainstream national and international research on transport, migration and tourism. Some of the studies on transit issues focus on freight transport infrastructure and its development [5,6] and logistics [7], while others focus on cost implications [8–11], environmental issues [12] and geopolitical aspects [13,14]. Researchers are much more interested in exploring the specificities of traffic flowing through large cities [15–17] than that between national borders.

Transiting is a specific form of mobility, as its main purpose is to cover the distance between the origin and the destination in the shortest possible time, while travellers usually do not consider the tourist experiences they may have on the way. However, transit does not exclude the use of the tourist services of the areas concerned, since transit passengers may interrupt their journey to buy fuel or to visit retail shops, but we should not forget the possibility of visiting certain tourist attractions and, in some cases, of using accommodation facilities [18–21]. Same-day movements are distinguished more by their duration and less by their radius. With minimal investment, same-day trips will meet tourist demand, and thus contribute to the development of tourism in general [22].

Tourism researchers have a surprisingly lenient approach to the issue of transit, which is certainly related to the statistical interpretation of the concept [23]. There are hardly any studies that have recognised the tourism implications of the behaviour of transit passengers. This topic is mainly addressed in studies on tourism in the former socialist countries of Central and Eastern Europe and South-Eastern Europe, where the flow of guest workers to the West is also highlighted [24–26].

Transiting is a key phenomenon not only in land transport but also in water [27] and air transport, with retail stores available from airport transit lounges, serving both to spend time and to encourage spending by transit passengers [28–31]. Researchers are also interested in the measurement of transit traffic, which, while not a potential substitute for classical traffic counting, can provide a useful complementary source of information from the spatial- and time-based recording of call volumes over a wide range of mobile communication devices [32]. Last, but not least, the specific tourist behaviour of caravans and motorhomes is unexplored in the relationship between tourism and transit [33].

Although our study tries to delimit the range of settlements that primarily benefit from transit tourism, we also consider it important to mention that transit has its drawbacks, the management of which is definitely a challenge for decision-makers. Such a challenge could be increased traffic, the resulting congestion, high levels of pollution, etc. This, in turn, leads us to the issue of tourism penetration [34], which may be the subject of further research.

2.3. Transiting as a Crypto Mobility Activity

The tourism aspects of this phenomenon have also been recognised by relevant EU experts, who have suggested, among other things, the need to measure transit travel. Recital 5 of the EU regulation (Regulation (EU) No 692/2011 of the European Parliament and of the Council of 6 July 2011 concerning European statistics on tourism and repealing Council Directive 95/57/EC) to modernise the methodology of tourism statistics states that:

"The changing nature of tourism behaviour . . . with the growing importance of short trips and same-day visits contributing substantially in many regions or countries to the income from tourism [. . .] means that the production of tourism statistics should be adapted."

The previous definition of tourism, which assumed a minimum one-night stay, therefore needs to be amended to take into account not only so-called "excursion" traffic (shopping, visiting relatives), which is mainly concentrated in border areas and lasts less than 24 h, but also transit traffic. Since the paradigm of thinking about tourism [35] excludes the discussion of the demand arising from the needs of freight transport actors and the supply created to satisfy them under the umbrella of tourism, it is still appropriate to ignore freight transport.

However, it should be noted that road corridors for freight transport include a number of infrastructure and suprastructure objects that are also used by lorry drivers. Thus, petrol stations offering complex services, roadside accommodation and catering outlets meet the demand not only of passengers but also of freight transport. Therefore, in a certain context, it is appropriate to carry out an analysis in this respect, even if the demand generated by freight transport is not considered as tourism expenditure.

If passenger transit is discussed as part of tourism, it is assumed that similar to conventional tourist mobility; it has its clear manifestations. However, while the fact of staying in a registered accommodation is included in tourism statistics, services used in unconventional tourism mobility rarely become part of a database that can be compared over space and time. The exploration of the territorial aspects of transiting, therefore, requires the creation of a methodological approach which, on the one hand, takes into consideration the specificities of the phenomenon under study and, on the other hand, is based on some statistically measurable fact. The challenge is not a minor one, as we need to make visible a crypto mobility, a quasi-invisible travel phenomenon. In our approach, we consider areas that are covered by official statistical data collection as visible tourism areas, and those that are not covered by official data collection as invisible tourism areas (for example: trips shorter than 24 h, border trips, the use of friendly accommodation). Within these, the present study deals mainly with the issue of transit.

For this, it is worth starting with the characteristic feature of transit that captures the moment of stopping for whatever reason. Buying fuel or shopping in retail stores is definitely one of them, but we should also bear in mind visiting certain tourist attractions and, in some cases, staying in accommodation. However, there is no statistical data on the number of visitors to each municipality, so in these cases only the OCR can provide a useful indication.

2.4. Delineation of the Municipalities Involved in Transiting Using GIS Methods

The first step of the analysis was to identify the Hungarian settlements that could be affected by transit traffic. The delineation was carried out using geographic information methods and taking into account the following criteria:

(a) When a transit traveller enters Hungary at a road border crossing point, he or she does not leave Hungary at the same border crossing point from which he or she arrived.
(b) Due to the nature of transit, it was also assumed that a person transiting through Hungary would use the shortest route in time between the entry and exit points.

Based on these criteria, the shortest travel time to all border crossing points in all neighbouring countries was determined. The municipalities affected by the intersection of each route were selected and summarised. The possibility was considered that transit traffic might benefit not only the settlements directly affected by transport routes, but also neighbouring settlements. However, we considered this to be an isolated and ad hoc phenomenon and the original delineation was therefore considered sufficient. Based on this delineation, 956 of Hungary's 3152 settlements were included in the scope of the study, i.e., this was the number of municipalities considered as potential crystallisation points for transit traffic, and further investigations were carried out on this population of municipalities.

3. Outcomes, Results

3.1. Exploring the Role of Tourism by Expert Assessment

The 956 municipalities included in the study were classified into three groups based on expert assessment of the role of the tourist attractions located in their administrative territory. Given that presenting the methodology of the expert assessment of tourism attractiveness would go far beyond the scope of this study, we will only outline the main points of the assessment carried out. Our work was based on the recommendations of the methodological handbook (compiled by Gábor Michalkó and Tamara Rátz), which was prepared in 2006 under the co-ordination of Hungarian Tourism Ltd. In this case, for the

classification of individual attractions, legislation (e.g., Act CXII of 2000 on the adoption of the Spatial Planning Plan of the Balaton Special Tourist Region and on the establishment of the Balaton Spatial Planning Code), official databases (e.g., the National Public Health and Medical Officer's Service, the Registry of the National Directorate General for Spas and Thermal Baths), surveys and registers of the HCSO (e.g., the number of overnight stays and offer of spa and wellness hotels), ratings published by professional organisations (e.g., the list of certified festivals of the Hungarian Festival Association) and the websites of the municipalities were used. For example, international and national ratings were awarded to those municipalities whose accommodation demand was dominated by foreign demand, which had the highest ranking in the various databases (e.g., settlement by Lake Balaton; spa; wellness hotel; festival with excellent rating). Municipalities with regional attractiveness include those towns and villages that were rated lower in the sources reviewed (e.g., settlement further from Lake Balaton, no spa, but there was thermal water for bathing; well-rated festival). The municipalities that were not included in the databases we processed and whose attractiveness could not be identified from the information on their websites were grouped into municipalities without significant tourist attractions. The first group included international and national attractiveness, the second group was made up of regional attractiveness and the third group contained municipalities without significant tourist attractions (see Figure 1). The data used in the following analysis were derived from the above settlement classification of the role of tourism attraction and the settlement aggregation of the OCR data related to tourism (see Tables 1–3).

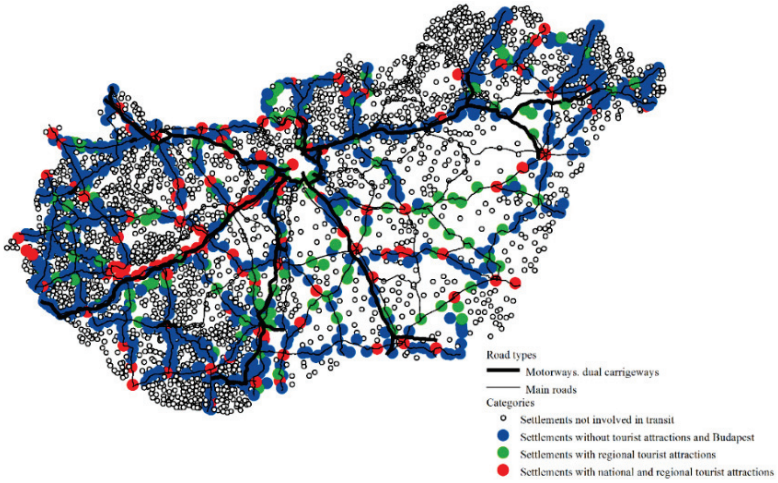

Figure 1. The Hungarian municipalities according to their tourism attractiveness.

Table 1. Number of surveyed municipalities as a function of tourism-related revenue and the tourism attractiveness category in 2018.

Category/Revenue	HUF 0–50 Million	HUF 50–250 Million	HUF 250–500 Million	HUF 500–1000 Million	HUF 1000–5000 Million	HUF over 5000 Million	Total
1 (municipalities without significant attractiveness)	481	184	31	12	6	0	714
2 (municipalities with regional attractiveness)	27	39	17	18	21	3	125
3 (municipalities with national, international attractiveness)	11	20	12	21	34	19	117
Total	519	243	60	51	61	22	956

Sources: Own calculations, based on OCR register.

Table 2. Number of surveyed municipalities as a function of tourism-related revenue and the tourism attractiveness category in 2019.

Category/Revenue	HUF 0–50 Million	HUF 50–250 Million	HUF 250–500 Million	HUF 500–1000 Million	HUF 1000–5000 Million	HUF over 5000 Million	Total
1 (municipalities without significant attractiveness)	465	196	30	15	7	1	714
2 (municipalities with regional attractiveness)	27	34	17	20	22	5	125
3 (municipalities with national, international attractiveness)	11	19	9	20	37	21	117
Total	503	249	56	55	66	27	956

Sources: Own calculations, based on OCR register.

Table 3. Number of surveyed municipalities as a function of tourism-related revenue and the tourism attractiveness category in 2020.

Category/Revenue	HUF 0–50 Million	HUF 50–250 Million	HUF 250–500 Million	HUF 500–1000 Million	HUF 1000–5000 Million	HUF over 5000 Million	Total
1 (municipalities without significant attractiveness)	484	187	25	13	5		714
2 (municipalities with regional attractiveness)	27	38	16	19	22	3	125
3 (municipalities with national, international attractiveness)	11	20	12	22	35	17	117
Total	522	245	53	54	62	20	956

Sources: Own calculations, based on OCR register.

The strength of stochastic relationships between qualitative and quantitative criteria can be measured by association measures [35,36]. The independence of the two variables (X and Y) is then

$$\Phi^2 = \sum_{i=1}^{I} \sum_{j=1}^{J} \frac{(p_{ij} - p_{i.} \cdot p_{j.})^2}{p_{i.} \cdot p_{j.}} \quad (1)$$

measured by statistics, where $P_{ij} = P(X = x_i, Y = y_j)$, $i = 1,2, \ldots .I$; $j = 1,2, \ldots ,J$.

If independent, the value is 0.

Noteworthy statistics are obtained by different normalizations of the quantity Φ^2 [37]:

Pearson's formula:

$$P = \sqrt{\frac{\Phi^2}{\Phi^2 + 1}} \quad (2)$$

Cramer's formula:

$$T = \sqrt{\frac{\Phi^2}{\sqrt{(I-1) \cdot (J-1)}}} \quad (3)$$

(P, $T = 0$ the two variables are independent of each other; P, $T = 1$ means a functional relationship, while $0 < P$, $T < 1$ indicates a stochastic relationship.)

Based on our calculations (Table 4) using the above theory, we found only a moderately strong stochastic relationship between tourism attractiveness and revenue. Hence, it has been demonstrated that there is no functional relationship between the importance of tourism attractiveness and tourism-related revenues. In fact, there is only a weak stochastic relationship.

Table 4. Association results between tourism attractiveness and corresponding OCR revenues in the surveyed municipalities.

	2018	2019	2020
P	0.566	0.564	0.567
T	0.386	0.385	0.387

Sources: Own calculations.

3.2. Identification of the Municipalities Involved in Transiting

In most cases, OCR and attractiveness were proportional at the level of municipalities, but there was a significant anomaly (Tables 1–3). The differences between the above criteria could be distinguished in two directions. In the first case, tourism attractiveness was much higher than the revenue, while in the second case, the municipalities where the revenue significantly exceeded the tourism attractiveness are included. In this study, we will focus on the latter group in more detail.

From Tables 1–3, we consider the municipalities as the crystallisation points of invisible tourism when:

- there was no significant tourist attraction and the corresponding OCR-revenue was above HUF 250 million;
- there was a regional tourist attraction and the above revenue reached or exceeded HUF 1000 million.

These municipalities clearly generate more revenue than would be expected from the role of tourist attractiveness in the area, according to the paradigms of the sector [38], and thus we have identified a group of municipalities that are likely to show a different attitude from conventional tourism.

In 2018, 2019 and 2020, we counted 73, 80 and 68 such municipalities, respectively. The number of municipalities varied slightly over the period. The frequencies of occurrence are shown in Figure 2.

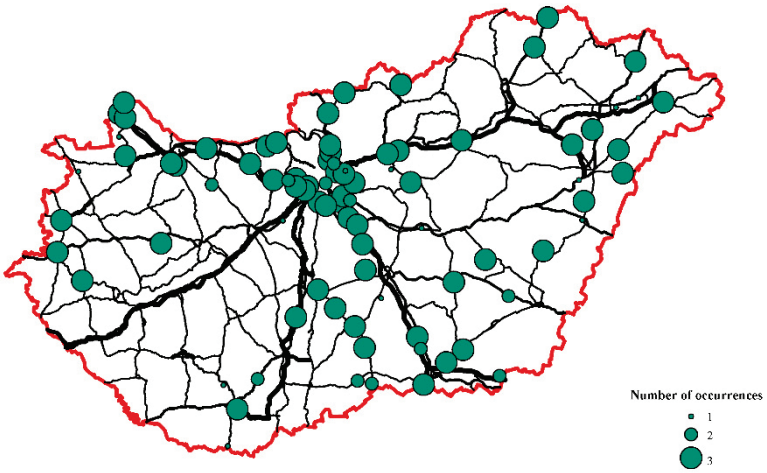

Figure 2. Geographical locations of the surveyed municipalities.

In Hungary, the total value added by the activities included in tourism satellite accounts was 3.4 times higher than the gross value added by tourism in the narrow sense, i.e., accommodation and food service. Based on OCR data, the national ratio was 4.2 for revenues. In 2020, the share of revenues was already 4.7 times for the 956 municipalities analysed. Moreover, in the 68 municipalities identified in 2020, it was more than 10 times higher. This underlines the relevance of the identified municipalities in invisible tourism.

3.3. Characteristics of the Municipalities Affected by Transit Tourism

In this section we will further examine the municipalities defined in the previous chapter as the focal points of invisible tourism, in order to identify the characteristics,

features and geographical locations of the municipalities where transit tourism may become relevant, and the characteristics that increase the chances of transit tourism in a given municipality.

The municipalities affected by transit tourism were highly heterogeneous in terms of population and socio-economic characteristics. We found that the economic and accessibility characteristics of the municipalities did not have a significant impact on the focal points of transit tourism. Therefore, it was assumed that the geographical location of the municipality may play a greater role in transit tourism. In fact, the spatial distribution of the municipalities theoretically affected by transit tourism (956) showed a strong link with road network nodes.

The table below shows: Category 1—there is a motorway slip road in the municipality, i.e., a main road intersects the motorway; Category 2—intersection of main roads; and Category 3—all other municipalities located at a point not important for road traffic (Figure 3).

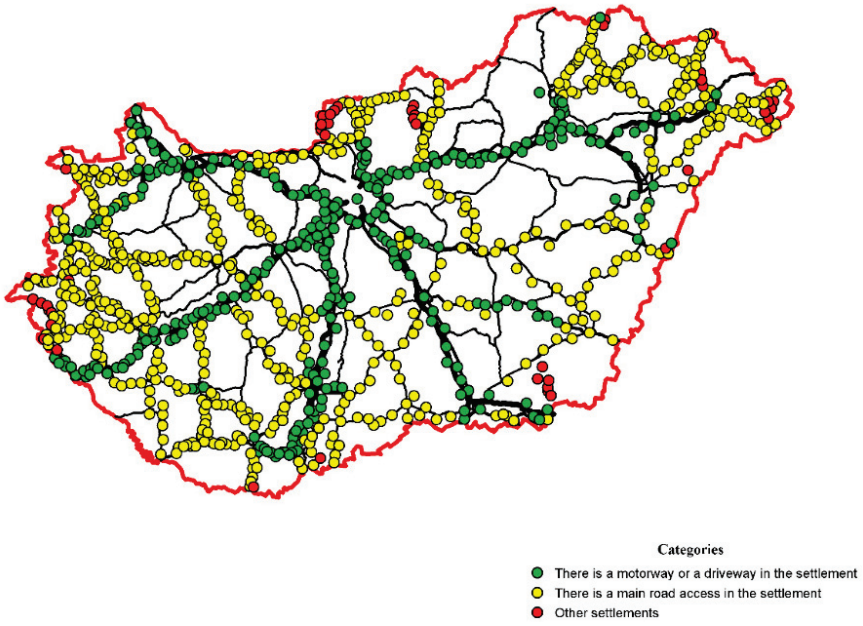

Figure 3. Categorisation of Hungarian settlements by road network.

Tables 5–7 provides a breakdown of the surveyed municipalities by OCR revenue and tourism attractiveness, broken down by the above node categories for the year 2020, highlighting in bold, italic number the municipalities most affected by invisible tourism on the basis of previous analyses. The results for 2018 and 2019 are presented in Appendix A Tables A2–A7.

Table 5. Number of municipalities with motorways and main roads as a function of tourist attractiveness and OCR tourism-related income in 2020.

Category/Revenue	HUF 0–50 Million	HUF 50–250 Million	HUF 250–500 Million	HUF 500–1000 Million	HUF 1000–5000 Million	HUF over 5000 Million	Total
1 (municipalities without significant attractiveness)	115	64	*14*	*10*	*5*		208
2 (municipalities with regional attractiveness)	7	8	7	5	*11*	*2*	40
3 (municipalities with national, international attractiveness)	5	6	3	5	20	13	52
Total	127	78	24	20	36	15	300

Table 6. Number of municipalities with main roads as a function of tourist attractiveness and OCR tourism-related income in 2020.

Category/Revenue	HUF 0–50 Million	HUF 50–250 Million	HUF 250–500 Million	HUF 500–1000 Million	HUF 1000–5000 Million	HUF over 5000 Million	Total
1 (municipalities without significant attractiveness)	338	118	*11*	*3*			470
2 (municipalities with regional attractiveness)	18	28	8	14	*11*	*1*	80
3 (municipalities with national, international attractiveness)	4	13	8	17	15	4	61
Total	360	159	27	34	26	5	611

Table 7. Number of municipalities located at a point not important for road traffic as a function of tourist attractiveness and OCR tourism-related income in 2020.

Category/Revenue	HUF 0–50 Million	HUF 50–250 Million	HUF 250–500 Million	HUF 500–1000 Million	HUF 1000–5000 Million	HUF over 5000 Million	Total
1 (municipalities without significant attractiveness)	31	5					36
2 (municipalities with regional attractiveness)	2	2	1				5
3 (municipalities with national, international attractiveness)	2	1	1				4
Total	35	8	2				45

Sources: Own calculations, based on OCR register.

This means (Table 8) that while invisible tourism was detected in 0% of the municipalities belonging to Category 3 (located at a point not important for road traffic), in Category 2 (existence of main roads), it was already 4–5%, while in Category 1 (motorway slip roads) it was 14–16% of the 956 municipalities originally delimited (results for 2018 and 2019 are presented in Appendix A Table A8). In other words, in these cases, the correlation between tourism attractiveness and OCR data cannot be explained.

Table 8. Number of municipalities affected by invisible tourism as a function of road network characteristics in 2020.

Road Network Characteristics	Number of Municipalities Affected by Invisible Tourism	Total Number of Municipalities Surveyed	%
1	42	300	14.00
2	26	611	4.26
3	0	45	0.00
Total	68	956	7.11

Sources: Own calculations, based on OCR register.

The results demonstrate that transit traffic generates significant invisible tourism revenue, primarily in municipalities with motorway slip roads and secondarily in municipalities bordering main roads (in municipalities with a large tourist attractiveness, these revenues are "visible", but for smaller ones, only the OCR data provide a guide). The lack of adequate connectivity practically excludes the emergence of invisible tourism.

4. Discussion

Hungary is one of Europe's transit countries. It has a significant role in both East–West and North–South passenger traffic on the continent. Transit passengers, most of who arrive by car, use motorways and/or trunk roads to cover the distance between two border sections, stopping off for a variety of needs. Transit is often disrupted in settlements where service providers have built their businesses specifically on transit. To ensure that these towns and villages are excluded from traditional tourism destinations, it is necessary to identify the characteristics that reliably indicate the likelihood of transit travel. This required the inclusion of a new data source (OCR) with sufficiently detailed spatial, temporal and activity level information to identify the tourism-related expenditure of transit travel. In the study, a geospatial delineation was carried out, based on which the groups were analysed according to their statistical characteristics It was assumed that a foreign transit passenger would also stop in a municipality that has no significant tourist attraction, but that its favourable location would contribute to its choice as a place for a break. Therefore, if a municipality located at the intersection of the shortest routes between border sections has above-average OCR tourism-related revenue, even though there is no significant tourism attraction, then the presence of transit traffic is probable. We were able to identify 86 municipalities that met the above criteria, which will be the focus of further research in the future.

We concluded that being located at the junction of a main road and a motorway or two main roads already has a significant impact on spending.

5. Conclusions

Overall, it can be concluded that the settlements that benefit most from the transit traffic of foreigners arriving in Hungary are those that:

- are located at the intersection of routes that allow the shortest time between each border section
- are located at the intersections of access from main roads to motorways, or at the junction of two main roads.

These results are certainly due to the psychological component of the nature of transit, in which intersections and nodes are seen as stages of the journey, the fulfilment of the desire to get somewhere, the physical completion of a stage (a well-deserved rest), and a place of preparation for the next stage.

We consider it important that the needs of the local residents and tourist service providers of the demarcated settlements, as well as transit passengers, be taken into account in spatial and transport planning. A complex approach is needed in order to ensure that the benefits of transit tourism do not only accrue to the service providers concerned, but also to minimize the damage or inconvenience it causes. Thus, instead of destroying tourist destinations, transit tourism becomes sustainable, even in the longer term. This, in turn, requires a holistic approach and long-term planning, the beginning of which we have tried to contribute to with our work.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Internationally recommended groupings of economic sectors related to tourism.

IRTS/TSA: RMF Tourism Industries [a]	ISIC Rev. 4	NACE Rev. 2 (TEÁOR'08) [b]	Description (TEÁOR'08)
Accommodation	5510	5510	Hotels and similar accommodation
	5520	5520	Holiday and other short-stay accommodation
		5530	Camping grounds, recreational vehicle parks and trailer parks
	5590	5590	Other accommodation
Food and beverage serving activities	5610	5610	Restaurants and mobile food service activities
	5629	5629	Other food service activities
	5630	5630	Beverage serving activities
Railway passenger transport	4911	4910	Passenger rail transport, interurban
Road passenger transport	4922	4932	Taxi operation
		4939	Other passenger land transport
Water passenger transport	5011	5010	Sea and coastal passenger water transport
	5021	5030	Inland passenger water transport
Air passenger transport	5110	5110	Passenger air transport
Renting and leasing of motor vehicles	7710	7711	Renting and leasing of cars and light motor vehicles
		7712	Renting and leasing of trucks (over 3.5 t)
Travel agency and tour operator activities	7911	7911	Travel agency activities
	7912	7912	Tour operator activities
	7990	7990	Other reservation services and related activities
Cultural activities	9000	9001	Performing arts
		9002	Support activities to performing arts
		9003	Artistic creation
		9004	Operation of arts facilities
	9102	9102	Museum activities
		9103	Operation of historical sites and buildings
	9103	9104	Botanical and zoological gardens and nature reserve activities
Sports and recreational activities	7721	7721	Renting and leasing of recreational and sports goods
	9200	9200	Gambling and betting activities
	9311	9311	Operation of sports facilities
		9313	Fitness facilities
	9321	9321	Activities of amusement parks and theme parks
	9329	9329	Other amusement and recreation activities
Country-specific tourism characteristic activities			
Other personal service activities (spa)		9604	Physical well-being activities
		8690	Other human health activities
Support activities for transportation		5221	Service activities incidental to land transportation
		5222	Service activities incidental to water transportation
		5223	Service activities incidental to air transportation

[a] Source: International Recommendations for Tourism Statistics 2008—Annex 3. [b] TEÁOR'08 is the Hungarian activity classification identical to the European one, NACE Rev.2. Statistical Classification of Economic Activities in the European Community, 2008.

Table A2. Number of municipalities with motorways and main roads as a function of tourist attractiveness and OCR tourism-related income in 2018.

Category/Revenue	HUF 0–50 Million	HUF 50–250 Million	HUF 250–500 Million	HUF 500–1000 Million	HUF 1000–5000 Million	HUF over 5000 Million	Total
1 (municipalities without significant attractiveness)	111	66	*15*	*10*	*6*		208
2 (municipalities with regional attractiveness)	7	9	8	4	*10*	*2*	40
3 (municipalities with national, international attractiveness)	5	5	4	5	19	14	52
Total	123	80	27	19	35	16	300

Table A3. Number of municipalities with main roads as a function of tourist attractiveness and OCR tourism-related income in 2018.

Category/Revenue	HUF 0–50 Million	HUF 50–250 Million	HUF 250–500 Million	HUF 500–1000 Million	HUF 1000–5000 Million	HUF over 5000 Million	Total
1 (municipalities without significant attractiveness)	338	114	*16*	*2*			470
2 (municipalities with regional attractiveness)	18	28	8	14	*11*	*1*	80
3 (municipalities with national, international attractiveness)	4	13	8	16	15	5	61
Total	360	155	32	32	26	6	611

Table A4. Number of municipalities located at a point not important for road traffic as a function of tourist attractiveness and OCR tourism-related income in 2018.

Category/Revenue	HUF 0–50 Million	HUF 50–250 Million	HUF 250–500 Million	HUF 500–1000 Million	HUF 1000–5000 Million	HUF over 5000 Million	Total
1 (municipalities without significant attractiveness)	32	4					36
2 (municipalities with regional attractiveness)	2	2	1				5
3 (municipalities with national, international attractiveness)	2	2					4
Total	36	8	1				45

Table A5. Number of municipalities with motorways and main roads as a function of tourist attractiveness and OCR tourism-related income in 2019.

Category/Revenue	HUF 0–50 Million	HUF 50–250 Million	HUF 250–500 Million	HUF 500–1000 Million	HUF 1000–5000 Million	HUF over 5000 Million	Total
1 (municipalities without significant attractiveness)	102	72	*14*	*12*	*7*	*1*	208
2 (municipalities with regional attractiveness)	*7*	8	7	4	*10*	*4*	40
3 (municipalities with national, international attractiveness)	5	5	3	6	18	15	52
Total	114	85	24	22	35	20	300

Table A6. Number of municipalities with main roads as a function of tourist attractiveness and OCR tourism-related income in 2019.

Category/Revenue	HUF 0–50 Million	HUF 50–250 Million	HUF 250–500 Million	HUF 500–1000 Million	HUF 1000–5000 Million	HUF over 5000 Million	Total
1 (municipalities without significant attractiveness)	333	118	*16*	*3*			470
2 (municipalities with regional attractiveness)	18	24	9	16	*12*	*1*	80
3 (municipalities with national, international attractiveness)	4	13	5	14	19	6	61
Total	355	155	30	33	31	*7*	611

Table A7. Number of municipalities located at a point not important for road traffic as a function of tourist attractiveness and OCR tourism-related income in 2019.

Category/Revenue	HUF 0–50 Million	HUF 50–250 Million	HUF 250–500 Million	HUF 500–1000 Million	HUF 1000–5000 Million	HUF over 5000 Million	Total
1 (municipalities without significant attractiveness)	30	6					36
2 (municipalities with regional attractiveness)	2	2	1				5
3 (municipalities with national, international attractiveness)	2	1	1				4
Total	34	9	2				45

Table A8. Number of municipalities affected by invisible tourism as a function of road network characteristics, 2018–2019.

2018			
Road Network Characteristics	**Number of Municipalities Affected by Invisible Tourism**	**Total Number of Municipalities Surveyed**	**%**
1	43	300	14.33
2	30	611	4.91
3	0	45	0.00
Total	73	956	7,64
2019			
Road Network Characteristics	**Number of Municipalities Affected by Invisible Tourism**	**Total Number of Municipalities Surveyed**	**%**
1	48	300	16.00
2	32	611	5.24
3	0	45	0.00
Total	80	956	8.37

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Capturing Unobserved Tourists: Challenges and Opportunities of Processing Mobile Positioning Data in Tourism Research

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Abstract: Even though tourism (both domestic and international) is one of the main triggering factors of human mobility worldwide, some of its forms are unexplored. This can be partly linked with the lack of reliable data and obstacles related to data processing and interpretation. Mobile Positioning Data (MPD) allows us to identify various forms of tourism that are undetectable through traditional data sources such as accommodation statistics. Using MPD, not only same-day tourists but also the real time mobility patterns of tourists among various destinations can be revealed, and even hidden (i.e., unobserved) forms of tourism can be detected. However, despite the obvious benefits of such data, very few comprehensive studies exist to date on the processing, and interpretation of MPD in tourism research. In this paper, a case study is presented on the challenges and opportunities of processing MPD from raw to good quality researchable data offering a baseline tool for MPD-based research in the field of tourism. With the methodology introduced in this paper, it is possible to provide a more accurate picture of tourist flows regarding unobserved tourists, including same-day visitors.

Keywords: mobile positioning data (MPD); tourism mobility; unobserved tourism; same-day tourists; international tourism; domestic tourism

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1. Introduction

With skyrocketing numbers of tourists and intensifying mobility flows, the tourism industry has experienced an extraordinary growth over recent decades [1] and, despite the significant fracture caused by the recent COVID-19 pandemic [2], the trend is likely to increase in the future. Therefore, unfolding and better understanding the spatial behavior of tourists is becoming increasingly important. On the one hand, for national and local governments it is crucial to have up-to-date information on the spatio-temporal dynamics and real time characteristics of international and domestic tourists at different destinations. Such knowledge can contribute to a more efficient planning and management of tourism-related infrastructure and transport facilities and can help elaborate national and local policies to increase tourism revenues [3–6]. On the other hand, alongside the obvious economic benefits, the rapid growth of tourism also brings challenges [7–9]. The negative impacts of tourism include the increasing carbon emission or damage to the natural environment [10–12], over-tourism and the discontent of local communities with mass tourism [13,14]. To make tourism development more sustainable, it is worth identifying tourist destinations with rapidly expanding ecological footprint, congestion and social conflict in order to mitigate the negative environmental and social impacts of tourism [15,16]. In addition, private actors, such as representatives of the hospitality industry, event organizers etc., can also benefit from a more comprehensive knowledge regarding the spatial and temporal behavior of tourists [17,18].

While traditional data sources (accommodation and border crossing statistics) are useful for macro-level analyses (countries, regions, larger administrative units) of the spatio-temporal aspects of tourism [19–21], such data have several limitations when it comes to a lower geographical scale such as the analysis of intra-urban tourist flows, intra-regional moves of same-day visitors or cross-border day trippers [22,23]. To capture such statistically unobserved forms of tourism, GIS-based data from a variety of sources can be used [24–30], such as GPS-based tracking systems [31,32], wireless, Bluetooth [33] and geotagged social media photos and posts [34], or mobile positioning data (MPD) [35–37]. With the spread of new Information and Communication Technologies (ICT), a more accurate tracking of human movements has become possible, especially with data obtained from mobile positioning data (MPD).

Previous studies using mobile phone datasets have focused predominantly on the possible methodological approaches of determining anchor points of users (most typically home and work) in order to assess the spatio-temporal mobility of individuals [38]. For instance, based on the analysis of communication data of 100,000 anonymized and randomly chosen individuals in Portugal and with the help of clustering methods, Csáji et al. [39] identified home and office locations of users and compared the results with official census data. In the same vein, many studies using mobile positioning data have been concerned, with either home detection [40–43] or flow detection [44–48] as a prerequisite of locating users in real time.

Despite the growing body of literature on the possible use of MPD in tourism research, there are still several methodological challenges and obstacles in the field [49]. According to Li et al. [33], this can be linked partly with the fact that most of the studies focus only on international visitors [37,50–53], which is also confirmed by Grassini et al., who highlight the overrepresentation of the international context in MPD tourism research [49]. One of the reasons behind the scarcity of MPD analysis of domestic tourist flows is the limitation regarding definitions, benchmarks and methodological considerations regarding how to process, filter and analyze such data. To date, we know only one comprehensive work focusing on methodological considerations related to MPD by Saluveer et al. [54]; however, domestic tourism is not considered by these authors either. This is the point of departure for this paper, which aims to introduce a data processing method regarding various forms of domestic and international tourism. This is a challenging task, because the overwhelming majority of MPD are generated by domestic users, resulting in log files that are Terabytes in size, which in turn makes data processing only possible if using big data compatible algorithms. This methodological advancement is important also because the role of domestic tourism has been on the rise recently due to the COVID-19 pandemic [55].

In addition to the analysis of domestic tourist flows, this paper also aims to provide new methodological considerations regarding international visitors. In this study, each event is attached to a municipality (i.e., settlement), instead of cell towers, resulting in more interpretable and geographically precise information. Via this method, we are also able to identify same-day visitors, day tripper shopping tourists from neighboring countries, extending the method used by Saluveer et al. [54]. Our aim here is to provide a data processing guideline through which not only domestic tourist flows can be understood better, separating touristic and non-touristic daily movements of local people [56–58], but also a more comprehensive picture on international tourist flows can be achieved, separating 'tourism' 'from transit traffic' or 'migrant workers'[54].

Before introducing the methodology and describing the steps in data processing, it is important to conceptualize and operationalize the terms used in this paper. We use the UNWTO recommendations [59]—along with Mamei and Colonna [58]—to define tourism-related terms, based on which a visitor is a person who travels for business, leisure or other personal purposes for less than a year. The domestic tourist is the visitor if his/her trip includes at least one overnight stay, while the same-day tourist (day trippers or excursionist) is the visitor who does not spend a night, so the day of arrival and departure is the same. With this interpretation, we follow the approach described by Saluveer et al. [54]. However,

using MPD we can identify significantly more tourists than appear in official statistics, also described by De Cantis et al. [60] as unobserved tourism, the extent of which has already been quantified by Nyns and Schmitz [61] based on AirDNA and CDR data. During the research, we apply the theoretical framework developed by De Cantis et al. for approaching unobserved tourism.

In the remaining part of the paper, first the data acquisition procedure is presented, with a general overview of the raw data. This is followed by the description of data processing methodology. In the results and discussion section, we assess the final database and shed light on the limitations of the proposed method. We use Hungary as a study area, but the purpose is not a case-study unto itself. Instead, we intend to enrich the literature with a detailed insight into every step of the data life cycle, focusing more on different aspects of the data processing procedure, such as the identification of unobserved forms of tourism, [50] rather than providing case-specific research findings.

2. Data Description

This research is based on a dataset obtained by the Hungarian Tourism Agency (HTA) from one of Hungary's mobile network operators (provider in the following), which had a market share of 26% of domestic subscribers and 28% of international users in 2018. Through a contract, HTA was able to get access to the full MPD of the provider stored between 1 June and 31 December 2018. Thus, the dataset contains the full log data of each SIM card that connected to the provider's network in the 6-month period as well as anonymized user meta information for the SIM cards. The MPD in this case is passive call detail records (CDR), i.e., log events that are generated each time a user makes a phone call, sends a text message or uses cellular data. In such events, the mobile phone connects to a nearby mobile cell tower, usually to the closest one, which logs the event. While connecting to the tower, the network is able to locate the position of the cell phone, with an accuracy that depends on various attributes, most importantly on the distance between the mobile phone and the tower.

The SIM cards present in the dataset are of two kinds: domestic and international. Domestic cards belong to users living in Hungary who have an active subscription with the provider. The international SIM cards correspond to foreigners who travelled to (or through) Hungary and their phones connected to the provider's network. These users are usually subscribers of the providers' partner networks in their home country. However, tourists also have the option to manually choose among operators. Furthermore, there is a random factor, determining which network a cell phone connects to when staying in a foreign country.

In the raw data we have two comma separated value (CSV) files without headers for each day in the 6-month period. One of them contains the log events for a particular day, while the other file contains the anonymized user information for each user that had at least one log event on that day. The log events file contains columns in the following order separated by semicolons:

- The date of the event with minute precision in datetime format;
- The id of the user, which is a 38-digit number;
- The type of the event, i.e., whether it is a voice call, text message (SMS) or data usage;
- The latitude coordinates;
- The longitude coordinates;
- The precision of the location.

The exact location of an event was fixed inside a circle with the center defined by the latitude and longitude coordinates and the radius defined by the precision variable (in meters). Figure 1 shows a sample of the raw log data. Because of this, the use of Voronoi tessellation algorithm (which was used through other CDR data processing [62–64]) is not necessary, since the CDR data contained the precision value, so we were able to correctly estimate the errors of the coordinates.

datetime	user_id	type	latitude	longitude	precision
2018.12.01 15:19	81222529376966600796154844505105996882	VOICE	17.569418204684844	47.54763045972998	2959.508
2018.12.01 10:20	21481358848537210680871644420644170366	VOICE	17.569418204684844	47.54763045972998	2959.508
2018.12.01 07:11	96042799109531519307714776903629345085	DATA	19.17403106762232	47.427257417511576	320.59
2018.12.01 13:20	16060905293480240524581111347511371866	VOICE	19.03216743781843	47.54260828890025	250
2018.12.01 12:27	24883139032204671622410850017675378902	VOICE	16.86894928734427	47.23863248277103	4884.144
2018.12.01 11:46	29615459468153898810790806871866412358	VOICE	19.815512008766433	48.09907214171443	771.213
2018.12.01 09:25	21660629094596154885279776820061639136	VOICE	18.892408078569424	47.412078273665635	670.82
2018.12.01 11:45	45446894552881422340015926547817832374	VOICE	21.63564063890104	47.44998755328685	2771.018
2018.12.01 08:19	16608005041345622377059330988305188602	SMS	19.073341218094413	47.52956448708487	353.553

Figure 1. Sample of the raw log data.

The user information files contain the following columns. Day; user id; whether the user has a pre- or postpaid subscription plan; business type; business type code; the country code of the SIM card; the name of the country where the SIM card was bought; whether the SIM is domestic or international; age; gender; country of residence; postal code; brand of the cell phone, if the user has a subscription, whether it is a smartphone or not; the amount of last bill in Hungarian Forints; whether mobile parking, motorway ticket, or other services have been bought through the subscription. However, not all information is available for every user. In addition, the data were anonymized, so it was not possible to identify a concrete person based on the attributes, and only the user id was used during the data processing, along with the data management regulations set by the European Union's General Data Protection Regulation (GDPR).

One log event file is around 2.5–4 GB in size when compressed and around 6–9 GB when uncompressed. For the user information files, these numbers are 110–140 and 500–600 MB, respectively. On average, a log event file contains around 100 million events, while a user information file contains around 3–4 million users. This means, the uncompressed raw log dataset was around 1.8 Terabytes, comprising around 18 billion events, which is the final raw dataset that we rely on in this paper (Figure 2).

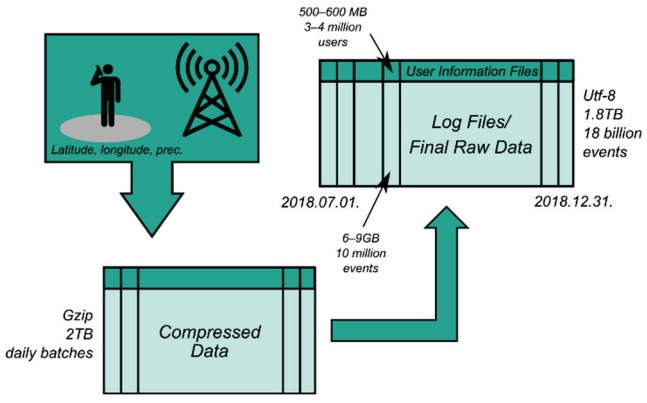

Figure 2. The uncompression of the raw data.

3. Data Processing and Cleaning

Prior to the assessment of mobile positioning data, it is important to describe the logic of data processing resulting in a reliable dataset. First, the steps of processing raw data are summarized which can be useful for similar research in the future. Then the steps of extending the database with user information and splitting it into international and domestic parts are described. For research purposes it is necessary to separate the domestic tourism-related movements from usual activities, for which the concept of network of usual places (NUP) is applied, based on the existing literature. Finally, a detailed description is provided regarding the filtering and cleaning of the two (domestic vs. international) datasets, removing possible errors (Figure 3).

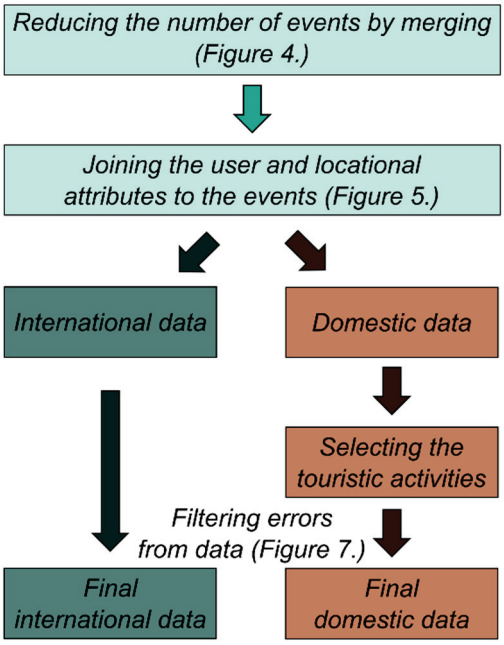

Figure 3. The steps of the data processing and cleaning.

3.1. Loading the Data into the SQL Database

As the first step of data processing, data were loaded into the sql database. To do this, a data collector script was used that downloads and uncompresses the daily batch files in chronological order, while splitting the data into rows and columns based on the separator characters. Then, the script inputs were applied in the Kafka stream processing application. The Kafka application uses a persistent storage, which means that it does not delete the raw data while processing it.

During data processing, the log and user information data were handled separately. Since the size of the user information files was relatively small, we were able to load them simply into a postgresql database using the raw data columns without any further modification. Next, the daily user information tables were merged into one table since the daily tables contain many repetitions. The resulting table contained all the 7.3 million users that appeared in the log events during the studied period.

To be able to load the huge log data into the database, the raw daily batch files had to be processed. Using the Kafka application, data were split into 12 partitions based on the user ids. This means that every event of a user was loaded into the same partition. A random sampling method of the user ids was used to partition them, based on the assumption that the ids are coming from a normal distribution.

Since the daily data batches are not grouped by user id, nor are they ordered by time, during processing a grouping and ordering step for each batch had to be included. This was done after partitioning the daily events based on the user ids, i.e., the events were grouped and ordered for each user chronologically in each partition. This made the processing significantly faster later, since the merge and heap ordering methods that were used have quadratic time complexity in terms of the number of events. Since the daily packages were processed in chronological order, in the final raw data tables the events of every user appeared in daily batches and were ordered by time.

When events were merged during the grouping and sorting process, the number of distinct events were also reduced for scalability reasons. Our aim was to merge several events into one robust event, which in itself contains all the information that the merged events contained, but in a denser format. Since the whole time series of a user could not be processed in one step due to the enormous size of the data, the merging was done right after processing each daily batch log file. In this way we were able to work with the grouped and sorted daily events while they were still in the Kafka stream and loaded only the merged

data into the sql database. The idea was that successive events of a user that happen at the same place are merged. A counter was kept that tracked how much time the user spent at a specific location in order not to lose any information from the raw data.

3.2. Merging Events

The input data for our proposed algorithm is a time series of circles on the map defined by their center and their radius. The output is a time series of points on the map with an extra attribute that refers to the time spent at the corresponding location. Events were iterated through each user and each day when the user had at least one event.

Our algorithm used four variables. The first one is the 'current place circle', where the user is assumed to be currently. The second is a 'time spent' variable that measures how much time the user spent at the current place. Third, a 'temporary circle' was used that was compared to the current place variable. Finally, a 'temporary set of circles' was used to calculate the exact place of the user in the merged event (Figure 4).

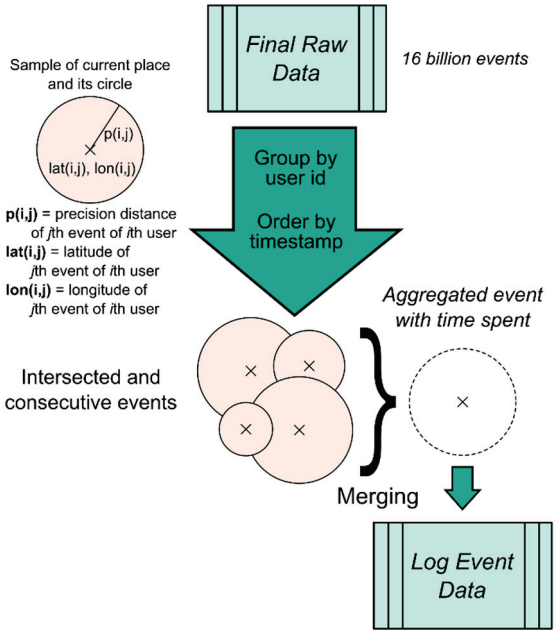

Figure 4. Visualization of merging algorithm.

For each user, the first circle was started with the first occurrence in the daily log data. The current place was set to the first circle and the time spent attribute to zero. This circle was also added to the temporary set of circles. Then, whether the subsequent circle of the user in the data intersected with the current place circle was checked (In practice, we used the maximum norm instead of the Euclidean norm, since it scales much better). If they intersected, this circle was merged into the current place; this circle was inserted into the temporary set of circles and updated the time spent attribute to the time difference between this and the current place event. The merging process was continued until a circle did not intersect with the current place circle or the user did not have any circles left. When this happened, first a new data point was created for the user, based on the current set of temporary circles and the time spent variable. The latitude and longitude coordinates for this new point were set to be the averages of the latitude and longitude coordinates of the temporary set of circles, respectively. The time spent attribute for this data point was set to be the current value of the time spent variable. Second, the current place variable was set to the temporary circle that did not intersect with the previous current place. The circles were also deleted from the temporary set of circles while adding this circle to the set, and the time spent variable was set to zero. The merging process was iterated for all the circles in the input for each user (Algorithm 1).

Algorithm 1. The pseudo code of the merging algorithm.

```
forall USER do:
   Input: USER_circles[]
   Output: USER_points_with_time_spent[]

   current_place_circle <- USER_circles [0]
   time_spent <- 0
   temporary_circle <- USER_circles[0]
   temporary_set_of_circles.append(USER_circles[0])

   for circle_i in USER_circles[1:] do:
      if circle_i INTERSECT temporary_circle do:
         temporary_set_of_circles.append(circle_i)
         time_spent += circle_i.time - temporary_circle.time
         temporary_circle <- circle_i
      else:
         current_location <- AVG(temporary_set_of_circles.location)
         USER_points_with_time_spent.append(current_location, time_spent)
         current_place_circle <- circle_i
         time_spent <- 0
         temporary_circle <- circle_i
         temporary_set_of_circles.clear()
         temporary_set_of_circles.append(circle_i)
      end if;
   end for;
   return USER_points_with_time_spent;
end forall;
```

Those events that were close to each other were merged, while keeping track of how much time the user spent at the place of the merged events. In summary, our algorithm compressed the data from 16 billion events to around 3.5 billion events, with almost a one to five compression rate. After the merging process the output data was loaded into the postgresql database and split into partitions.

3.3. Adding User Information and Interpreting Coordinates

Although the dataset became denser after the first stage of processing, further steps were needed to make it more compact and researchable. For example, the data types of the user id and the coordinate variables had to be changed, since they were not efficient, which made querying slow. Thus, a new user id was created that is a 32bit integer, instead of the large integer used previously; in addition, a 16 bit floating point number was used for the coordinates moving forward. The information contained in the log events and the user information tables were joined, in order to make querying possible based on, for example, the users' country of origin. At this point, although it was possible, no additional information on the users was added to the tables in order to keep the size relatively small.

The next step was to connect the coordinates of each event to a local municipality. This enabled later querying and filtering of events based on their location. This was done by using an additional data source that contained the polygon coordinates of all municipalities (3155) in Hungary and each event was assigned to a polygon of a settlement (i.e., municipality). Finally, based on the municipality where the event took place, the code of the county and the region of the event also added. These attributes helped us later to easily find all the tourists in a certain region or to identify tourist flows between counties or municipalities.

Consequently, there were 11 attributes for the final baseline sql tables; a new user id that is an 8-digit integer; the time of the event; the day of the event; the country of origin of the user; the time spent attribute; the latitude and longitude coordinates; the municipality, the postal code, the county and the region.

3.4. Identifying Domestic and International Users

After processing the raw data and loading the results into the sql database using the Kafka stream processing framework, the data processing was continued in the postgresql environment. First of all, the data were split into two groups according to the nationality of the users: domestic and international. This was important because the overwhelming majority of the domestic data was not tourism-related, while most of the foreign user data belonged to this category. Hence, these two groups had to be handled separately and processed differently.

Figure 5 shows that the datasets of domestic and foreign users differ significantly. First of all, the number of events generated by domestic users (3.5 billion) is almost a hundred-fold that of foreign users (37 million). However, the number of distinct users is almost the same in the two groups (3.8 and 3.5 million users, respectively). The average number of events per user is 947 with a median of 387 for the domestic users and 10.7 with a median of 4 for the foreign users. This difference is, however, quite intuitive, since domestic users were present in the country for the whole period, while international users were captured only for a shorter period of time. Domestic users had events in 68 different days on average with a median of 62 days, while the same value for international users was 4 and 2, respectively. The event density (i.e., the number of events per day) was 14 for the domestic and 3 for the international users. This means, that not only the number of events, but their density is also significantly higher among domestic users. More than half of the international users had only less than 5 events (Figure 6). For domestic users, the numbers were much more balanced, but in this case also more than one-third of the users had less than 180 events in total, which is less than one event per day.

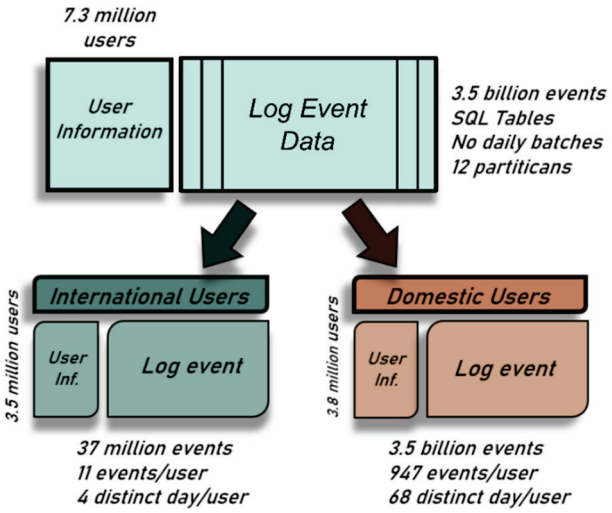

Figure 5. Sorting process of final raw dataset.

3.5. Defining the Touristic Activities of Domestic Users

Since our aim was to create a database that would provide meaningful insights on tourism-related movements, not only for international but also for domestic users, we had to clean the dataset further to get rid of the bad quality and noisy data. For domestic users, those intervals had to be defined that could be related to tourism activities and they had to be separated from the usual environment, following the UNWTO approach [59]. A conceptual framework has already been developed for the detection of the usual environment [65,66], which we also used to select tourism events, but we had to adapt it to our own database and purposes. A table was created to support the labelling as follows: first, the number of events was counted for each user as well as the number of distinct days at every location the user visited. Based on these data, we could define for each user the Usual Place ('UP'), Near Usual Place ('NUP') or Touristic Place ('T') and label the municipalities. The motivation of the labelling was to identify those places where a user usually spent longer

time and more frequently, such as the users' home and workplaces or places they regularly visited. In defining these places, existing conceptual frameworks and the principles of the concept of network of usual places (NUP) [65,66] were considered, although the thresholds were determined based on the natural breaks shown in our dataset. These events should not be considered as touristic movements. At the same time, all other events that were not at or near usually visited places were considered as tourism-related activity.

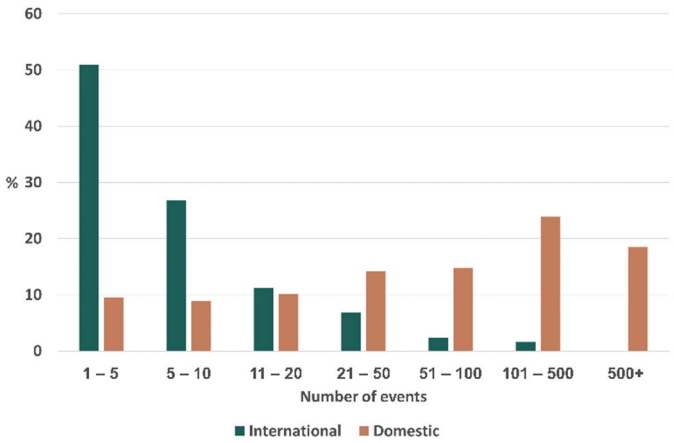

Figure 6. The distribution of the average number of events by international and domestic tourists.

For a user, we labelled a location UP if at least one of the following held:

- It was (one of) the users most visited place(s), based on the number of days the user spent there;
- The user had an event on at least 25 distinct days;
- The user had an event on at least 20% of his/her total number of days.

A location was labelled NUP, if it was less than 15 km away from the place labelled as UP. The intuition with the NUP label was that certain movements in the narrower home/work environment could not be considered as tourism-related events, such as, for example, if the user went home on a different route or visited a nearby shopping mall or sport facility. Every other place was labelled as T.

As a next step, in order to separate tourism-related activities of a user, events that took place in a location labelled either UP or NUP were deleted. Doing so, the users' timeline was split into touristic intervals, i.e., such intervals that were consecutive events with T labels. As a result, every interval could be considered as a possible touristic visit for each user. Each such visit could be considered a separate entity, similar to an international visit, and a special ID was assigned for each of them. This means that a distinct touristic visit could be examined without considering the users' other visits.

In order to detect the usual places properly, every user was filtered out with less than 100 distinct days. This was necessary to be able to work with only those users that had events throughout most of the examined period. Users with less distinct days also tended to have proportionally more touristic visits, because of the definition of the usual place.

Obviously, this labelling is not perfect, for example, rare occasions such as family visits or work trips are not distinguishable from touristic visits, since they have very similar patterns. Although the original aim of the research was precisely to explore unobserved tourism (which contains these activities), and in practice our methodology works well for identifying touristic visits, and because of the size of the domestic data, more sophisticated filtering methods would not be scalable.

As a final step of the labelling of domestic data, the resulting dataset was divided into two tables: same-day visitors and tourists, based on whether the user had at least one sleeping event (stay overnight) during the visit or not. For some research questions, these

two tables were merged; however, for certain questions it was more meaningful to work with two separate tables.

3.6. Filtering the Data

The next step was to clean the datasets, extracting the touristic movements of domestic users and international visitors from roaming activities. For this, the following heuristic was used to filter bad quality users and events. First, the variables of 'time difference', 'distance' and 'velocity' were created. The time difference variable refers to the time difference between the current and the previous event. The distance variable is the distance between the locations of the current and the previous event. The velocity variable equals the distance divided by the time difference. These parameters were created to filter such errors in the dataset where the users travelled very long distances during a very short period of time. These events usually came in bunches for certain users, with the user jumping back-and-forth between places far from each other.

Next, different variables were created with the help of experts from the Hungarian Tourism Agency (HTA) that helped identify meaningful events at certain places, such as: '1 h spent', '4 h spent' and 'sleeping'. These variables were experimented and calculated beforehand based on the time spent variable, which indicated for a particular event how much time the user stayed at a certain place. If the time spent variable for an event was greater than 1 h or 4 h, then we assigned the value 'True' to these variables. The value 'False' was assigned otherwise. As for the sleeping event, we assigned 'True' to either the very first event after 4 am in the morning or the last event before 4 am, based on which place is more common for the users, based in turn on his/her visit. If these two events were at the same place then the user obviously slept there. However, when the place of these two events differed, it was not obvious which place should be chosen as a sleeping place. In these cases, the heuristic above proved to work the best in finding the sleeping place.

These variables could be used in further steps of the research to answer the questions: 'Where did those people stay overnight who spent at least 4 h in a specific location but did not sleep there?' or 'Have the tourists staying at a particular location taken same-day trips in neighboring places?'.

As a first step, those visits were filtered for which at least one of the following criteria was fulfilled:

- It has less than five events,
- It does not contain at least one event where the 1 h spent variable is true,
- The difference between the latest and earliest event is less than 12 h,
- The speed variable in one of the events exceeds 500 km/h,
- The speed variable exceeds 300 km/h and the time difference variable is at most 3 in multiple events.

The last two conditions aimed to filter visits that contained errors. On the one hand, where the speed exceeded 500 km/h, the user travelled way too fast for the event not to be an error. On the other hand, the last condition filtered out those back-and-forth movements that usually are the result of two users having the same user id.

All the thresholds above are purely based on heuristics and can be changed when using other datasets. At the same time, these numbers were those that worked the best for us on this particular dataset in terms of the resulting data quantity and quality trade-off. To answer specific research questions, obviously other threshold settings can be used. For example, to examine a place with only few tourists, the settings can be loosened, allowing consideration of more users in the filtered dataset. However, analyzing such problems where the number of users was big enough, stricter filtering settings could be applied for the sake of better data quality.

For the international users, our assumption was that, except for some special cases (e.g., truck drivers), every visit can be considered as tourism-related activity. However, similarly to the domestic users, we had to filter the data to keep only those that reflect tourist

visits. Every international user was disregarded for whom at least one of the following was fulfilled:

- The user had less than five events in total,
- The user had an event per day ratio less than 1.5,
- The user had events on more than 25 distinct days,
- The user did not have a sleeping event.

The first two conditions are straightforward data quality requirements. The third one makes sure that users who stay in the country for a longer period of time (e.g., Erasmus students) are not considered, since they are not tourists by strict definition. Finally, the last criterion filters out the same-day visitors. Separate tables were created for the users with at least 25 distinct days and one day tourists in order to be able to gain insight also into their spatial behavior [6]. Figure 7 shows the overall event distribution for the filtered international and domestic events and users within Hungary.

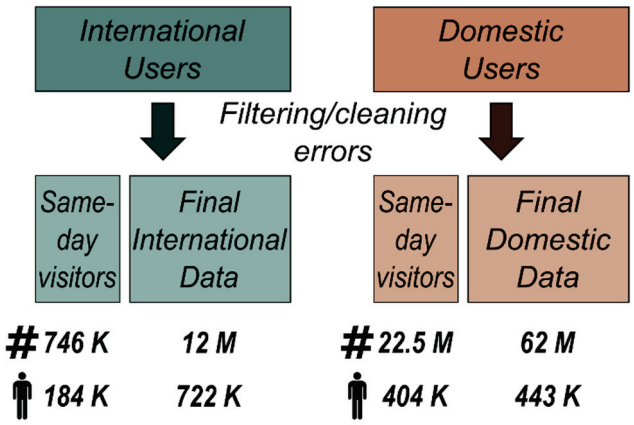

Figure 7. The cleaned event and user numbers of the datasets (# represents the number of events).

3.7. Validation of the Final Database

In order to assess the reliability and representativeness of the filtered database, official tourism-related statistics of the Hungarian Central Statistical Office (HCSO) were used. During the assessment, the official data of guests and spent guest nights of a given period at the municipal level was compared to the dataset based on MPD. While the former contains only data of tourists who were officially registered by commercial accommodation services, the latter includes the data of those who used the services of the provider (between 27 and 45% of all domestic mobile users [67]). However, we must keep in mind that in the case of international tourists it is not straightforward which network their mobile phone connects to when they arrive to a given country. Therefore, the shares of the total visitors that connected to our network provider for each country had to be calculated. In addition to representativeness at the macro-scale, spatial and temporal validation of domestic and international tourists is also important. For this purpose, correlation and regression coefficients were calculated regarding the spatial (settlement level) and temporal (monthly) distribution of guests and guest nights derived from the HCSO and the MPD datasets, in order to determine to what extent the filtered database differs from official statistics. However, certain biases do not necessarily mean that the database is of bad quality, as several tourism-related activities can be detected with the MPD, which are not included in commercial statistics (e.g., unobserved tourism which can be linked with family relations, or private accommodation services, or same-day visits).

4. Results and Discussion: Assessment of the Final Database

In this section we aim to assess the reliability and representativeness of the final database. For the validation, we use official statistics collected by the Hungarian Central Statistical Office at the settlement level. Data on international and domestic tourists staying

at commercial accommodation establishments (hotels, pensions, camp-sites, hostels, bed-and-breakfasts, etc.) cover the period 1 July–31 December 2018. The share of officially recorded international tourists captured by MPD differs very much by country (Table 1). According to our dataset, more than two thirds of tourists arriving from France, Cyprus and Bulgaria were connected to the network of our provider, whereas only 6% from the USA, and even fewer from Japan and Norway. This means that MPD of a single service provider can be highly representative for some countries, whereas it has limitations for others. Our estimation is that, below 20% representativeness, the data of foreign visitors should be handled with caution. For a full coverage of international tourism, obviously, data of all mobile network operators (in Hungary there are three) should be collected and processed, which means not only a methodological, but also a financial and organizational challenge.

Table 1. Share of tourists by countries tracked by MPD.

Country	Ratio (%)	Country	Ratio (%)	Country	Ratio (%)
France	77.38	Estonia	36.41	Turkey	23.7
Cyprus	74.04	Croatia	35.52	Israel	20.29
Bulgaria	73.36	Switzerland	35.16	Serbia	16.66
Poland	58.28	Ukraine	35.07	United Kingdom	14.94
Belgium	53.13	Latvia	34.06	Sweden	12.73
Slovenia	50.3	Italy	33.68	Canada	11.81
Portugal	47.39	India	33.18	Brazil	9.87
South Africa	46.75	Russia	32.2	South Korea	9.67
Romania	41.55	Ireland	29.59	Australia	8.13
Iceland	39.49	Slovakia	28.99	Finland	8.03
Malta	38.89	Denmark	28.94	China	7.28
Austria	38.8	Czech Republic	27.66	USA	6.34
Greece	38.05	Spain	26.38	Japan	2.15
Netherlands	37.38	Germany	25.12	Norway	1.16

As a next step, the filtered datasets (both domestic and international tourists) were evaluated with correlation coefficients at the settlement level (Table 2). Regarding the number of domestic tourists, the correlation coefficient is 0.733 and the slope of the regression line is 0.24. The latter means that, on average, 24% of tourists were detected using MPD, while the former shows how accurately the tourist pattern was captured by the filtered database when compared to the official statistics. The degree of correlation can be considered good, especially since the figure shows that the MPD tended to overestimate the number of tourists at those settlements where the number of visitors was low, and hence they are probably more exposed to unobserved tourism (i.e., tourists not appearing in accommodation statistics) [68]. The values were similar in the case of the number of guest nights, but this was estimated with a slightly higher efficiency (R = 0.766), but to a lesser degree (19%). With the exclusion of those municipalities where the number of guests was zero in commercial accommodation, but the MPD detected tourist movements, the efficiency of the estimation increases (R = 0.771 and R = 0.779).

The spatial concentration of international tourists is very high in Hungary, but Budapest, the capital city, attracts a disproportionately large share of foreign visitors, which thus, distorts the correlation and regression calculations which are highly sensitive to outliers. Therefore, the efficiency of the estimation was also examined without Budapest. Nonetheless, the calculated correlation coefficients and the slope of the regression lines also provided useful information, as according to both official statistics and MPD more than half of the international tourists concentrated in the capital city and 21% of these guests and 17% of guest-nights were captured by MPD (Table 2). These values significantly decrease with the exclusion of Budapest (16% and 7%, respectively).

Table 2. Correlation coefficients.

	R	Constant	Slope
Domestic tourists	0.733 **	708.793	0.24
Domestic tourists (without zero values)	0.771 **	1500.525	0.23
Domestic nights	0.766 **	1417.592	0.19
Domestic nights (without zero values)	0.779 **	2117.036	0.19
International tourists	0.998 **	109.760	0.21
International tourists without Budapest	0.764 **	137.980	0.16
International nights	0.996 **	9.723	0.17
International nights without Budapest	0.711 **	194.776	0.07

** Correlation is significant at the 0.01 level (2-tailed).

We were also interested in the geographical pattern of unobserved tourism. Based on Figure 8, our preliminary assumption was that unobserved tourists concentrate predominantly outside major tourist hotspots. To test this hypothesis, we separated the data of Budapest and the 100 biggest destinations based on the number of officially registered tourists (both international and domestic) within the country. As Table 3 shows, the 101 most important tourist destinations concentrated 93.5% of the international and 76.6% of the domestic tourists officially registered in the country in the second half of 2018. Our MPD dataset captured 28.2% of the officially recorded international visitors in the period, which is very similar to the market share of the provider. However, the spatial distribution of international SIM cards was significantly different from national statistics on tourism, since, as opposed to 93.5%, only 70.9% of the international tourists could be linked with major tourist destinations. In our opinion, a substantial part of international visitors travelling to regions/settlement less frequented by tourism normally stay with friends, relatives, or at private accommodation facilities. In this way most of them remain hidden for tourism statistics. According to our data, the share of unobserved visitors is even higher in domestic tourism. There were 3.7 million domestic tourists in Hungary in the studied period, out of which MPD recorded 3.1 million, again predominantly outside the most frequented tourist destinations. These results shed light on the limitations of accommodation statistics and confirm the usefulness of MPD as a proxy for the actual number of tourists in a given location/region.

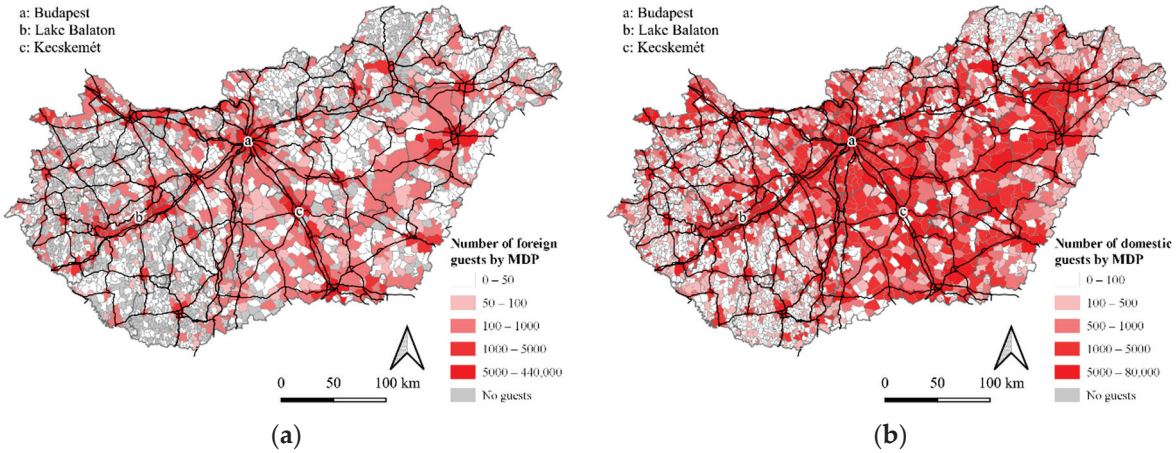

Figure 8. Spatial distribution of international (**a**) and domestic (**b**) tourists.

Table 3. Official and unobserved tourism in Hungary.

	Major Tourist Destinations		Rest of the Country		Total
	Number	Ratio (%)	Number	Ratio (%)	
Number of municipalities	101	3.2	3054	96.8	3155
Number of domestic tourists by official statistics	2,848,648	76.6	871,708	23.4	3,720,356
Number of domestic tourists by MPD	942,569	30.1	2,189,202	69.9	3,131,771
Number of international tourists by official statistics	3,097,826	93.5	215,854	6.5	3,313,680
Number of international tourists by MPD	664,806	70.9	272,533	29.1	937,339

The correlation coefficients calculated on a monthly basis reflect the spatial accuracy of the estimation in time. Based on this calculation, we can say that there was no significant change in the case of domestic tourism, i.e., the MPD database estimated the official statistics with similar efficiency in every month (Table 4). However, the accuracy of international tourism estimates is steadily declining over time in terms of both the number of guests and the guest nights. This may be the result of the high seasonality of international tourism in Hungary [69], i.e., it is easier to create a geographically accurate database from MPD for a larger number of tourists in the summer period (Figure 9). Thus, for the late fall and winter months, our dataset is less accurate.

Table 4. Correlations between the spatial distribution of tourism data by official statistics and MPD.

Time Period	Domestic Tourists	Domestic Nights	International Tourists *	International Nights *
All	0.733 **	0.766 **	0.764 **	0.711 **
July	0.738 **	0.735 **	0.790 **	0.785 **
August	0.768 **	0.771 **	0.786 **	0.746 **
September	0.751 **	0.748 **	0.769 **	0.676 **
October	0.761 **	0.767 **	0.717 **	0.638 **
November	0.766 **	0.757 **	0.693 **	0.629 **
December	0.803 **	0.777 **	0.613 **	0.540 **

* Without Budapest. ** Correlation is significant at the 0.01 level (2-tailed).

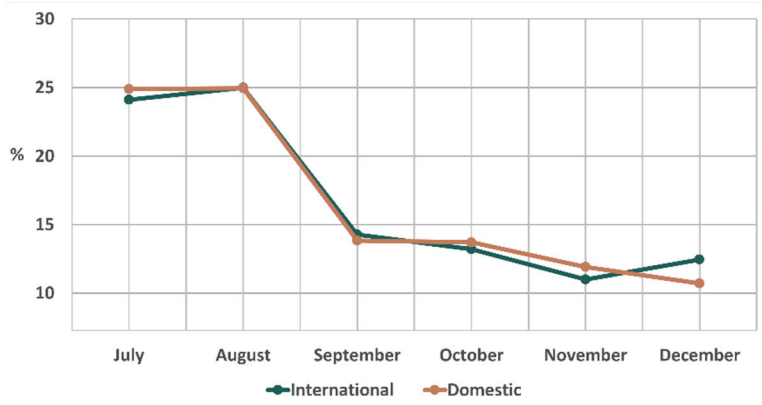

Figure 9. Temporal distribution of users by MDP.

The difference between the number of guests predicted by the regression line and detected by the MPD has distinct spatial variations for both domestic and international tourists (Figure 10a,c). In the case of domestic tourists, the inaccuracy of the estimate is minimal for major tourist destinations (i.e., regional centres), while in the case of medium-size towns and smaller settlements, where the phenomenon of unobserved tourism is more likely, the number of guests was overestimated (Figure 10a). This can also be observed in

the case of Lake Balaton (for the estimation of international tourists too), where a significant part of guest nights is not recorded in commercial accommodations [70,71]. The spatial configuration of international tourists shows a similar but much more concentrated pattern, where flows related to the concentrations of foreign direct investments (i.e., business and logistic centres) may play a role in the overestimation (for example, the Mercedes plant in Kecskemét) (Figure 10c). In addition, there are several settlements in Hungary without commercial accommodation services (where no guests can officially be registered), but we could detect tourists on the basis of MPD (Figure 10b,d). Out of the 3155 Hungarian settlements, international tourists were captured in 1531, and domestic tourists in 1404 locations, i.e., 48.5% and 44,5% of the settlements, respectively. According to our understanding, they can be defined as unobserved tourists. This phenomenon is more prevalent in the central part of the country, in the wider urban agglomeration of Budapest, and in the eastern part of the country [72]. In our opinion, most of these visitors are either people staying with relatives or friends, or use some alternative (non-registered) accommodation, or they are transit travelers (especially near the border crossings) (Figure 10b).

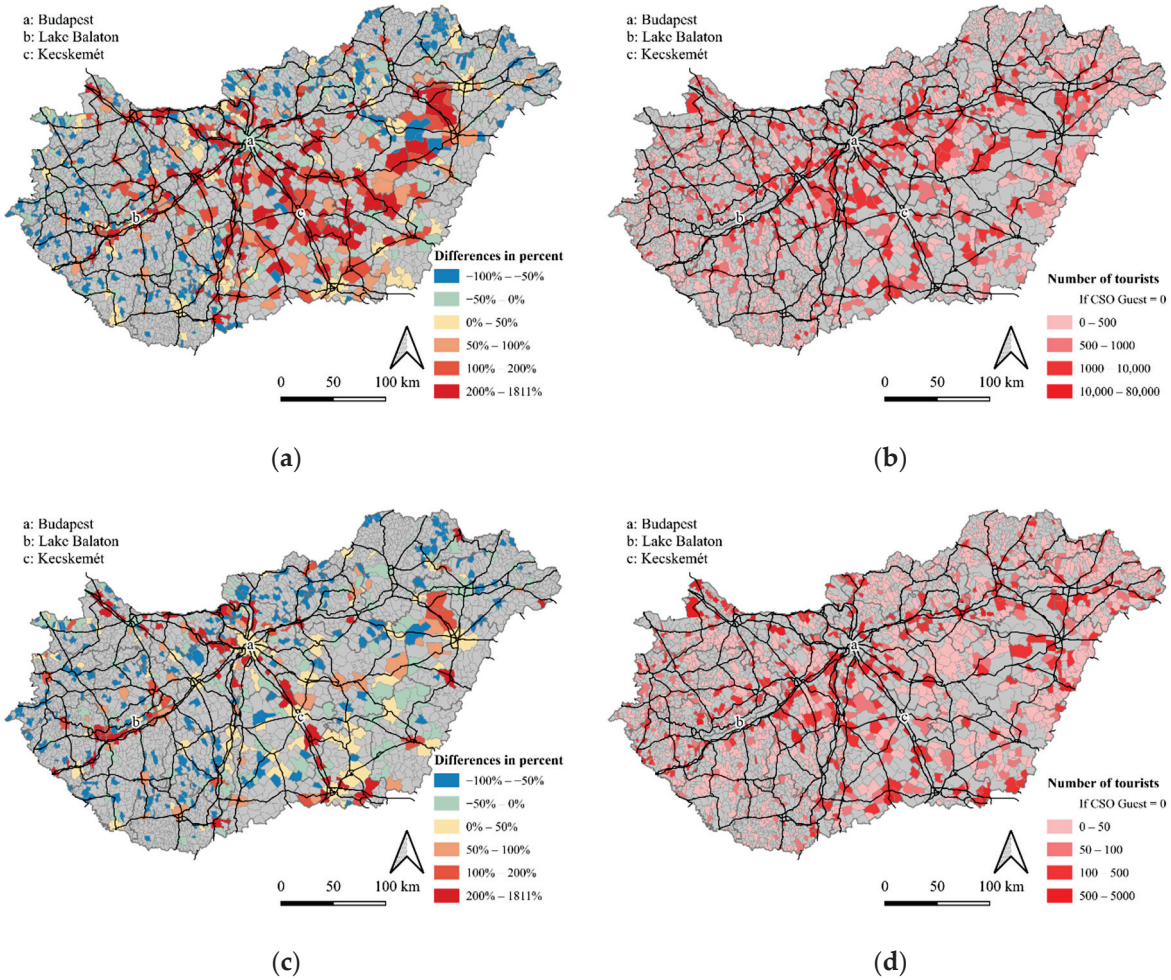

Figure 10. The spatiality of under- and overestimation in the case of domestic (**a**) and international (**c**) tourists and unobserved tourists in the case of domestic (**b**) and international (**d**).

5. Conclusions

Even though this research had clear methodological considerations, the presented results also have some conceptual and policy implications. As was demonstrated, official statistics on tourism have many shortcomings and ambiguities that can be eliminated by new research technologies, such as mobile positioning data. Knowledge of the real-time

activities of tourists at a certain location and their spatio-temporal behavior can provide much added value for sustainable tourism policy and destination management [73]. As was highlighted in the introduction of this paper, despite the growing importance of Big Data sources in tourism research, a comprehensive overview of the processing and filtering of mobile positioning data to capture various unobserved forms of tourist movements is by and large missing from the literature. Therefore, the main aim of this paper was to present a case-study on the processing and cleaning mechanisms of mobile positioning data to gain reliable information about the actual number of visitors (both domestic and international) at a certain location. Such data sources can extend the knowledge provided by accommodation statistics, improving the timeliness and spatiotemporal resolution of the data.

While the majority of previous studies in the field used only data for a shorter period of time (e.g., two weeks or the time of specific events) [74] or focused exclusively on inbound international tourism [75], this research was based on the full dataset of one of Hungary's mobile network operators for six months in 2018. Our main aim was to shed light on the challenges and opportunities of MPD processing, especially regarding statistically unobserved forms of tourism (e.g., day trippers, family visitors), and to provide possible benchmarks and solutions. On the one hand, we presented solutions to challenges caused by the size and structure of the dataset (e.g., data management, filtering, cleaning, etc.), and on the other hand, we demonstrated how a more accurate picture of the spatio-temporal dimensions of tourist movements can be achieved. The novelty of the research lays in (1) the definition of thresholds for data filtering, (2) a more sophisticated and accurate definition of possible errors in the dataset, (3) the introduction of new variables that facilitate data reduction in tourism-related analyses, (4) an accurate identification of unobserved (same day) tourism. The definition of the thresholds is well-grounded due to the size and the time-span of the dataset. After defining the key variables, it was possible to identify and analyze the flows of various user groups (i.e., domestic and international tourists). As was shown with the inclusion of the 1-h and 4-h spent variables (and the merging of these events), a significant data reduction could be achieved, while the new dataset offered good opportunities for measuring hidden forms of touristic activities (e.g., cross border trips, one day visitors) [76]. Thus, we can say that through the application of our approach, the study of various forms of unobserved tourism at the intra-urban and intra-regional level becomes possible.

Furthermore, the delimitation of secondary destinations without officially registered tourist visitors became possible and the spatio-temporal characteristics of the related tourist flows could also be measured [6]. Such locations can gain useful information about the actual number of tourists (both international and domestic) visiting them, their seasonality and spatio-temporal behavior. This knowledge can help less frequented tourist destinations elaborate their own tourism policies and pursue sustainable tourism planning and destination development. Altogether, the methodological procedure presented in this study can help increase the efficiency and reliability of the use of MPD and contribute to the standardization of the methods used in Big Data tourism research. The methodology can support the analysis of local tourism flows; thus, it may lead to better management and more optimal policy formulations at the local level. At the macro-geographical (national, regional) scale, the analysis of MPD with the suggested methodology can help track tourism flows more accurately, identifying secondary tourism hot spots that remain very often hidden in statistics [16]. Challenges related to the recent COVID-19 pandemic also increased the importance of such analyses [15,77]. Tracking the tourism-related spread of infections or monitoring the effects of changing travel regulations on tourism activities has great potential in future studies [2]. Future research could also refine the data cleaning process, for example, filtering transit traffic (e.g., truck drivers) that cross the country without any tourism-related activity.

As with other research in the field, this study has also certain limitations. First of all, we used data only from one network provider and the clienteles of the other two operators

have not been covered. As was shown by our assessment, using the data of one single operator may lead to bias. This is important to note because the structure of the data and the problems arising during data processing may be different in the case of other providers. In addition, the sending countries are not equally represented either, because this depends on the provider's international collaborations, so this distortion should be considered in the interpretation of results. Furthermore, the simultaneous use of data from various providers may positively affect the reliability and comparability of such data. Last, but not least, while MPD offers useful insights to tourism flows, their underlying causes and motivations remain unexplored, thus the presented Big Data method should be extended by conventional methodologies (e.g., surveys) to obtain a comprehensive picture of the driving forces of tourism related mobility.

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The Emergence of Unconventional Tourism Services Based on Autonomous Vehicles (AVs)—Attitude Analysis of Tourism Experts Using the Q Methodology

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Abstract: The spread of autonomous vehicles (AVs) could fundamentally change tourism-related mobility in the near future. However, the empirical research on tourism impacts is still very limited. This research aims to systematize the expected tourism impacts of AVs and to explore how experts in different fields of tourism view the technological innovation ahead. The opinions of tourism experts (n = 21) involved in the research were analyzed using the Q methodology. Statements (n = 40) were formulated in topics derived from the literature. Based on the analysis, we distinguished four groups of opinions. An optimistic, technology-oriented group of experts suggested that AV-based sightseeing may emerge as a prominent unconventional service. An accessibility-focused group of experts predicting slow progress stressed that the spread of AVs could improve access to infrastructurally advanced destinations. A mobility-service-oriented group considered that the use of AVs is becoming conventional in terms of mobility, but its appearance remains unconventional for other tourism services. Due to the potential negative effects, a skeptical group of experts believes that AVs will not become conventional in tourism. The value of the research is the creation of groups based on tourism experts' attitudes, which can help prepare strategic tourism decisions in the future.

Keywords: autonomous vehicles (AVs); unconventional tourism services; tourism experts' perception; Q methodology; future of tourism

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1. Introduction

Innovative technologies and new mobility services of the fourth industrial revolution (Industry 4.0) are rapidly transforming the supply of tourism services. Although fully autonomous vehicles (AVs) have not yet entered the market, partial automation has already had an impact on tourism. It is, therefore, essential to be prepared for the spread and potential impacts of AVs [1]. In contrast, the literature on tourism does not focus much on the potential risks and benefits of AVs. This is supported by previous research [2] that addressed the impact of AVs on commuting travel. The exploration of this topic area was typically in the Global North, which highlights future research opportunities.

The relevance of this research is also supported by the fact that AVs are expected to be first adapted for long-distance trips, hence the need to explore the tourism side of the topic [2]. Furthermore, since COVID-19, the use of personal vehicles to get to and from a destination has also become even more valued [3].

To the best of our knowledge, except for one study [4], no research examines the attitudes of tourism service providers to the emergence of AVs, even though this technology may lead to the creation of new, unconventional tourism services in the future.

There are several approaches to unconventional (or non-conventional) tourism in the literature. It can refer to tourism solutions that primarily benefit local communities and not visitors to the destination. It can be called unconventional if it represents an alternative

route to capitalist tourism. It can also be unconventional if it goes against and criticizes mass tourism or traditional tourism. However, the approaches all represent something unique in tourism services [1].

With all these in mind, our research seeks to clarify the expected role of AVs in tourism and, in contrast to previous research, draws together the potential changes, including threats and opportunities for conventional tourism services. For this, the attitude of tourism experts to the impact of AVs on the tourism industry has been analyzed by applying the Q methodology. We completed our research with 21 Hungarian tourism experts from the subsectors of accommodation, hospitality, attraction management, and mobility fields. As global research assumes that we still need ten more years to reach a mainstream adoption of fully automated vehicles [4,5], our research is an exploratory study of the impact of AVs on the tourism sector.

Our results have both theoretical and practical contributions. On the one hand, the findings of our research (four groups of experts identified: mobility-service oriented, accessibility focused, skeptic, optimists) provide a new perspective on the study of AVs in the social sciences and thus provide important input for academics. In addition, our findings might help tourism stakeholders to prepare for the impact of the technological revolution ahead (e.g., transforming conventional tourism services with AVs to increase competitiveness).

2. Expected Impacts of AVs on Tourism and Mobility

Since automation is a quite complex and incremental innovation, the basic definition of the technology needs to be clarified. First, we explain the different levels of AVs and then introduce some current initiatives and the expected impacts of AVs on tourism.

2.1. The Incremental Nature of Automation (SAE Levels)

Automation is an innovation of the fourth industrial revolution (Industry 4.0), which is rooted in the acceleration of information and communication technologies (ICTs) in the second half of the 20th century. The questions around AVs are numerous and variable; therefore, the knowledge of industrial and consumer behavior is limited. Regarding AVs, we discuss the incremental technology that is not only free of human intervention but is able to transport by itself. The current technology described as self-driven still depends on decisions made by a human driver. The real self-driving experience is getting closer, however, with the help of intense development.

Based on international standards, we can distinguish five levels of automation as suggested by the Society of Automotive Engineers (SAE) [6]:

- Level 0: The only controller of the vehicle is the human driver; the phase is described as a complete lack of automation.
- Level 1: The only controller of the vehicle is still the human driver, but there are supporting functions (e.g., change in the direction or speed, occasional automated steering of the wheel).
- Level 2: The only controller of the vehicle is still the human driver, but the supporting functions can be applied simultaneously. Cars currently available for purchase belong to this category (e.g., Tesla Model 3).
- Level 3: The role of the human controller is necessary, but the continuous observation of the surroundings is not required; the car is able to handle the driving operations. Yet when the car notifies the driver, the driver must take control of the vehicle.
- Level 4: The car can control every task for the duration of the journey. The presence of the human driver is optional in this phase as the system does not require them to take control of the vehicle. Based on the predictions of top companies in the automotive industry (Tesla, BMW, Google Waymo), cars with a high level of automation can be expected in the mid-2020s.
- Level 5: All aspects of driving can be owned and sustained by the car. Whether steering wheels and pedals will be needed for manual control remains an open

question at this stage of development. How future road users will react to the complete removal of the driving experience is uncertain.

Based on SAE levels, we can see that lower automation (SAE Levels 2–3) does not change mobility patterns much, while higher automation (SAE Levels 4–5) might completely change tourists' travel preferences and conventional tourism services. Tourists are typically the first users of this new technology, while for commuters, higher driving frequency and experience result in lower AV level preferences [7].

There are already destinations where AVs have been introduced and are undergoing public trials. The Lake District National Park (UK) is planning to introduce AVs on SAE Level 3 as a sustainable transport solution [8]. Gatwick Airport (London, UK) offers the autonomous solution as a shuttle service for passengers [9]. In Beijing's Haidan Park (China), the Apollo minibus is operated on SAE Level 4 automation, where tourists can experience 700 m of autonomous driving, free of charge. Seven passengers are allowed to use the vehicle at a time, on a predetermined route, at a limited speed (15 km/h), and there is a supervisor on board [10]. In the city of Sion (Switzerland), AVs are being tested on public roads, carrying 11 passengers at 20 km/h. As these are SAE Level 4 vehicles, a safety supervisor is also on board [4]. The Dubai Roads and Transport Authority (RTA), the local roads and transport authority, is set to become the first taxi operator in the emirate to switch to pure electric and autonomous vehicles. The first vehicles are planned to be on the road in 2023, and the company "Cruise" will have exclusive service rights for autonomous taxis until 2029. Dubai will thus become the first non-US city in the world to operate electric autonomous vehicles. The fleet should reach the target of 4000 vehicles by 2030 [11].

2.2. Potential Benefits of AVs from the Tourist Perspective

Previous research has shown that AVs will primarily be used for leisure [2] rather than non-leisure activities [10]. Research on the topic [12–14] revealed that respondents would use autonomous taxis more as tourists than as residents, which also demonstrates the significant impact of AVs on tourism-related mobility.

While traveling, tourists can also engage in other activities [15–19]: watching TV, relaxing, sleeping, reading, taking photos, eating, playing games, and gathering information. On SAE Level 5, tourists are even able to travel alone [20,21], which will be a major opportunity for people with disabilities [22]. Importantly, it is also expected that tourists will travel more often and greater distances by AVs [21]. The proliferation of AVs might help overcome barriers in terms of unfamiliar traffic rules and environments [23], making car rental easier for international tourists solving the problem of jet lag or the anxiety that comes from unusual traffic rules or conditions [9]. It also provides freedom of travel for people without a driver's license [24], is a more convenient solution for people under stress [25], and reduces isolation by providing easier access to services [15].

2.3. Changes in Tourism-Related Mobility

In terms of tourist mobility, there are two main categories of changes expected from AVs: accessing a destination and intra-destination mobility.

2.3.1. Access to a Destination for Tourism Purposes

In infrastructurally developed destinations, AVs can compete primarily with short-distance mobility services (e.g., rail, bus, public transportation) [2] and become alternatives to taxis [16,26] as well. As AVs can be a viable alternative for tourists on short-haul trips, it is expected that low-cost airlines will switch to long-haul trips [9] to preserve their competition. Due to the rapid and early market growth of AVs [27], traditional taxis will have to fulfill a new function, i.e., they will have to provide additional services (e.g., tour guiding) to compete with AVs.

2.3.2. Intra-Destination Tourism Mobility

AVs could have both positive and negative impacts on urban traffic in the future. It is important to note that AVs are primarily suited to urban transport and will therefore spread first to urban areas and then to rural areas. Initially, they can only travel along a defined route. Adverse weather conditions can cause problems [4], which will make the service less accessible to areas with low infrastructure [26].

In urban areas, however, there are several transport benefits that can be gained from the spread of AVs. Through efficient route selection and more efficient use of traffic lanes [28], congestion can be reduced [29], leading to improved urban traffic flows [30]. However, scholars [9] predict this is for shared vehicle use. Individual vehicle use tends to increase traffic, and as the number of AVs increases, this may cause congestion around the must-see tourist attractions.

In response to this, there might be some car-free destinations where tourists can only park outside the center and access the city by shared AVs [4]. As AVs spread, the design of cities may also change. Research suggests that in urban spaces, fewer parking spaces will be needed [2,31]. By eliminating parking spaces, green spaces can be created [32], which can increase the livability of cities. Thus, the spread of AVs can also increase the sustainability of tourism, thus having a positive impact on the environment, which is a priority for the sector these days [33]. The freed-up areas can be used for pedestrian and cycling facilities [28] or urban parks. The development of check-in points will also transform shopping districts, as they drop shoppers off at the store and pick them up later [9].

2.4. Expected Changes in Conventional Tourism Services Due to AVs

2.4.1. The New Dimension of Car Use

With the spread of full automation (SAE Level 5), driving as an activity will disappear, transforming it into a unique experience [26]. Destinations, where AVs appear for the first time, can enhance their image and strengthen their attractiveness [4]. At the same time, the spread of AVs can also promote cooperation between operators and destinations. Due to the seasonality of tourist destinations, it may make sense to share AVs between destinations with different seasons, e.g., ski areas in winter and lakes in summer. This will require flexibility and that these areas are geographically close to each other [4].

2.4.2. Sightseeing and City Tours

AVs can transform many areas of conventional tourism services. One of the most likely changes relates to sightseeing tours. Several studies have discussed pre-planned, AV-based sightseeing tours [9,26] and the resultant expected decline in walking and hop-on-hop-off tours [26]. However, with the proliferation of AVs currently, conventional bikes, Segways, and walking tours may become niche products in the longer term [26]. The new types of sightseeing tours will be algorithm-based, favoring those operators who pay more to be included on the itinerary, i.e., multinational operators will be favored over local businesses [9]. However, the automation of hiking trails can also raise problems such as the possibility that some of the less attractive, but the real face of destinations may remain hidden from tourists.

2.4.3. Hotel Industry, Restaurants, and MICE Tourism

The use of AVs will not only affect tourism during the day. As AVs are also suitable for overnight travel [34] and can be used for sleeping, the significance of accommodation services might be decreased in the long run. In addition to hotels selling rooms for a couple of hours, AVs can provide a more convenient alternative to the airport's sleeping pods [26] and can be applied as mobile motels by both business and leisure travelers [9].

AVs will also be suitable for holding meetings [25,26], which might result in the displacement of smaller meeting and conference rooms from the market. AVs could function as mobile restaurants in the future, combining sightseeing and restaurant services

like dinner cruises [9]. The creation of mobile restaurants could also boost wine tourism, as the consumer does not have to drive the vehicle.

There are diverging views on what pricing can be expected for AVs. In the airport environment, they have emerged as a free service in the areas tested, but in the near future, it may also represent a price premium for users due to their benefits and novelty.

2.5. Research Gap

Based on the literature, we can see that the spread of AVs, especially at higher levels of automation (SAE Levels 4–5), could change the mobility and experience of tourists, passenger transport to and within the destination, and the content of traditional tourism services. The literature suggests three main categories of expected changes (Figure 1, [2–40]).

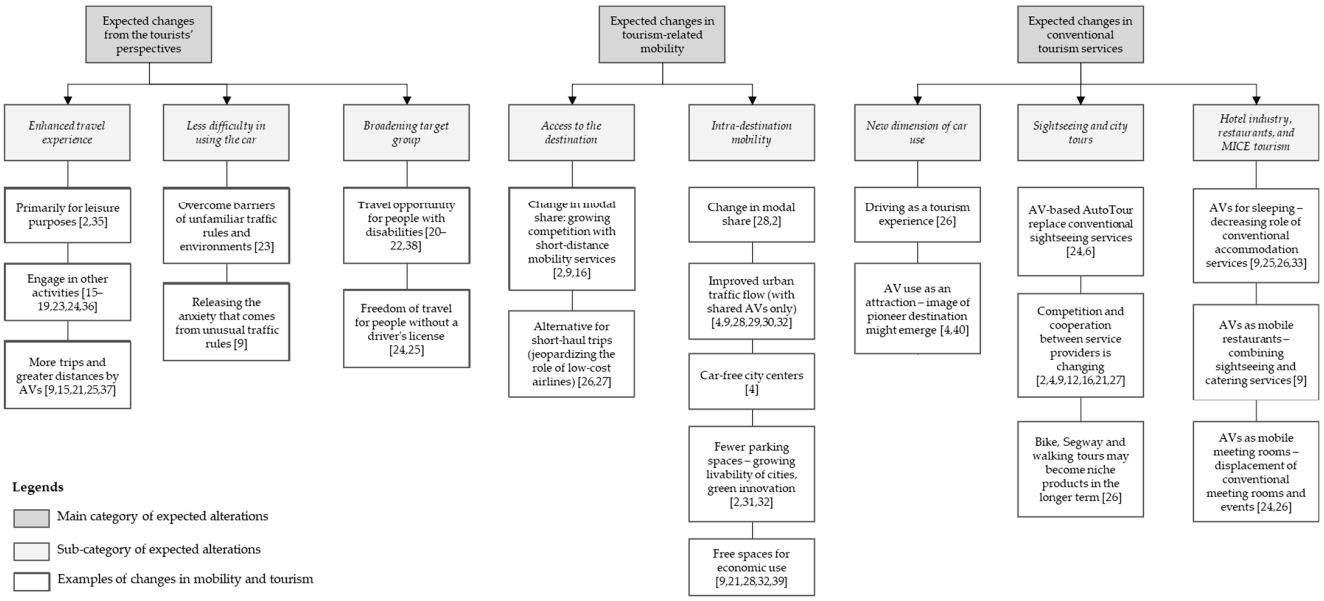

Figure 1. Expected alterations in tourism with the spread of autonomous vehicles (AVs). Source: Authors' own editing, based on the literature review [2–40].

Our analysis revealed that in previous research, attitudes toward expected changes have usually been examined from the perspective of potential consumers. In contrast, the views of experts working in specific sub-sectors of tourism are an under-explored topic. With this in mind, we have developed our primary research directions.

3. Methodology

3.1. Overview of Q Methodology

Since the main objective of our research is to identify the attitudes of tourism professionals, we applied the Q methodology. It is a useful method for identifying technological opportunities [41] and is also applicable to the field of transport [42]. The Q methodology was developed in the 1930s by William Stephenson. A distinctive feature of the methodology is its positioning between qualitative and quantitative methodologies. It is appropriate for exploring patterns along with the different preferences of respondents and reducing the complexity of opinions while also providing numerical results. Its advantage over the Likert scale is that it does not rate statements separately but ranks the respondent's preferences in relation to each other, which results in more sophisticated opinions [43]. While the methodology has been previously applied to exploring the field of AVs, it has been used to investigate user attitudes and adoption primarily [44], rather than in a tourism context [45]. Our research, therefore, is methodologically novel in the field of studying the impact of AVs on tourism from the experts' perspective.

3.2. Steps in Q Methodology

We implemented the Q methodology in six steps (Figure 2).

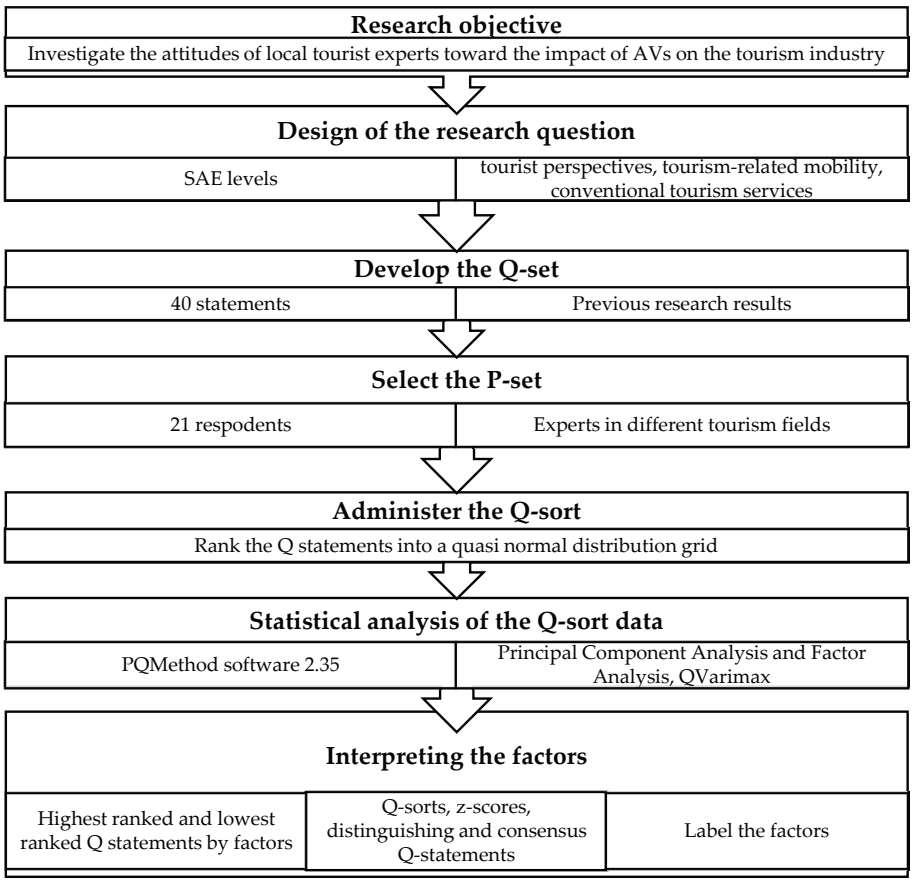

Figure 2. Steps of Q methodology. Source: Authors' own editing.

As a first step, we defined our research objective, which was formulated along the gap identified in the literature review, namely, to explore the impact of AVs on tourism not from the tourists' point of view but to analyze the views of tourism professionals. In the second step, we analyzed the peer-reviewed sources on the subject [45–47] and interpreted them along with a novel structure. However, previous articles on the topic conducted their research and drew their conclusions assuming SAE Levels 4–5, and therefore there were fewer results for SAE Levels 2–3. The effects identified in the various sources are therefore grouped according to Figure 1. For the three themes (changes from the tourists' perspectives, in tourism-related mobility, and in conventional tourism services), we formulated a total of 98 claims. We stopped at this number of statements because the content of the remaining statements had become repetitive. To make the layout of the method meaningful to respondents, it was necessary to reduce the number of statements [48], which previous research has shown to be satisfactory at between 40 and 50 [42] and 30 and 60 [49]. The number of statements was eventually reduced to 40 (see in attachments: 8.1); those with similar content were grouped together. To check comprehensibility, statements were pre-tested and, where appropriate, shortened or supplemented with illustrative examples (Appendix A).

To learn more about the tourism experts' attitudes to the potential impacts of AVs, the Q method statements were completed by key figures from the Hungarian tourism sector, from different areas of tourism (accommodation, hospitality, attraction management, and mobility fields), including market, non-profit, and public actors.

The tourism experts were limited to the domestic destination (Hungary, which is a growing car market in Europe [7]), representing a wide range of opinions and all major tourism service and expert groups. No knowledge of AVs was required. A particular

feature of the Q methodology is that the participants themselves are the variables; they are not selected randomly but according to their theoretical knowledge [46]. Typically, 10–40 participants are asked to arrange the set of statements [50] since, with this number of participants, the factors are comparable. In our case, a total of 21 people participated in the study. When completing the questionnaire, respondents were asked to place the statements in a quasi-normally distributed table (Table 1), which forced them to rank them in relative order of preference. Quantitative analysis and qualitative interpretation of the responses are presented in the next section.

Table 1. Sorting distribution.

	Most Disagree			**Neutral**			**Most Agree**
Value	−3	−2	−1	0	+1	+2	+3
Frequency	4	5	7	8	7	5	4

Source: Own construction.

4. Results

The ratings by respondents are called Q-scores; we analyzed them using PQMethod version 2.35 software [51]. We performed principal component analysis, followed by varimax rotation, and then designed four factors along with the following criteria: an eigenvalue above 1 [47], minimum of two opinions per factor [49], variance level above 50%, each factor should account for at least 10% of the total variance [52], and low correlation between factors (below 0.5).

The distribution of the number of opinions varied between the factors, with five in Factor 1 and Factor 3, three in Factor 2, and eight in Factor 4 (Table 2). The factors were characterized according to the highest- and lowest-rated statements, considering separately those with significantly different opinions from the other factors.

Table 2. Rotated factor score matrix and explained variance.

Respondents	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**
SZCE	0.0567	0.7638X	−0.0982	0.0917
FZS	0.6259X	−0.0139	0.2900	0.1151
NK	0.6469X	0.0741	0.0002	0.2116
GP	0.2218	−0.3163	0.1423	0.7275X
HG	0.9237X	−0.0523	0.1112	0.0658
HD	0.9237X	−0.0523	0.1112	0.0658
BA	−0.2495	0.7940X	0.1610	−0.1005
MAJ	0.2007	0.0230	−0.0639	0.7002X
MZ	0.1718	0.3105	0.3071	0.5223X
LP	0.1749	0.5869X	0.2865	0.1498
NJS	0.4381	0.2867	0.5907X	0.0727
RB	−0.0474	0.0093	0.1781	0.4678X
KN	0.1169	0.1120	0.1201	0.5504X
FD	−0.0741	0.2574	0.1209	0.5618X
HH	0.1785	0.0286	0.6882X	0.2507
BE	0.2267	0.4655	−0.4729	0.5440X
HD	0.1132	0.1744	0.4850X	0.1076
VE	0.2465	−0.1234	0.4883X	0.3670
OA	−0.0113	−0.0031	0.8016X	0.1107
AA	0.2939	−0.0718	0.2117	0.5930X
FM	0.4237X	0.1396	0.1180	0.3742
Number of respondents	5	3	5	8
% Explained Variance	16	11	13	15
Name of factor	Mobility-service oriented	Accessibility focused	Skeptics	Optimist, technology-oriented

Source: Own edition.

4.1. Mobility-Service Oriented Group

The first factor sees the impacts of AVs on tourism primarily in terms of mobility. They see the need for door-to-door mobility coming to the fore as opposed to public transport, but they also see SAE Levels 4–5 vehicles as a substitute for airport transfers and taxis. These experts predict a strong preference of tourists for individual travel; they think that lower demand for shared AVs can be expected. As they see the rapid spread of AVs, they no longer consider driving in a foreign environment as an obstacle. They also agree that the potential for the development of wine tourism as a designated driver will no longer be needed. They agree the most that conventional driving will become a tourist experience. However, it is interesting that they only see the changes in terms of mobility but do not agree that AVs could replace hotels, restaurants, or event venues. In sum, AVs can appear as an unconventional mobility service for tourists. Therefore, we named this factor mobility-service oriented.

4.2. Accessibility Focused

Factor 2 sees the main impact of AVs on tourism as the change in accessibility. They agree that geographically the opportunities are widening; more distant and less-known destinations can be included in tourism, which can be understood on two levels: tourists prefer to visit a destination farther from their home when traveling to a tourist attraction, and they prefer shorter distances within the destination, giving greater visibility and accessibility to attractions. At the same time, there is a risk that areas that are difficult to reach and less developed in terms of infrastructure could be at a disadvantage because they are less accessible to AVs. Factor 2 believes that closer cooperation between destinations sharing AVs is feasible. Based on the responses, AVs will not undermine the role of public transport and will rather be used for longer-distance (inter-destination) transport. Factor 2 alone disagrees with the emergence of car-free destinations and does not believe that traffic would be less or cities more livable because of the advent of AVs. These experts think that wine tourism and barrier-free tourism will develop, which could result in increased over-tourism. In terms of tourism services, this factor is not in favor of the development of AutoTour services. Their order of preference reflects the fact that traveling to more remote places by AVs would become conventional, but they see it less so within cities, where the emergence of AVs would remain unconventional. Therefore, we call this factor accessibility-focused.

4.3. Skeptics

The opinion of Factor 3 reflects the negative impact of AVs as a safety issue from a transport, privacy, or data point of view. Tourists are reluctant to use shared AVs because they do not want to travel with strangers. As it is not safer for pedestrians to use AVs, they do not agree with the increase in the number of walking tours. Factor 3 considers AVs to be suitable for both shorter and longer distance trips, and these experts also believe that they will be used more for leisure and visiting friends and relatives (VFR) by tourists. They agree that new AutoTour services could be created but also emphasize the risk that small local businesses will be at a disadvantage compared to multinationals. Factor 3 also rejects the idea of destinations cooperating and sharing AVs. They also see an opportunity for taxis to survive if they develop additional services (e.g., tour guide service). This factor is therefore labeled skeptics, as they are less likely to believe that the uptake of AVs can become conventional in tourism due to the threats listed.

4.4. Optimist, Technology-Oriented Group

Factor 4 is optimistic about the emergence of AVs and positive about their impact on tourism. They think that AVs will be a viable alternative to public transport, taxis, and airport transfers. This factor is the most likely to see AVs as meeting rooms or mobile motels but does not feel that this threatens conventional hotel services. They see a potential for the development of wine tourism because of the elimination of driving, which could

increase demand, but they do not fear the emergence of over-tourism. Factor 4 agrees that AVs will also have a positive impact on passenger transport and that the transformation of urban spaces will make cities more livable, making them even more attractive to tourists. Experts in this group believe that AVs can be suitable in both the short and long term and can therefore influence destination choices. However, they agree that, for the time being, AVs can offer an unconventional tourist experience, which can also translate into a price premium. Based on these opinions, this factor has been labeled an optimist, technology-oriented group.

5. Discussion

To obtain a complete picture of respondents' views, we have highlighted the distinguishing, consensus, and neutral statements for each factor, which helps us draw conclusions and make recommendations.

5.1. Distinguishing Statements

As we have seen in the literature review, there was no common understanding and approach in all areas of previous research on the impact of AVs on tourism. In the present research, we also found areas where tourism experts have quite different views. There is no uniform picture as to whether shared AVs can be as successful with tourists as individual AVs, i.e., whether both can become conventional. Factors 1 and 3, supporting the previous results [2,11] that tourists prefer individual travel for leisure trips, while contrary to other findings [16], Factors 2 and 4 do not see sharing with strangers as a problem. There are experts who say that the issue of data security will be a problem (Factor 3), while others do not consider it a matter of concern (Factors 1 and 4), so this will not prevent the use of AVs from becoming conventional. The transformation of urban spaces can have several consequences, as it depends on whether the freed-up parking areas are used for civic or business purposes. According to Factors 3 and 4, creating green spaces and parks would not only make a city more attractive but also more livable, a view also expressed in previous research [9]. Although previous research predicts AV use for longer distances [21], respondents are also divided on this issue. While some believe that removing barriers, such as traveling in unfamiliar environments [23], will increase demand, fueled by expanding accessibility [2,21], there is no consensus on whether this will lead to over-tourism. However, accessibility could be a key factor in making AVs increasingly part of conventional tourism in terms of mobility.

5.2. Consensus Statements

On certain issues, tourism experts think very much alike. They consider AVs a less flexible mobility service since they can only travel along a predefined path, which takes away access to destinations with poorer infrastructure, as pointed out previously [24]. It would therefore be important to prepare these destinations for the roll-out of AVs so they can meet the required conditions as soon as possible and take advantage of the opportunities offered by AVs (e.g., 5G network extension). At the same time, AVs will broaden the range of destinations available [2], bringing tourists to parts of the destination that may have been less frequented or even considered undesirable due to inappropriate surroundings [4]. All four factors agree that, since there is no need for a driver in SAE Level 4–5 AVs, this represents an opportunity for the development of wine tourism. While there was not complete agreement on the use of parking spaces, as mentioned in the distinguishing statements, there was consensus on the idea that these spaces are less used for economic purposes; previous research [9,21,28] highlighted many utilization options that would be worthwhile for tourism experts to rethink. By becoming a place for rest and sleep [9], AVs could replace the function of some hotels, which is questioned by our domestic experts. Factors 2 and 4 are more concerned with the expansion of available destinations, and all four factors reject the conventionalization of AVs as mobile motels.

Thus, not only are central hotels part of conventional tourism, but the use and booking of the peripheral areas also become conventional.

5.3. Neutral Statements

While several previous studies confirm that tourists will benefit more from the emergence of AVs [2], domestic tourism practitioners have paid less attention to the issue of inequality between locals and tourists [8]. All factors put these claims in the neutral category. However, the involvement of locals plays a key role in the acceptance of AVs; AVs may even provide an opportunity to connect locals and tourists [8], a demand that is becoming increasingly conventional nowadays. From the perspective of locals, technology will have an impact not only at the residential level but also at the entrepreneurial level [8]. Except for Factor 3, our experts consider competition between small local services and multinational services in tour planning to be less of an issue. The issue of growth in demand for overnight experiences is also neutral across all factors, implying that overnight experiences will become less conventional, not affecting changes in demand for tourism services to the same extent, contradicting previous findings [26]. In terms of service change, factors were neutral regarding the replacement of the restaurant, suggesting that they do not see the mobile restaurant function of AVs as unimaginable but that it will not become conventional in the near future (2030).

6. Conclusions

The research has shown how experts in different areas of tourism perceive the changes that we are facing as a result of the spread of AVs. An important result of our research is that we have explored the role of conventional tourism services from an expert perspective, thus improving the accuracy of previous predictions. Based on the four groups of opinions generated, we can see that the role of AV-based mobility and AV-based sightseeing is likely to increase in the near future, which could greatly improve the tourism experience offered by destinations with well-developed infrastructure.

An important question is whether tourism experts want to play a leader or a follower role in the emergence of AVs. The academic sphere of tourism has a responsibility to help tourism service providers understand the possible changes that may affect them. Policymakers and investors should also place greater emphasis on assessing the impacts on tourism, as leisure travel can be the first area using AVs.

The opinion groups generated by the Q methodology can be useful to quickly identify different opinions and to develop different communication strategies based on them to increase the acceptance of AVs among tourism experts. For the skeptics (Factor 3), it is worth emphasizing the safety of the technology, providing evidence that the lack of a human factor does not reduce confidence or even offer them the opportunity to try the technology.

A limitation of our research along the Q methodology is that we must limit the number of statements (30–60) to be transparent to respondents, so some topics must be combined or even omitted. The sample is also a limitation, as we only asked tourism experts in Hungary; cultural differences may influence the formation of opinion groups. Another limitation of the research is that new developments may emerge in the coming years, leading to new insights and opinions.

For further research, there is a need to explore opportunities for cooperation between tour companies (e.g., Hop-on Hop-off) and automotive companies to develop the details of an AutoTour service based on self-driving vehicles. It should also be a great contribution to the current findings to conduct a consumer attitude analysis based on real experiences (e.g., participation in living lab surveys) to verify the validity of the variables I have identified that influence the technology acceptance of autonomous vehicles.

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Appendix A

Table A1. Q statements.

N	Q Statements
1.	Tourists prefer fully autonomous vehicles to public transport.
2.	The spread of autonomous vehicles could lead to over-tourism.
3.	Autonomous vehicles will be used more for recreation and VFR (visiting friends and relatives) tourism.
4.	Tourists will be less open to the use of autonomous vehicles because they are concerned about their personal data.
5.	Autonomous vehicles will improve urban transport and reduce congestion.
6.	It will be more difficult for autonomous vehicles to travel on unimproved roads, making it harder to reach destinations with less developed infrastructure.
7.	It is predicted that autonomous vehicles could replace the role of traditional shuttle buses and taxi services, completely redefining urban passenger transport. The role of airport shuttles and taxis will also be reduced.
8.	Autonomous vehicles will be used as mobile motels, replacing hotel rooms rented for only a few hours.
9.	Autonomous vehicles will make door-to-door mobility more in demand than public transport (e.g., between rail and accommodation).
10.	Shared and autonomous vehicles will be less used by tourists than individually owned vehicles, as they are more sensitive to the presence of strangers on a leisure trip.
11.	With the spread of autonomous vehicles, there will be more interest in leisure and recreational services than in shopping and administration.
12.	The availability of autonomous vehicles will not be a determining factor in the choice of destination.
13.	Autonomous vehicles will be free of charge during the test period.
14.	Shared and autonomous vehicles will reduce costs, so only those will be allowed into cities, and other vehicles will have to park outside the city. Car-free tourist destinations could be created.
15.	Shared and autonomous vehicles can create a new type of sightseeing, called AutoTour services, which are more flexible and fully customizable, thus replacing conventional walking and bus tours.
16.	Local businesses are marginalized by the funding of multinational companies (disadvantage of smaller attractions).
17.	Tourists will travel to more distant destinations as the partially/fully autonomous system makes longer distance travel more comfortable.
18.	Autonomous vehicles offer the possibility to reach new destinations and attractions, allowing tourists to use hotel or restaurant services in more and more places.
19.	Urban spaces transformed by autonomous vehicles will be less attractive to tourists.
20.	There is no sense of security towards autonomous vehicles; it is like a tourist traveling in a driverless „box," the possibility of crime is more likely to arise.
21.	Testing fully autonomous vehicles could increase travel motivation and be a stand-alone tourist experience in places where the technology is not yet widespread.
22.	Solving parking problems will create more liveable urban centers with more green spaces.
23.	Autonomous vehicles can be used as mobile offices/meeting rooms.
24.	Sightseeing tours with autonomous vehicles will easily hide the negative side of the urban environment, masking the reality.

Table A1. *Cont.*

N	Q Statements
25.	The demand for accessible tourism will increase, as more people will be able to travel alone (due to the rise of autonomous vehicles, tourists without a driving license and with health problems can now travel alone).
26.	The number of evening sightseeing/night-time tourist experiences is increasing.
27.	Autonomous vehicles will be used by tourists for longer distances rather than short commutes.
28.	Autonomous vehicles will make travel safer.
29.	For tourists, driving a conventional vehicle will become a tourist experience as autonomous vehicles become more common.
30.	Less parking places will be needed, their space will be used for economic purposes (e.g., hotel to expand the number of rooms, event venue, bicycle paths).
31.	Restaurants will be in competition with mobile restaurants or vehicles combining sightseeing with dining, such as dinner boats.
32.	The spread of autonomous vehicles will benefit wine tourism as there is no problem with driving after drinking alcohol.
33.	The unfamiliar surroundings will no longer be a limiting factor; autonomous vehicles help by eliminating the barriers that international tourists face when traveling in unfamiliar surroundings.
34.	The number of walking tours may increase because there are fewer pedestrian accidents.
35.	Autonomous vehicles can create inequalities in urban transport if the interests of tourists take precedence over residents. Self-driving taxis will be used more by tourists than by residents.
36.	Tour management will become easier as the route becomes more flexible.
37.	Shared and autonomous vehicles operate only on pre-defined routes and under strictly controlled conditions (e.g., as airport shuttles, connecting airports or train stations to city centers, on urban sightseeing routes, or in off-road locations such as zoos), and therefore the system is not flexible.
38.	Traditional taxis and city bus tours can be maintained if they provide an additional service (guided tours), as a different type of staff will be needed.
39.	Hotels on the motorway will disappear because passengers will be able to sleep in the autonomous vehicle and will not have to stop for a rest during a long journey.
40.	Depending on seasonality, destinations can share their fleet of autonomous vehicles, reducing environmental pollution and congestion (e.g., making autonomous vehicles available in ski resorts in winter and in beach destinations in summer).

Source: Own edition.

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Addressing the Phenomenon of Overtourism in Budapest from Multiple Angles Using Unconventional Methodologies and Data

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Abstract: This paper addresses the phenomenon of overtourism in Budapest from multiple perspectives, starting with an overview that uses information collected from news, media, and academic tourism literature. Further, the phenomenon of overtourism is addressed quantitatively using different indicators, including tourism density and intensity. According to these indicators, the center of Budapest (formed by districts I, V, VI, VII, VIII, and IX) has been strongly affected by the presence of tourists, while districts physically far from the center have been less affected. This fact suggests the heterogeneity of the city in terms of overtourism. The number one catalyst of the negative impacts of foreign visitors' behavior is party tourism ('ruin pub' tourism), which involves an unconventional use of the Hungarian capital. Finally, using an unconventional optimization method called fuzzy linear programming, we attempt to explore the challenging problem of identifying the optimal number of tourists for the city. The results of the study have important theoretical, methodological, and practical implications. On the theoretical side, we offer a comprehensive understanding of the phenomenon of overtourism in Budapest. Methodologically, the integrated approach in terms of data gathering and unconventional analytical methodologies (comprised of a case study analysis, the assessment of effective indicators for measuring the discussed phenomenon, and the demonstration of the sustainable number of visitors) represents a novel perspective about the extent of overtourism in Budapest. On the practical side, our findings provide valuable guidance for policymakers to help mitigate the problem of overtourism in the city. With regard to future research, we suggest extending and updating the results presented in this study to develop more sustainable tourism strategies.

Keywords: overtourism; Budapest; tourism carrying capacity; unconventional data gathering; unconventional analytical methodology

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1. Introduction

In 2019, Budapest was named the best destination in Europe, outranking classic urban destinations such as Paris, London, and Barcelona [1]. Within the same calendar year, the capital of Hungary ranked second on the "Best in Travel 2020" list, being awarded the title of the world's most affordable large city [2]. Indeed, the year 2019 witnessed unprecedented tourist traffic in Budapest and the Hungarian tourism sector enjoyed "a golden age" [3] before the COVID-19 pandemic. The contribution of tourism to GDP reached 13.2% in 2019 and the growth rate of the tourism sector exceeded both the EU and worldwide average [4]. Being among the most popular tourist destinations, however, has its downsides. Earlier,

Budapest was ranked fifth among the European cities most affected by overtourism in 2017 [5]. Followed by Barcelona and Amsterdam, Budapest is third on the list of cities most impacted by overtourism at night [6].

Budapest is divided into 23 districts that have their own political, economic, social, and cultural structures. The fragmentation of the city in terms of district management, and uncoordinated urban planning in the post-socialist years have led to few attempts at planning for tourism [7]. Previous research [8] concluded that tourism planning and management in Budapest is fragmented. Moreover, one city agency responsible for tourism was closed, and the remaining state-owned Hungarian Tourism Agency is focused on marketing and communications rather than planning or development [7]. As Smith et al. [9] noted, unplanned urban processes may result in many adverse effects from tourism-related activity. For instance, the unstructured and somewhat unregulated urban planning system in Budapest was one of the reasons for the expansion of the ruin bar market and the formation of the whole party area, as well as the growth in Airbnb accommodation [7]. Additionally, the city is extremely congested due to the existence of sections of national roads and a Budapest-centric transport infrastructure [10]. Consequently, the 'Pearl of the Danube' is considered one of the most affected urban areas.

The phenomenon of overtourism in the context of Budapest has recently been investigated in the tourism literature. For instance, Pinke-Sziva et al. [11] analyzed the phenomenon of overtourism with specific reference to the night-time economy in District VII—the so-called "party quarter of Budapest." With a focus on the same District VII, Smith et al. [7] explored the two closely connected phenomena—ruin bars, and the high density of Airbnb apartments—which are local and global examples of tourism consumption. Smith et al. [9] explored the role of tourism in growing resident discontent and resistance, while Remenyik et al. [6] assessed the extent of overtourism in Budapest. Party tourism is an unconventional tourism product in an urban environment which was first developed for cultural, health, and conference tourists [12]. Due to the divergent interests of inhabitants and the management of flows on the territory, scholars have highlighted the difficulty of measuring overtourism in such urban environments [13].

The excessive use of resources, infrastructure, and the facilities of a destination is among the causes of overtourism, implying that cities have a carrying capacity that tourism can exceed [14]. As per Camatti et al. [15], the tourism carrying capacity of a destination is an essential reference point for developing responses to the complex phenomenon of overtourism. Hence, we refer to the concept of tourism carrying capacity (TCC), which reflects the dynamics of the destination environment [16,17]. TCC is a management tool [18] designed for tourism planning that enables the development of initiatives for managing tourist flows via the balanced redistribution and segmentation of demand, introducing regulations or reservation systems, and creating alternative itineraries or novel tourist attractions [15,17].

Prior research has shed some light on the problems of overtourism in Budapest. However, we still lack an integrated view that links its emergence and comprehensive measurement in a city setting. In our study, we aimed to identify factors that made overtourism possible in Budapest, to apply recognized indicators of overtourism to better understand the city's carrying capacity and flows of different types of visitors, and to determine the sustainable number of tourists in the Hungarian capital. To address the research objectives, three research questions were raised: (1) What are the factors that led to the emergence of overtourism in Budapest? (2) How can one quantify the phenomenon based on verified overtourism-tailored indicators? (3) How can one approximate the optimal number of visitors in the city?

As suggested by Remenyik et al. [6], the overtourism phenomenon and the capability of an area may be assessed via the use of complex methodologies. Therefore, we adopted an integrated view built upon a case study of urban destination indicators to assess the degree of overtourism in Budapest, and calculated the sustainable number of visitors with the use of unconventional optimization methods such as Fuzzy Linear Programming (FLP).

The application of different methods for data collection and data analysis opens up fresh lines of inquiry into the phenomenon of overtourism in Budapest and its districts. The following section presents the theoretical discussion of the overtourism phenomenon and its measurement, with a focus on TCC.

2. Literature Review

2.1. Definition of Overtourism

Over the last two decades, the number of global outbound tourists has more than doubled. International tourist arrivals increased from 673 million in 2000 to 1460 million in 2019 [19], harming many popular destinations [20]. Even though the term 'overtourism' has attracted increased interest among researchers in recent times, the issue of the crowding of destinations has been addressed in the literature since the mid-1960s [21–26]. Along with rapid urbanization, tourism mobility, low-cost flights, increases in income, the growing popularity of Airbnb, and the proliferation of social media and information communication technologies have increased the demand for city tourism immoderately [27,28]. To define the unfavorable consequences of this excessive demand, Skift created the term 'overtourism' in 2016 [27], which has been increasingly used in the literature [14]. Nevertheless, there is no academically accepted definition of the term; thus, it remains open to multiple interpretations [29]. According to the UNWTO definition, overtourism is "the impact of tourism on a destination, or parts thereof, that excessively influences perceived quality of life of citizens and/or quality of visitors experiences in a negative way" [27] (p. 4).

One of the main economic problems caused by overtourism is the increase in the price of housing, goods, and services in destination areas [30] which fuels gentrification. Gentrification is the process of the displacement of low-income households from a transforming destination that often entails great expense [31]. The other element that drives gentrification is short-term rentals, which decrease the housing stock for long-term rentals [32]. The social and cultural issues associated with overtourism include depopulation, conflict between residents and tourists, insecurity, decreasing quality of life, and the destruction of local culture. With the increase in the touristification of urban centers, living conditions change and become less suitable for residents, which leads to depopulation [33]. An excessive number of tourists per resident decreases the quality of life of residents, resulting in tourismphobia [34]. Young travelers may be driven to seek out new experiences, causing a severe deterioration in perceived security because of their poor behavior, alcohol/drug use, and engagement in prostitution and gambling that diminish moral values and cultural traditions [35].

In terms of negative environmental impacts, overtourism drastically increases water, land, air, noise, and aesthetic pollution, and is associated with solid waste, littering and sewage treatment issues, infrastructure degradation, natural resource depletion, biodiversity loss, and climate change [36,37]. Additionally, although tourists may treat cultural assets with respect, an excessive number of visitors can threaten the physical condition of historical and archaeological sites through wear and tear, together with insufficient regulation and poor management [38].

2.2. The Measurement of Overtourism

The literature has defined several indicators for measuring the phenomenon of overtourism, which affects the wellbeing of both tourists and residents. For instance, Simancas Cruz and Peñarrubia Zaragoza [39] estimated tourist accommodation density, an indicator for determining a state which is undesirable for tourists and, thus, defines the optimal limit for accommodation saturation. Table 1 presents six indicators of overtourism as defined by Peeters et al. [40].

Table 1. Indicators of overtourism. Source: [40].

Indicator	Definition	Description
Tourism density	Bed-nights/km^2	Annual number of bed-nights per km^2
Tourism intensity	Bed-nights/resident	Annual number of bed-nights per resident in the destination
Sharing economy: Airbnb	Number of Airbnb offers	Number of Airbnb offers in a destination
Share of tourism contribution to GDP		
Air transport intensity	Air passengers/Bed-nights	Ratio of the number of air passengers to the number of bed-nights
Closeness to airports		Arrivals within 50 km
Closeness to cruise ports		Number within 10 km
World Heritage Sites closeness		Number within 30 km

The indicators above are designed to estimate whether a destination may be at risk of overtourism from an economic or social perspective. However, the authors [40] point to the inability of assigning a general value to an indicator that infers when a state of overtourism is likely to develop.

Additionally, to avoid negative consequences (e.g., overcrowding, congestion, or environmental degradation) arising from tourist activities and flows, how tourism develops in relation to the principles of sustainability should be considered [41]. As Coccossis et al. [41] note, planning and management for tourism growth are of particular importance in the context of sustainable development. Hence, it is especially important for tourism destinations to apply a minimum number of consistent indicators for assessing sustainable tourism [42] and the phenomenon of overtourism.

2.3. Tourism Carriying Capacity

In measuring overtourism, the concept of TCC is considered a valuable operational tool for identifying the limits to sustainable tourism activity [18,43]. On the one hand, a growing number of visitors positively affects the income and employment levels of some of the population in the tourist destination. On the other hand, growth in visitor numbers can generate negative effects. Understanding the number of tourists a destination can tolerate has become one of the major challenges which policymakers and scholars have been trying to address.

The topic of TCC prevails in the overtourism debate. The concept was defined by the World Tourism Organization as "the maximum number of tourists that a space can absorb without a lowering of the quality of the visitor's experience and without serious consequences for its ecology and its socio-economic structures" [44] (p. 5). The literature outlines three main dimensions of carrying capacity, including the physical–ecological, socio–demographic, and political–economic dimensions which are derived from problems such as the threat to the physical environment of a destination, the loss of a local community's character, and the dependence of the local economy on tourism [15,18].

An early description of TCC referred to the maximum number of visitors that could be supported without an unacceptable decline in the quality of visitor experience and the quality of the environment. Subsequently, the definition of TCC was complemented with reference to other types of capacity, including the capacity of supporting facilities, among them the maximum number of accommodation units, sitting places associated with the catering sector, parking spaces, the capacity for solid waste disposal, and other services which cater to the needs of visitors. These facilities can constrain the tourist capacity of the destination and impose additional costs on residents [45]. Previous research has widely applied the TCC model to determine the optimal number of visitors, especially in the context of cities, which have been exposed to negative externalities because of overtourism over recent years. Several scholars have estimated the carrying capacity of

different destinations—including for the historical center of Venice [16,45], Rome [46], a coastal destination on the Costa del Sol, Spain [43], and Dubrovnik in Croatia [15].

In terms of the practical calculation of TCC, as Bertocchi et al. [16] highlighted, one of the prominent research streams is dedicated to the use of fuzzy linear programming. Costa and Van der Borg [47] and Canestrelli and Costa [45] were among the first to determine the social–economic carrying capacity of Venice's historical center by applying fuzzy linear programming. Fuzzy linear programming permits the estimation of the optimal number of tourists by considering several constraints and using approximate data [45,46]. The advantage of this unconventional method of optimization is its capacity to incorporate imprecise data.

However, there is no single and universal method of calculating TCC [16], since TCC can be studied in relation to its specific components and through a holistic approach involving the application of different methodologies and approaches. Some indicators cannot be operationalized because of the lack of data. The concept of TCC has also been criticized in the literature, as this type of measurement simplifies the problem of overtourism [14,43,48,49]. Some scholars assume that the concentration on calculating carrying capacity may be misleading as the estimated number of tourists may be too large and suboptimal [50]. Hence, the focus should be on visitors' experiences and behavior, rather than on the number of people [9,14,51].

Notwithstanding the difficulty of establishing the carrying capacity of destinations [9] and the critiques of the approach, McCool and Lime [49] confirm that in some cases the carrying capacities for facilities (e.g., parking lots or cultural sites) may be identified. In general, proponents believe that TCC can help stimulate sustainable development scenarios and the better management of tourist flows [16]. In this study, we adopt the commonly accepted indicators for measuring the carrying capacity of a given city by applying FLP to identify the optimal number of visitors to Budapest. Thus, we attempt to contribute to an under-researched area of urban sustainable tourism [52] that may help create the highest possible utility for tourism actors and the local community and economy.

This section has attempted to provide a summary of the literature related to the phenomenon of overtourism and its measurement. Much of the research on overtourism has focused on identifying and evaluating the reasons for the adverse effects of tourist activities and streams. To date, various methods have been developed and introduced to measure overtourism. However, the previous studies indicate the difficulty of measuring this phenomenon, especially in urban environments, outlining the need for comprehensive methodology to analyze the extent of overtourism in a city setting. Collectively, those studies highlight the critical role of determining the tourism carrying capacity of a destination and adopting an integrated approach in terms of data gathering and unconventional analytical methods. To address the issues related to overtourism in the context of Budapest, we, therefore, implemented the complex methodologies which are carefully described in the next section.

3. Materials and Methods

3.1. Methodological Triangulation

The phenomenon of overtourism in Budapest has been investigated by applying a combination of multiple methods of data collection and data analysis. The use of different data collection methodologies, called triangulation [53,54], has been theorized and adopted in tourism literature [55–57], including research about tourism-related issues in Budapest [7,9,11]. A triangulation strategy increases the credibility and validity of research [56,58], and provides better conclusions through the convergence and collaboration of findings [59]. However, as Koc and Boz reported, tourism literature lacks studies for which more than one method of data collection was used [56].

Following the recommendation of Koc and Boz [56] to increase the use of data triangulation, we triangulated different data sources from several independent sources to explore the studied phenomenon. First, we analyzed the academic literature and online

media news on the appearance of overtourism in Budapest to understand the problems the city experienced before the outbreak of the coronavirus pandemic and subsequent border closures. Second, one of the authors collected photographs depicting the negative impacts of tourism activities in Budapest during 2019. Previous studies have confirmed the practicality of using images of tourist destinations as a research tool [60,61], as such images encapsulate the visual look of a place, its atmosphere, and the emotions it evokes [62].

The adoption of qualitative techniques preceded the development of further quantitative research [53,55]. Hence, third, we collected longitudinal tourism data for Budapest and its 23 districts. The data was complemented with the results of a survey distributed among Hungarian tourism industry experts. Similar to the studies of Bertocchi et al. and Camatti et al. [15,16], we adopted the criteria of TCC to study pressure on the urban destination (i.e., Budapest) to define the sustainable number of tourists staying in three types of accommodation. Unlike in Venice and Dubrovnik [15,16], Budapest has geographical characteristics that make it more difficult to capture the phenomenon of overtourism. Subsequently, eight tourist-supporting facilities (see their description in Section 4.3) were selected as relevant as they cater to the needs of tourists, and were analyzed with the application of FLP. Based on the integrated approach, the unconventional analytical methods applied in the current research offer new lenses and perspectives with which to understand the extent of overtourism in Budapest.

3.2. Tourism Carrying Capacity Model: Fuzzy Linear Programming

This section presents the mathematical background behind the estimation of the ideal maximum number of tourists in Budapest. Considering previous research on TCC [16], we use the unconventional optimization method called FLP to estimate the optimal number of tourists in the city. As an optimization tool, FLP helps identify the optimal number of tourists in a destination by considering, on the one hand, the need to maximize the total revenue generated by tourists in the destination, and on the other, the inherent limitations of the destination in terms of physical–ecological, socio–demographic, and political–economic constraints.

Mathematically, the FLP problem can be formulated as:

$$\begin{gathered} \text{maximize} \widetilde{z} \approx \widetilde{\boldsymbol{c}}\mathbf{x} \\ s.t. \widetilde{\boldsymbol{A}}\mathbf{x} \preccurlyeq \widetilde{\boldsymbol{b}} \\ \mathbf{x} \geq \mathbf{0} \end{gathered} \tag{1}$$

where the symbols $\approx$ and $\preccurlyeq$ mean equality and inequality, respectively, with respect to a given linear ranking function, F; $\widetilde{\mathbf{c}}^T = (\widetilde{c}_1, \ldots, \widetilde{c}_n)^T \epsilon R^n$ is the cost vector; $\mathbf{x} = (x_1, \ldots, x_n)^T \epsilon R^n$ is the vector of decision variables; $\widetilde{\boldsymbol{b}} = \left(\widetilde{b}_1, \ldots, \widetilde{b}_m\right)^T \epsilon R^m$ is the right-hand side vector of the constraints, and $\widetilde{\boldsymbol{A}} = \left[\widetilde{a}_{ij}\right]_{mxn} \epsilon R^{mxn}$ is the constraints matrix, being $\widetilde{c}_j$, $\widetilde{b}_i$, and $\widetilde{a}_{ij}$ fuzzy numbers, for $i = 1, \ldots, m$, $j = 1, \ldots, n$.

In the context of this study, given the revenue generated by each type of tourist in Budapest (the cost vector), the goal is to maximize total revenue, denoted as $\widetilde{\boldsymbol{c}}\mathbf{x}$, subject to the inherent limitations of the city represented by $\widetilde{\boldsymbol{A}}\mathbf{x} \preccurlyeq \widetilde{\boldsymbol{b}}$. The use of fuzzy numbers indicates that information is only an approximation (rather than exact information).

The solution to (1) uses the concept of the ranking function, where the original problem is transformed into its equivalent crisp problem and then standard methods such as the Simplex Method are applied [63]. This study considers the following ranking functions:

$$\text{Yager's } F_1 \text{ function}: \; F_1(\widetilde{a}) = \frac{1}{3} \cdot \frac{\left[\left(a^R\right)^2 - \left(a^L\right)^2\right] + \left(R^2 - L^2\right) + \left(Ra^R - La^L\right)}{\left(a^R - a^L\right) + (R - L)}$$

$$\text{Yager's } F_3 \text{ function}: \; F_3(\widetilde{a}) = \frac{L + a^L + a^R + R}{4}$$

where $\widetilde{a} = \left(a^L; a^R; L; R\right)$ is a trapezoidal fuzzy number, being $L < a^L < a^R < R$ real numbers.

4. Results

4.1. Appearance of Overtourism in Budapest

With EU accession in 2004, the tourism industry in Budapest experienced rapid growth in international visitor numbers [11]. Low-cost airlines and numerous Airbnb units leveraged the number of tourists in Budapest, particularly younger tourists whose main motives were having fun and partying in the so-called Jewish ghetto of Budapest, located in the city center [9]. Besides these factors, the government and Hungary's tourism marketing organization, which covers Budapest, share responsibility for this boom in party tourism due to the lack of a consistent and strong marketing campaign between the years of 1990 and 2010 that resulted in an ambiguous brand image for the city [64,65]. The figure presented below (Figure 1) demonstrates the marketing strategies of Budapest; note that the focal point in 2012 differs from the image creation strategy in 2018.

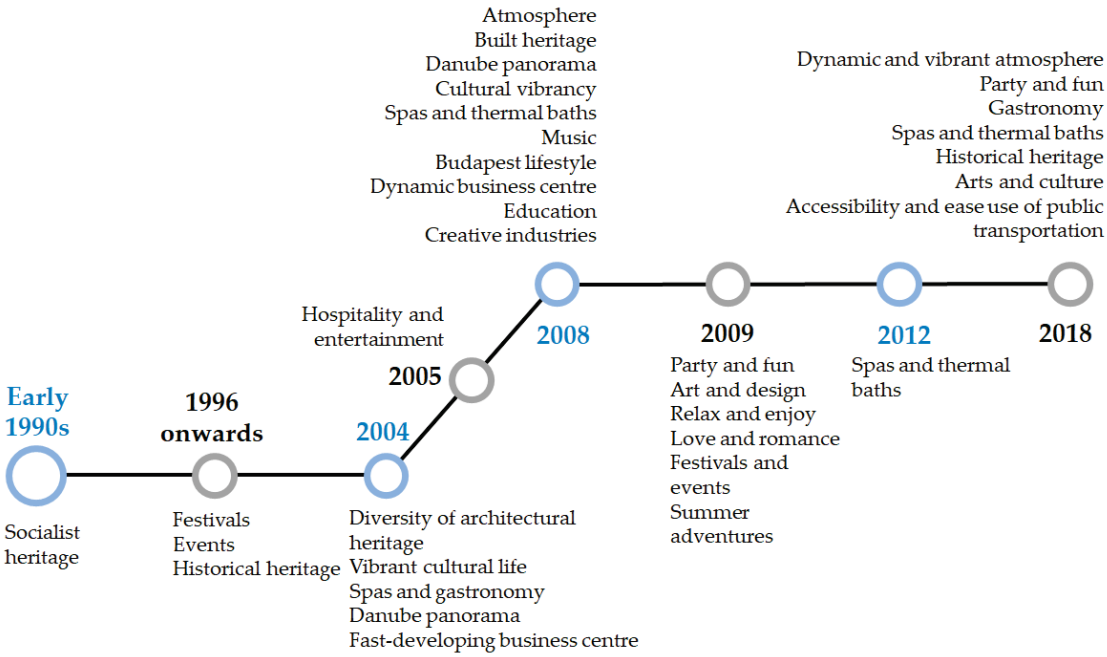


Figure 1. Main developments in the destination marketing strategy of Budapest. Source: Adapted from Ref. [66].

The other factor that boosted demand for the night-time economy was news about cheap alcohol and entertainment opportunities. In the mid-2000s, budget airlines promoted the low price of beer in Hungary in their marketing campaigns [9]. News on websites until 2016 similarly portrayed Budapest as the cheapest urban destination among European cities with a focus on alcoholic beverages. Problems caused by heavy alcohol consumption and party tourism created resistance among locals against tourism development in the city [9]. Since 2018, the news has centered upon overtourism and its negative consequences. In order to mitigate the phenomenon, the government introduced new regulation that authorizes municipalities to decide on or limit the maximum period of Airbnb rentals. Figure 2 exemplifies the evolution of online news about the capital city for 2013–2020.

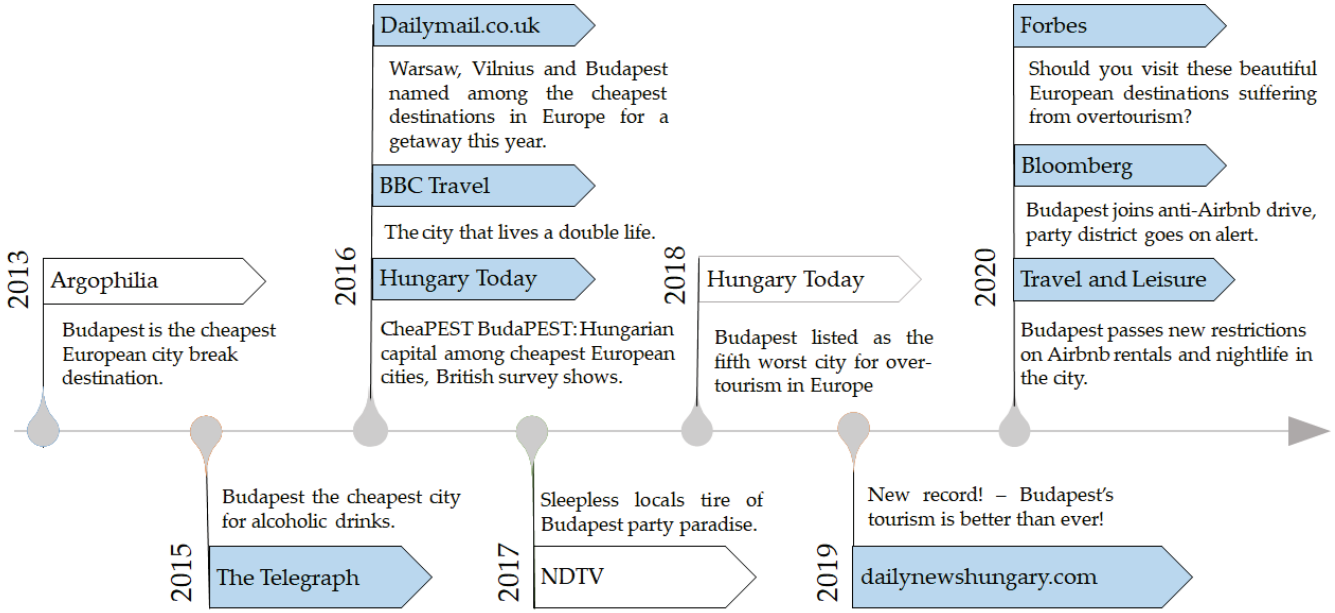


Figure 2. Online news about Budapest between 2013 and 2020. Sources: [67–77].

Pinke-Sziva et al. [11] conducted interviews with locals and tourists, and identified that most of the complaints arising from overtourism came from the city center of Budapest (District VII), which became a party and alcohol-centered quarter that provided an authentic visitor experience due to its ruin bars and the traces of Jewish cultural heritage. The concentration of short-term vacation rentals on Airbnb in this area is, likewise, influential in terms of leveraging the number of non-cultural tourists [78]. The touristification of the city center rapidly increased housing prices [9]. Based on data from the Hungarian Central Statistical Office (HCSO), housing prices increased 80% from 2007 to 2019 [6], which generated gentrification [9]. Other complaints about overtourism included public urination, street crime, litter, dirty streets, and the number of drunk people [11]. The photos below (Figure 3), taken in April–May 2019, demonstrate the negative environmental impacts of overtourism (cluttered streets caused by overloaded garbage containers, vomit-stained streets, and the social issue of overcrowding).

(**a**)

(**b**)

Figure 3. *Cont.*

(**c**) (**d**)

Figure 3. Impacts of overtourism in District VII, Budapest. (**a**) Overloaded garbage container; (**b**) dirty street; (**c**) overcrowding in Szimpla Garden (a ruin pub); and (**d**) overcrowding in Gozsdu Court. Source: Authors.

4.2. Indicators of Overtourism

This section explores the phenomenon of overtourism in Budapest considering four indicators: (1) tourism density, (2) tourism intensity, (3) the sharing economy, Airbnb, and (4) total occupation of hotels. The first three indicators are described in Table 1, while the last one describes the historical evolution of the total occupation rate in hotels.

4.2.1. Tourism Density and Intensity

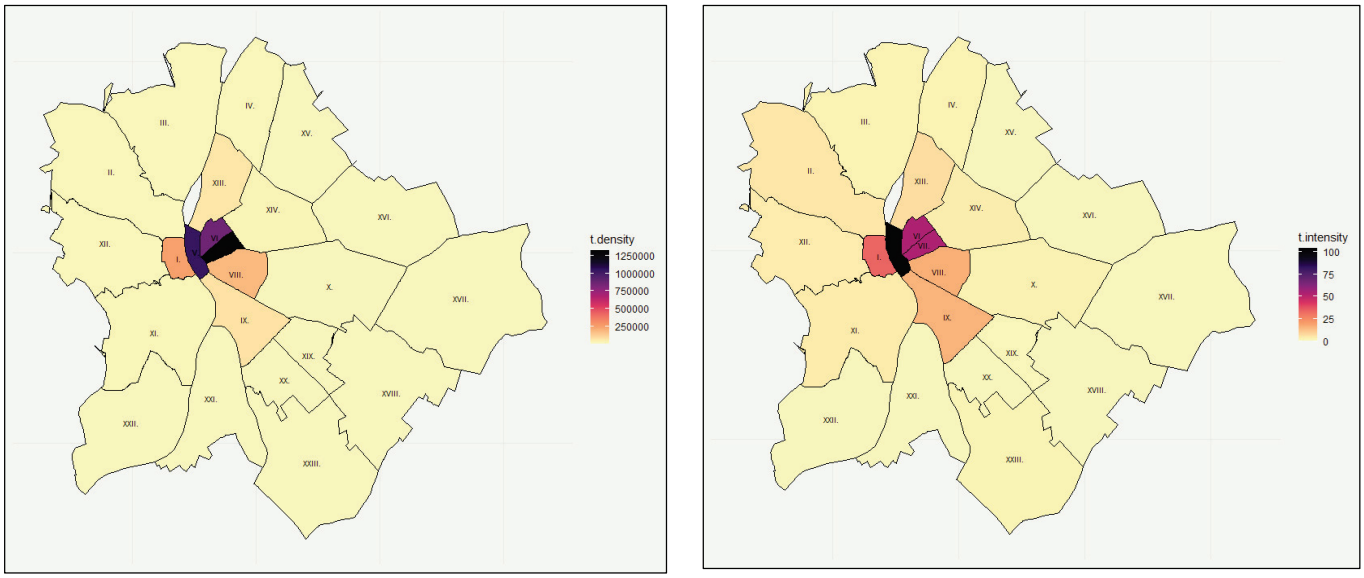
According to Peeters et al. [40], the phenomenon of overtourism is primarily associated with tourism density (tourists per square kilometer) and tourism intensity (tourists per resident). Table 2 shows the calculation of both indicators considering Budapest (as a city) and five selected districts.

Table 2. Tourism density and intensity, Budapest and selected districts, 2019. Source: HCSO, calculations by authors.

Region	Bed-Nights (Annual Number)	Estimated Area (km^2)	Estimated Number of Residents *	Tourism Density	Tourism Intensity
				(Bed-Nights/km^2)	(Bed-Nights/Resident)
Budapest	1,405,548	525.14	1,751,251	26,765.20	8
District I	837,986	3.41	25,181	245,743.70	33.3
District V	2,688,192	2.59	25,975	1,037,912.00	103.5
District VI	2,050,451	2.38	38,670	861,534.00	53
District VII	2,758,598	2.09	51,896	1,319,903.30	53.2
District VIII	1,240,092	6.85	76,784	181,035.30	16.2

* Resident population in the middle of the year.

The results show that both indicators of overtourism vary significantly from district to district (see full table in the Supplementary Material). For instance, the minimum value for tourism density is associated with District XVII (value 65.3), while the maximum occurs in District VII (value 1,319,903.3). In the case of tourism intensity, the minimum also occurs in District XVII (value zero; after rounding 0.0408), while the maximum occurs in District V (value 103.5). Figure 4 shows both indicators graphically.



(**a**) (**b**)

Figure 4. Tourism density and intensity by district: (**a**) tourism density by district; and (**b**) tourism intensity by district. Source: HCSO, calculations by authors.

Based on Figure 4, the area most affected in terms of both measures is the center of Budapest (formed by districts I, V, VII, VII, and VIII). Moreover, tourism intensity also affects the nearest districts, such as districts II, IX, XI, XII, and XIII.

Table 3 presents the data per percentile group. Note that the last group (the 5th percentile) captures most of the range of values—approximately 90% in the case of tourism density and 85% in terms of tourism intensity (skewed distribution). It also shows that the districts within the 1st, 2nd, and 5th group are the same for both indicators.

Table 3. Percentiles for the 23 districts of Budapest, 2019. Source: HCSO, calculations by authors.

Percentile	Tourism Density (Bed-Nights/km^2)	Districts	Tourism Intensity (Bed Nights/Resident)	Districts
1st	65.3–709.4	XVI, XVII, XVIII, XXI, XXII	0–0.2	XVI, XVII, XVIII, XXI, XXII
2nd	709.4–6292.3	XV, XIX, XX, XXIII	0.2–2.3	XV, XIX, XX, XXIII
3rd	6292.3–13,855.3	II, III, IV, X, XII	2.3–4.0	III, IV, X, XII, XIV
4th	13,855.3–138,265.1	IX, XI, XIII, XIV	4.0–15.9	II, IX, XI, XIII
5th	138,265.1–1,319,903.3	I, V, VI, VII, VIII	15.9–103.5	I, V, VI, VII, VIII

4.2.2. Sharing Economy: Airbnb

Peeters et al. [40] also suggested monitoring the number of Airbnb offerings in the destination since this might be an indicator of overtourism (e.g., in the form of uncontrolled offerings in destinations, or their uncontrolled growth). Figure 5 presents the number of offerings in private accommodation (including Airbnb) by district.

Figure 5 shows that private accommodation is highly concentrated in the center of Budapest (formed by districts I, V, VI, VII, and VIII). Indeed, this zone concentrates 79.1% of the total offerings of the city. It also shows that nearby districts were also affected, such as districts II, IX, XI, and XIII.

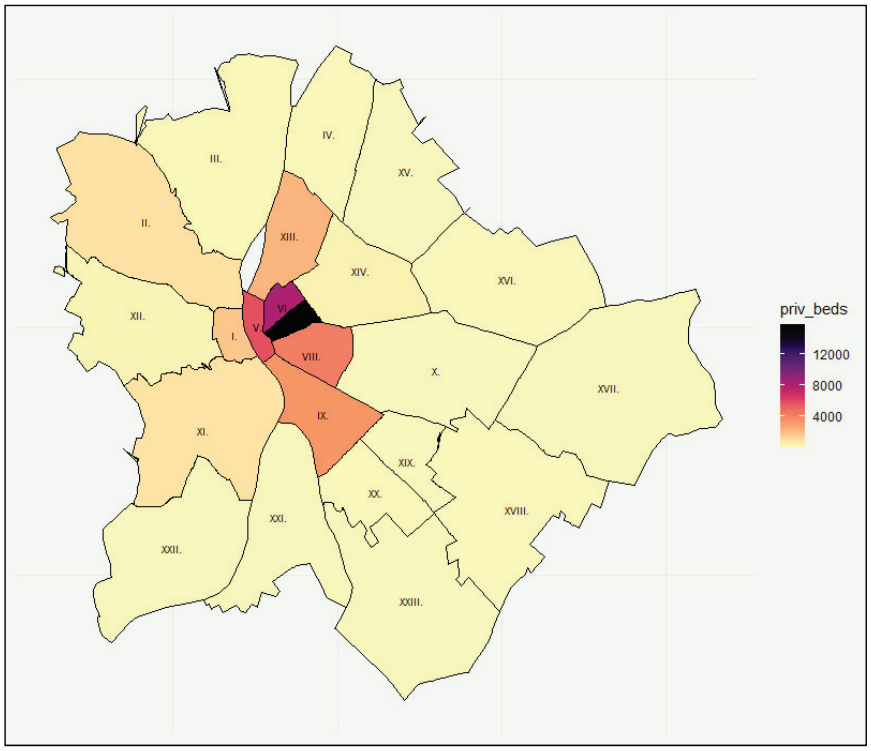


Figure 5. Number of units of private accommodation (including Airbnb). Budapest and its districts in 2019. Source: HCSO, calculations by authors.

4.2.3. Total Occupation in Hotels

The last indicator, as exemplified by Figure 6, illustrates the historical evolution of the total occupation of hotels (from 2010 to 2019).

Figure 6. Occupation rate in hotels from 2010 to 2019. Source: HCSO, calculations by authors.

The figure displays the information at various geographical levels. At the national level, denoted as 'hu', the occupation rate in hotels increased by 37.7% (up from 31.3% in 2010 to 43.1% in 2019). In Budapest, denoted as 'bp,' the rate increased by 41.2% (from 40.3% in 2010 to 56.9% in 2019). However, at the district level the occupation rate increased unevenly. For instance, consider two districts located in the center of Budapest: in District VI, the occupation rate increased by 25.1% (from 44.2% in 2010 to 55.3% in 2019), while in District VIII the rate was 56.6% (from 41.5% in 2010 to 64.9% in 2019). Based on Figure 6, we conclude that the hotel occupation rate in Budapest displayed a robust increasing trend in the 2010s, and the rates for inner districts reached a high value by the end of the decade.

4.3. Estimation of Tourist Carrying Capacity

This section presents the first attempt to identify the optimal number of tourists in Budapest using an unconventional optimization method called FLP. The FLP problem can be formulated as

$$\begin{gathered} \text{maximize} \widetilde{z} \approx \widetilde{\boldsymbol{c}}\mathbf{x} \\ s.t. \widetilde{\boldsymbol{A}}\mathbf{x} \preccurlyeq \widetilde{\boldsymbol{b}} \\ \mathbf{x} \geq \mathbf{0} \end{gathered} \tag{2}$$

where $\mathbf{x} = (\mathrm{TH}, \mathrm{TO}, \mathrm{TP})^T$ represents three types of tourists visiting Budapest: tourists staying in hotels (TH), tourists staying in other types of commercial accommodation excluding hotels (TO), and tourists staying in private accommodation (TP). The vector $\widetilde{\boldsymbol{c}}^T = (\widetilde{c}_1, \widetilde{c}_2, \widetilde{c}_3)^T$ represents the economic benefit per day generated by each type of tourist. To capture the uncertainty associated with these values we use fuzzy numbers:

$$\widetilde{c}_1 = (25,200;\ 28,000;\ 30,800), \widetilde{c}_2 = (18,900;\ 21,000;\ 23,100), \widetilde{c}_3 = (22,050;\ 24,500;\ 26,950)$$

The limitations of the city, represented by $\widetilde{\boldsymbol{A}}\mathbf{x} \preccurlyeq \widetilde{\boldsymbol{b}}$, have been selected based on the available information. Table 4 summarizes the selected constraints.

Table 4. Selected constraints for Budapest.

	Tourism System	Description	Source	Utilization Rates			Maximum Daily Capacity
				TH	TO	TP	
1	Commercial accommodation: Hotels	Number of bed places in hotels (from 1 to 5 stars)	HCSO	1	0	0	$\widetilde{b}_1$
2	Commercial accommodation: Excluding hotels	Number of bed places excluding hotels	HCSO	0	1	0	$\widetilde{b}_2$
3	Private accommodation	Number of bed places in private accommodation (e.g., Airbnb platform, etc.)	HCSO	0	0	1	$\widetilde{b}_3$
4	Public transportation (Buses, Trams, Trolleybuses and Subway)	Daily maximum capacity for tourists (persons)	BKK Zrt. and authors' calculations	1	1	1	$\widetilde{b}_4$
5	Tourist attractions (The Hungarian Parliament Building)	Maximum capacity (persons)	Tourism Departments, Office of the Hungarian National Assembly	$\widetilde{a}_{51}$	$\widetilde{a}_{52}$	$\widetilde{a}_{53}$	$\widetilde{b}_5$
6	Tourist attractions: (Széchenyi thermal bath)	Maximum capacity (persons)	Budapest Spas cPlc.	$\widetilde{a}_{61}$	$\widetilde{a}_{62}$	$\widetilde{a}_{63}$	$\widetilde{a}_6$
7	Tourist attractions (Gellért thermal bath)	Maximum capacity (persons)	Budapest Spas cPlc.	$\widetilde{a}_{71}$	$\widetilde{a}_{72}$	$\widetilde{a}_{73}$	$\widetilde{b}_7$
8	Environment	Waste production per person (in kilograms)	HCSO and authors' calculations	$\widetilde{a}_{81}$	$\widetilde{a}_{82}$	$\widetilde{a}_{83}$	$\widetilde{b}_8$

Note: the acronym HCSO stands for Hungarian Central Statistical Office.

Table 4 presents some limitations of the city in terms of tourism. The first three constraints are associated with the capacity of the city in terms of accommodation. This study considers three types of accommodation: commercial accommodation in hotels, commercial

accommodation excluding hotels, and private accommodation (including Airbnb). The fourth constraint shows the most frequently used forms of public transportation in the city: buses, trams, trolleybuses, and subway lines. The fifth constraint is related to the capacity of the Hungarian Parliament Building, which is considered one of the most scenic buildings in Budapest, and it symbolizes Hungary itself [79]. The following constraints are associated with two attractive places in the city: the Széchenyi and Gellért thermal baths. Typically, 90% of visitors who purchase daily tickets to these baths are foreign tourists [80]. Finally, the last constraint is related to an environmental aspect of the city in terms of waste production.

Table 4 also displays the utilization rates considering our three types of tourists: TH, TO, and TP. The utilization rates associated with tourist attractions (the Hungarian Parliament Building, and the Széchenyi and Gellért thermal baths) were estimated using a survey. We distributed a survey among Hungarian experts in the field of tourism [questionnaire in the Supplementary Material]. The survey contains four questions. For each question we asked for an approximation of the minimum, central, and maximum value. After the responses were collected, we calculated the means of the latter estimations. The resulting mean values were entered into the model through the following fuzzy numbers:

$$\widetilde{a}_{51} = (0.31; 0.41; 0.50), \widetilde{a}_{61} = (0.20; 0.30; 0.40), \widetilde{a}_{71} = (0.20; 0.30; 0.40), \widetilde{a}_{81} = (0.8; 1.1; 1.4)$$

$$\widetilde{a}_{52} = (0.28; 0.39; 0.50), \widetilde{a}_{62} = (0.16; 0.28; 0.39), \widetilde{a}_{72} = (0.16; 0.28; 0.39), \widetilde{a}_{82} = (0.7; 1.0; 1.4)$$

$$\widetilde{a}_{53} = (0.30; 0.43; 0.55), \widetilde{a}_{63} = (0.20; 0.31; 0.42), \widetilde{a}_{73} = (0.20; 0.31; 0.42), \widetilde{a}_{83} = (0.7; 1.0; 1.3)$$

The last column in Table 4 shows the elements of vector $\widetilde{\boldsymbol{b}} = \left(\widetilde{b}_1, \ldots, \widetilde{b}_8\right)^T$. The fuzzy numbers, $\widetilde{b}_{i's}$, were created in line with the following intuitive idea: consider the maximum daily capacity associated with the first constraint, $\widetilde{b}_1$. From HCSO, we know that the maximum number of bed places in hotels is 45,546. Based on this value, we created the fuzzy number (36,892; 40,991; 45,546), which indicates that the desirable number of occupied bed places in hotels is 90% of the maximum capacity (a value of 40,991), the minimum corresponds to 80% of maximum capacity (36,892), and the maximum represents 100% of maximum capacity (45,546). Using the same idea, we created the fuzzy numbers:

$$\widetilde{b}_1 = (36,892; 40,991; 45,546), \widetilde{b}_5 = (2734; 3038; 3375), \widetilde{b}_8 = (40,500; 45,000; 50,000)$$

$$\widetilde{b}_2 = (5311; 5901; 6557), \widetilde{b}_6 = (6184; 6872; 7635)$$

$$\widetilde{b}_3 = (36,357; 40,397; 44,885), \widetilde{b}_7 = (2809; 3121; 3468)$$

The fourth fuzzy number, $\widetilde{b}_4$, was created slightly differently. In this case, $\widetilde{b}_4$ represents the proportion of public transportation in Budapest (buses, trams, trolleybuses, and subway trips) associated with tourists. To our knowledge, there is no such information; thus, we asked experts to provide an approximation [questionnaire in the Supplementary Material]. According to the experts, the approximate proportion of public transportation accounted for by tourists in Budapest ranges from 7.3% to 18.8% of maximum daily capacity. Finally, based on the information provided by BKK Zrt., the estimated maximum daily capacity of public transportation in Budapest is 3,898,800 places, yielding the fuzzy number $\widetilde{b}_4$ = (304,106; 518,540; 732,974).

The solution of the FLP problem (2) was generated using the package FuzzyLP implemented in R [81,82]. Since the solution requires the use of ranking functions, we considered the following ones:

$$\text{Yager's } F_1 \text{ function}: \; R(\widetilde{a}) = \frac{1}{3} \cdot \frac{\left[\left(a^R\right)^2 - \left(a^L\right)^2\right] + \left(R^2 - L^2\right) + \left(Ra^R - La^L\right)}{\left(a^R - a^L\right) + (R - L)} \tag{3}$$

$$\text{Yager's } F_3 \text{ function}: \; R(\widetilde{a}) = \frac{L + a^L + a^R + R}{4} \tag{4}$$

where $\widetilde{a} = \left(a^L, a^R, L, R\right)$ is a trapezoidal fuzzy number, being $L < a^L < a^R < R$ real numbers.

Before introducing the results of our model, we reviewed the official information provided by HSCO. According to this institution, in total 5,694,027 tourists visited Budapest in 2019, staying at one of our three types of accommodation (TH, TO, or TP). This means that approximately 15,600 tourists visited the city per day (omitting the seasonality factor). Of these 15,600 tourists, approximately 11,269 (72.24%) stayed in hotels (TH); 1,378 (8.83%) stayed in other types of commercial accommodation excluding hotels (TO); and 2953 (18.93%) tourists stayed in private accommodation (TP).

Table 5 presents the estimation of the maximum number of tourists in Budapest using FLP. Considering our current information, the model suggests that the optimal number of visitors staying in hotels in Budapest is 7560 (right-hand side of Table 5) per day. Furthermore, we conducted a simulation study to explore under which circumstances it may be possible to accept more types of tourists into the city. Table 5 also displays the result of two selected simulations. In both cases, we modified the utilization rates associated with tourist attractions (the Hungarian Parliament Building, and the Széchenyi and Gellért baths), affecting three out of eight constraints of the model. The simulated utilization rates reported in Simulation 1 yield the optimal number of visitors: 9026 tourists staying in hotels, and 2643 tourists staying in other types of commercial accommodation. Similarly, the simulated utilization rates reported in Simulation 2 yield the optimal number of visitors per day: 8103 tourists staying in hotels, 5923 tourists staying in another type of commercial accommodation, and 991 tourists staying in private accommodation.

Table 5. Optimal number of tourists. Estimated result vs. Simulations.

Tourism System		Utilization Rates: Estimated and via Simulations			Optimal Number of Tourists		
		TH	TO	TP	TH	TO	TP
Tourist attractions (The Hungarian Parliament Building)	From experts	(0.31; 0.40; 0.50)	(0.28; 0.39; 0.50)	(0.30; 0.42; 0.55)	7560	0	0
	Simulation 1	(0.24; 0.28; 0.32)	(0.16; 0.20; 0.24)	(0.17; 0.24; 0.32)	9026	2643	0
	Simulation 2	(0.16; 0.23; 0.30)	(0.13; 0.17; 0.20)	(0.15; 0.20; 0.25)	8103	5923	991
Tourist attractions (Services of baths: Széchenyi and Gellért)	From experts	(0.20; 0.30; 0.40)	(0.16; 0.27; 0.39)	(0.20; 0.31; 0.42)			
	Simulation 1	(0.16; 0.23; 0.30)	(0.38; 0.40; 0.41)	(0.16; 0.23; 0.30)			
	Simulation 2	(0.13; 0.17; 0.20)	(0.18; 0.26; 0.35)	(0.16; 0.23; 0.30)			

The challenging problem of defining the optimal number of tourists in Budapest seems to be complex. In this section, we have made a first attempt to solve this problem using FLP.

5. Discussion and Conclusions

An initial objective of the study was to examine how the selected urban destination is affected by overtourism. First, the authors discussed the factors that caused overtourism in Budapest and presented the evolution of the marketing strategy in Budapest from the early 1990s to 2018 that resulted in unsustainable tourism in the city, associated with an ambiguous brand that focused on party tourism and cheap alcoholic beverages.

Second, the presence of tourists was estimated based on indicators such as tourism density and tourism intensity, the number of offerings in private accommodation, and total occupation in hotels. The calculation of tourism density and intensity at the district level revealed the uneven distribution of the former in the city. The center of Budapest (formed by districts I, V, VI, VII, VIII, and IX) was most affected by the presence of tourists in terms of the number of tourists per square kilometer and the number of tourists per resident. In contrast, districts XVI, XVII, XVIII, XXI, and XXII, which are physically far from the center, were less affected. This finding is consistent with that of Koens et al. [14], who stated that

the impact of overtourism was not city-wide and could predominantly be observed in the more popular parts of the city. In the context of Budapest, Remenyik et al. [6] detected the rapid development of tourism in all 23 districts, with the downtown districts most affected. In this area, the mass of tourists and their behavior reached intolerable levels for locals.

Another important finding is related to accommodation. The number of offers of private accommodation, including Airbnb, is highly concentrated in the center of Budapest (districts I, V, VI, VII, and VIII). According to our calculations, this zone concentrated 79.1% of all offerings. This fact might partly explain the phenomenon of overtourism in these districts. This outcome was reported by Smith et al. [7], who highlighted the highest density of Airbnb accommodation in District VII and its neighboring districts.

In reviewing the literature, no data was found in relation to determining the sustainable number of visitors in Budapest. However, studies have noted the importance of defining the optimal number of tourists [15,16,43,45,46] in order to plan and manage their influx [41]. In the present study we have attempted to specify the optimal number of tourists in Budapest using an unconventional optimization method called FLP. The aim was to maximize the total revenue generated by tourists in Budapest considering a set of limitations associated with the city—specifically, in terms of accommodation, public transportation, tourist attractions (the Hungarian Parliament building, and the Széchenyi and Gellért thermal baths), and waste production. The results suggest that the optimal number of tourists per day is 7560 staying in hotels, compared to the actual, approximately 15 thousand in the peak year of 2019.

The major limitation of this approach is associated with the availability of data. Hence, we suggest incorporating additional information that was not available for the present study. For instance, this could include more types of tourists (e.g., one-day tourists or cruise tourists that transit along the Danube River), or more constraints (e.g., number of seating places available in restaurants, bars, cafes, pubs, number of available parking spaces, capacity in theaters or museums, and the like).

The complexity of the city environment demands that more attention be paid to estimating the optimal number of tourists in Budapest. One policy implication is that the implementation of a centralized system might contribute to the periodic collection of the information required for analysis. The use of technologies can be helpful in the data collection process. For example, Camatti et al. [15] proposed employing new sources of data, including sensors, telecommunication data, cameras, and data from connected objects, for constructing new indicators. Pásková et al. noted that the utilization of TCC could be facilitated by recent advances in tourism studies and information technologies—namely, in the fields of big data collection, advanced data analysis, and modeling [17]. Another policy recommendation is monitoring the places visited by tourists in Budapest using different technologies. This information could be useful for thoroughly evaluating the phenomenon of overtourism in the city.

The data-driven management of visitors may be appropriate for regulating the tourist flows, local traffic, and housing sector. The regulation of private accommodation offers is seen as a significant means of alleviating the situation of overtourism in the downtown area of Budapest. We encourage the local authorities to implement more sustainable tourism strategies and policies by restricting Airbnb apartments in Districts V, VI, and VII, but encouraging their operation in Districts VIII, IX, and XI, and other places, as well as opening new hotels and other types of commercial accommodation on the periphery of the city. Overall, visitors should be dispersed to the less crowded districts of the capital. Thereby, the heterogeneous character of overtourism in Budapest calls for a careful investigation of this phenomenon at the district level.

In agreement with Koens et al. [14], we conclude that overtourism cannot be alleviated by focusing on tourism alone, insofar as the wider usage of the city should be considered. With the help of the insight and knowledge obtained from the application of unconventional analytical methodology, local authorities would be able to better monitor their policy responses and improve the urban infrastructure—for example, by promoting alternative

routes and attractions on the city outskirts. Increasing cooperation between multiple city departments and other stakeholders, including residents, is also advised.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/su14042268/s1: Table S1, Tourism density and intensity in Budapest and its districts, 2019. Questionnaire S1, Survey for experts.

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A Theoretical Concept of an Innovative and Sustainable Product Based on an Unconventional Approach to Design Development

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Abstract: Health security measures have become increasingly important in tourism, as there is a heightened need to rebuild the trust of tourists in destinations and tourism services. Innovative product development might help respond to the emerging health-related needs of tourists. We address the lack of the application of Designcommunication (DIS:CO)-based approaches in the field of tourism, present a process for the theoretical development of a smart device, and explore its applications. Combining the results of the qualitative inquiry and applying DIS:CO in research and development, the concept of 4S—traveling Safe, Secure, Smart, and Sustainable—emerges in a socio-cultural and economic context, supporting the foundation of the material realisation of the product. As a result, the 4S concept presents how customised, continual feedback on the health condition of the user before and during a trip, and notifications about possible health risks in different tourist areas, might facilitate the process of trust-building. Although data on unconventional tourists is not included in tourism statistics, the designed product can assist in gathering information about them, too. With the permission of users, the built-in functions of the designed product can be used to detect their position and direction of movement. The product also helps monitor the health of tourists by providing up-to-date data on infection levels to tourism service providers. In its passive mode, as a souvenir, the device strengthens travel desire.

Keywords: tourism safety; design concept; Designcommunication; unconventional approach; cross-border mobility

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1. Introduction

The novelty in our research is that we present a process of how Designcommunication (DIS:CO) and tourism can be connected in a way that results in the creation of the design concept of the product. The term "Designcommunication" is a patented expression (abbrev. DIS:CO), intentionally written in compound form referring to the definition of the term provided by its author, Attila Róbert Cosovan: Designcommunication = DIS:CO = communication integrated into development, according to the Hungarian Gazette for Patents and Trademarks (113. no. 12./I., 2008.12.15. Registration number: 196961). Interpreting the field of tourism as a context for design has become an increasingly common phenomenon. The field of service design seems to be a rapidly developing area. A strong customer-centred approach, combined with an academic understanding of both tourism and service design research, enhances both fields [1,2]. The branch of design theory that we work in can be identified as an example of human-centred design, applied in tourism in this case. The definition of Tussyadiah (2013) [3] (p. 548) of such approaches is that they can be characterised by an extensive awareness of the needs, wants, and expectations of humans, and the goal is to establish "a direct connection between the internal state of users, design characteristics, and the contexts of interactions between users and design". The DIS:CO theory and method fit this description, and thus can become excellent tools for development in the field of tourism. The application of DIS:CO facilitates concept formulation in a way that utilises the

capacity for creativity in the form of interdisciplinary collaboration without the limitations of a rigid process.

The travel restrictions put in place by governments as a response to the COVID-19 pandemic have not only affected tourism revenues worldwide [4,5] but have also changed the behaviour of tourists [6]. According to Irimiás and Michalkó (2016) [7], attitude is shaped by enduring beliefs and tendencies (such as hate or longing) in relation to objects or persons. The researchers also found that mood and attitude can greatly differ with the levels of emotion [7]. Travel craving can be interpreted as a context-specific construct that appears when people are unable to travel, either for economic or health reasons or due to external constraints [8]. Travel craving is not a precursor of actual travel, but a cognitive-emotional event in time that focuses on travel when it is not possible [8]. Previous tourism practices will no longer meet the changing demands of tourists and, as a result, actors in the tourism supply chain need to be prepared for the challenges of the post-COVID-19 era. This is by no means a return to 'the normal' we experienced before, but an adaptation to a changing and developing world that will never be the same as it was before the pandemic. In the post-COVID-19 era, tourism practices need to be redesigned, and an unconventional approach based on product design and development will play an important role in the process. Based on the findings of Freire-Gibb and Lorentzen (2011) [9] (p. 165), we created the theoretical concept of an innovative product that is built on the idea that "taking unconventional approaches leads to the creation of something special. When we work together, across all kinds of boundaries, we can achieve things that we could never accomplish alone." The B-bridge product concept [10] has been expanded on this basis in this paper. The tool theoretically created as part of the B-bridge concept, a bracelet, may play an important role in the restoration of tourist traffic to Budapest, may contribute to the incentivisation of domestic tourists to visit the Hungarian capital, and may result in longer lengths of stay. The idea of the B-bridge concept—the name of which was inspired by the bridges of Budapest—has served as the basis for the 4S (Safe, Secure, Smart, and Sustainable) concept of our new product created in response to the pandemic. The new product (which is also a bracelet), while active, constantly monitors the state of health of the tourist and, when inactive, functions as an accessory and souvenir. The designed product has the capacity to influence both the mood and the attitude of the wearer. In its active mode, it shapes their mood as a smart device that monitors their state of health and offers various services, while in its passive mode, it shapes attitudes by evoking the longing for the pleasant memories it recalls, which is a reflection of the phenomenon explored in the literature.

The paper is structured as follows: a description of the reasons that justify the need for the research and of the current situation of international tourism is followed by a presentation of the trends of new tourism such as safety, smart technology, and sustainability, based on the literature (Section 2). In the Methodology section, the research design (the formulation of research questions and the explanation of the qualitative research method) is described in detail. With the interdisciplinary approach of the scientific fields that our research is rooted in, we have identified six dilemmas that helped us formulate our research question. Our research question is: "How can sustainable product design and development support the prosperity of different tourism products in the new normal?" (Section 3). The next section discusses the results, for which the groundwork is laid by the findings of the qualitative research, and the 4S product concept is created. The idea behind the product is presented both from a product designer's and a user's perspective, supported by theoretical examples (Section 4). The paper is then closed with the conclusions that can be drawn from our research, the description of the recommended managerial implications (Section 5), and a review of the limitations of the study and of the possible directions for future research (Section 6).

2. Literature Review

2.1. Designcommunication (DIS:CO) as a Bridge between Society, Economy, and Design

Design, in general, translates to design art, creative design, and creative behaviour—it is now an integral part of business planning as well, and the popularity of the design thinking method is no accident [11] (p. 233). In the case of Designcommunication, it is combined with communication integrated into development, as the definition of DIS:CO [12] suggests. Studies linking design and tourism prefer to employ the specific and rigid process of Design Thinking (e.g., [13–15]). In the present study, we attempted to go beyond this iterative linear development model and chose the DIS:CO method, with possible exponential development in mind. As Cosovan et al. (2018) [11] suggest in the anthropological analysis of Designcommunication: it is a process where value creation takes place during a transitional rite, a value-oriented process that forms the configuration of designers' roles and the outcome at the end of the process. In the case of design thinking, this could only take place through a fixed routine and within the boundaries of pre-set creator roles. Designcommunication refers to utilising the perspectives and creative abilities of designers in order to solve open-ended problems within a divergent and unstrained process. The person or group utilising the DIS:CO approach and methodology gains transdisciplinary and interprofessional methods that can be used to create real-time links between education, research, and business [16,17]. DIS:CO is a relationship-building concept that emerges like a bridge between the phenomena of the various disciplines of society and the economy [11] and [17] (p. 36).

2.2. Safe and Secure Traveling

It is essential to clarify context in order for value creation to be realised through Designcommunication; thus, the theoretical background of related travel trends such as tourism safety, smart technologies, and sustainability are described in detail below. Efficient customer communication, strategy creation, the training of staff, and cooperation to ensure the quickest possible containment of the pandemic have become essential in this new situation and, as a result, tourism has needed to find new pathways since 2020 [18]. The popularity of domestic tourism grew dynamically in 2020 and 2021 since visitors were much more willing to choose nearby destinations during the crisis than more distant locations that were deemed less safe. Following the elimination of lockdown measures, the primary motivation behind touristic travel was visiting friends and relatives (VFR), which, beyond the reinforcement of personal relationships, also contributed to an increase in tourist traffic [19]. The COVID-19 pandemic also influenced the behaviour of tourists, since certain travellers chose to refrain from travelling in order to avoid the risks of the pandemic [20]. Thus, residents need to be encouraged to travel locally and visit local attractions, as it is their own country's or region's pandemic status that they know best, and they and their family can travel safely within the destination that they are residents in [21]. International research agrees that tourism first needs to be boosted through the promotion of domestic travel, and that will be followed by the growth of international tourism markets [22–24].

The popularity of local travel is not a new phenomenon—the concept of the "staycation" had already been present during the world economic crisis. The phrase was coined from the words "stay" and "vacation", and its message is that people can recharge even while staying at home. In this touristic genre, visitors do not leave their homes during the vacation, and make one-day trips to local tourist attractions or participate in locally available recreational activities [25]. According to the 2021 report of the UNWTO, staycations and holidays spent near the home will regain their popularity in the future, as they provide a sense of safety for visitors. In the post-COVID-19 era, travel will continue to play an important role in stress reduction, socialisation processes, and the reinforcement of interpersonal relationships, but the exploration of local recreational options will be prioritised, as proven by the research of Steen Jacobsen et al. (2021) [26] through the territorial example of the metropolis of Oslo. The research of Weman-Josefsson (2021) [27]

also confirms the market penetration of the staycation: 86% of the Swedish population reported that in 2020 they spent their summer vacation domestically, at a destination close to their home, instead of previously preferred destinations. With the gradual return of the demand for international travel, personal safety and the health safety status of touristic destinations (which have been increasingly important factors even before the pandemic) are becoming top factors in destination choices. In the future, the public health situation of locations will cease to be an independent tourism safety factor, and it will need to be harmonised with classic sustainability goals which will also need to be a reference point for regulation and educational strategies [28]. The pandemic has highlighted not only the difficulties around public health but housing inequalities and the related health effects as well. The restrictions put in place for the containment of the pandemic changed people's attitudes toward their homes, which became the sole physical location of their everyday lives, and as a result, became multifunctional spaces [29].

The restrictions that have regulated international travel during the pandemic will contribute to increased tourist traffic during the restart period, as people wish to remedy the frustration caused by long periods of confinement by travelling. According to the conclusions of Crompton (1979) [30], after the end of the pandemic, the tourism sector will continue to need to prioritise product development and marketing activities focused on unmet socio-psychological needs in order to increase tourist traffic. However, the longing for novelty may decrease the willingness to return, as a destination that has been once visited can no longer be considered a novelty. At the same time, even novelty-seeking tourists can be induced to visit again through efficient product development. The COVID-19 pandemic and its effects will not override the two dimensions of the process of choosing a destination, as internal psychological and external non-psychological considerations [31] continue to be important factors. However, the two dimensions will presumably be broadened by additional elements, and the relative ratio of their importance in the decision-making process will change. The internal factors that influence decision-making constitute the push factors during decision-making, which include (1) psychological considerations, (2) physical factors, (3) social interactions, (4) and searching/discovering. These include 11 additional subcriteria as well, such as escapism, prestige, the desire for recreation, and the maintenance and improvement of health. External factors draw visitors to destinations as pull factors, as tangible immaterial and intangible factors. The two-pull type motivational factors include an additional nine subfactors, such as transport options, personal safety, the attractiveness of the destination, and expected benefits [32].

2.3. Smart Technologies

Besides the negative effects of the pandemic, certain consequences can be interpreted as positive, such as technological innovation, the fast-paced development of the information technology skills of humanity, and the penetration of virtual reality in tourism. These have been proven to have contributed to and enhanced the wellbeing and satisfaction of people during lockdowns and travel restrictions [33]. Although virtual tourism has alleviated people's frustration during lockdowns, studies [34–36] have shown that it cannot replace in-person tourism in the long run; thus, new tourism provides destinations an opportunity for renewal. Currently, predominant trends include the increasing advancement of extended reality systems, condensed experience-seeking, and interactivity, since new and innovative forms of tourism have emerged as a result of the travel restrictions of 2020 [37]. Extended reality (XR) includes all immersive technologies. It covers all of those that already exist, such as augmented reality (AR), virtual reality (VR), and mixed reality (MR), and also includes those that are yet to be created [38]. Virtual reality transfers users into an environment that is entirely different from physical reality, namely, into a virtual environment created and displayed by computers. This, contrary to augmented reality, does not include elements of the physical environment [39]. The role of hyper-reality and virtual communities continues to grow and, as a result, traditional interpretative methods are obsolete for today's tourists, particularly for generation Z, who are familiar with the full spectrum of audio-visual

technology. Tourists wish to participate in this active, entertaining, and informative process with all of their senses. One of the leading segments that spearheaded innovative solutions in response to the pandemic was the meetings and events industry; countless events were transferred into the online space fully or partially (hybrid events) or were postponed to later dates. The 2020 Tokyo Olympics were eventually held in the summer of 2021, and individuals entering the venues of the event and potential close contacts were identified through innovative biometric face recognition software [40].

The challenges posed by the COVID-19 pandemic have also created an opportunity for accepting certain rules as the norm. These can be adjusted as needed during a potential future crisis situation and, as a result, humanity can be more prepared to combat infectious diseases. Wearing masks to cover one's nose and mouth, regular hand sanitisation, physical distancing, and contactless technology all make it possible for business activities to continue, albeit under different conditions. In tourism, these contactless technologies can replace physical menu cards through scannable QR codes, and make contactless hotel check-ins possible through mobile room keys, contactless payment methods, and orders that can be submitted through mobile applications [41]. Contactless, easily adaptable, and customisable automated tools and devices facilitate and efficiently support both front-office (such as check-in/check-out) and back-office (such as guest follow-up, aftercare, and marketing) tasks. In the new normal, companies and organisations in the tourism sector need to have solutions that can help them manage uncertainty through the utilisation of automated and contactless services [42]. Even after the COVID-19 pandemic subsides, travellers will need to remain prepared, keep the appropriate distance from one another, sanitise their hands regularly, and pay extra attention to personal hygiene, while touristic service providers also need to be prepared for having these rules respected.

2.4. Aspects of Sustainable Development

The concept of sustainable development was defined in the 1980s, and its generally accepted and widely known definition was developed by the Brundtland Commission [43]. The goal of sustainable development is meeting the needs of modern-day society in a way that does not jeopardise the needs of future generations, creating equality between the generations [44]. The idea of sustainable development is comprised of three main aspects: environmental, economic, and sociocultural dimensions. However, there is no unified consensus yet among researchers regarding the synthetisation and measurement of sustainability [45–48]. Members of the scientific community agree that the time horizon of sustainability is long-term [49,50] since sustainable practices—although they are capable of generating minor development even in the short term—can only yield real results in the field of touristic products and services if applied in the long term. Adopting a sustainable approach as widely as possible has become important for the mitigation of the negative effects of tourism; thus, the question of sustainability is being considered increasingly consciously by academics, tourism experts, and the tourists themselves [48].

The pandemic, despite the damage it has caused to tourism, is creating the opportunity for conscious change so that the sector can ensure long-term environmental, economic, and sociocultural sustainability. In the literature of tourism, sustainability was first understood as environmental sustainability alone, and researchers dedicated special attention to studying the subject [46]. Studies exploring environmental sustainability were increasingly focused on the investigation of the effects of climate change, and the ecological footprint of the tourism sector has proven to be rather large [51,52]. However, beyond the environmental factor, the economic dimension of sustainability also needs to be explored, as these issues can only be tackled jointly. The economic dimension of sustainability is the protection of the economic needs and the standard of living of the population [48]; in the context of tourism, this means that tourism-derived revenues need to benefit local residents as well. Being aware of the sociocultural aspect of sustainability is indispensable from a tourism perspective, as studies [53,54] have shown that environmental and sociocultural dimensions constitute the aggregated touristic resources jointly—that is, they are the defining

factors in the attractiveness of touristic destinations and the basis of touristic demand. A sustainable approach, besides its influence on the destination choices of tourists, is capable of inducing cultural change within a society according to Hediger (2000) [55], and this is what the innovative product presented in this paper could support. The sustainable approach represented by the product can be manifested in numerous ways. Traditionally, the environmental aspect was central for the designing and development of a sustainable product, and then a reflection on all three pillars of sustainability emerged [56]. The procedure contributes implicitly to the realisation of social equality and cohesion [57]. According to Santos et al. (2022) [58], in order to anchor this much more holistic interpretation of sustainability, a new paradigm needs to be applied in the case of touristic destinations. This theory needs to be manifested on the level of the product as well since the sustainability-related factors in product development are tightly connected to the concept of the circular economy and regenerative systems [59,60].

3. Methodology

3.1. The Aim of the Study

The relevance of the research is supported by the fact that opportunities provided by technological solutions supporting tourism are significantly increasing in today's digitalisation. This goes hand in hand with the challenges indicated by tourism megatrends and the need to provide solutions that support the safe and sustainable satisfaction of growing travel needs. The theoretical gap this paper aims to cover is that, although the interdisciplinary field of tourism is related to market-oriented fields such as marketing, more practical, design-oriented approaches to research and development are underrepresented.

The starting point of our interdisciplinary research was the following question: how can research and product development that support sustainable value creation be realised in the intersection of tourism, design, and marketing? Our goal is for theory and practice to manifest in an integrated form, and beyond research findings, provide a useful starting point for the creation of a concrete product in the future. This paper is the extension of our previous research [10,18], with our investigation extended to the subject of sustainability. While previously, [18] our objective was the reduction of pandemic-related health risks, this study and its findings aim to contribute to new tourism in a way that is sustainable in the long term, in the form of a concrete product concept that can be utilised in a practical way.

3.2. Research Question

The formulation of the final research question was supported by the process of creative dialogue based on Designcommunication [12]. DIS:CO "*is a unique perspective where 'communication' emerges simultaneously to problem seeking and solving and is coded into the product, service or procedure created*" [11] (pp. 233–234) and thus it is a design framework that can be utilised in various fields of society. The next figure (Figure 1) shows that, firstly, the common pool of researchers' and designers' subject-related questions was established in relation to the fields involved and their intersections. This method of formulating questions is in accordance with the approach of DIS:CO, as it can be understood as a form of creative connection building and creative behaviour that manifests on the level of dialogue between individuals [17].

The following dilemmas, connected to the various approaches and their intersections, assisted the process of formulating the research question through a designers' and creators' dialogue:

1. What will be the new norm of tourism?
2. How can design support achieving the new norm of tourism?
3. How can we design future-proof products in today's analog and digital worlds?
4. How can we create a sustainable product?
5. What types of products and services are there consumer demand for?
6. How can the new norm of tourism serve consumer needs?

The final research question was distilled as a synthesis of the above general questions:

How can sustainable product design and development support the prosperity of different tourism products in the new normal?

Sub-question used for qualitative research:

Q1: What are the important aspects of digital and analog lifestyles?

Sub-question used in DIS:CO product development process:

Q2: How can the aspired value (derived from Q1) manifest through a product concept?

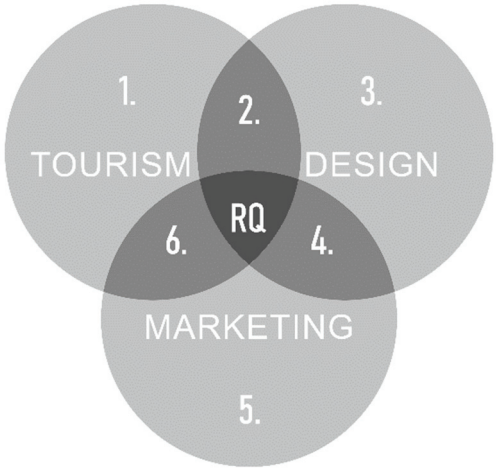

Figure 1. Mapping the overlapping interdisciplinary fields of tourism, design, and marketing. Source: author's own editing.

3.3. Research Strategy

For the exploration of the research question we formulated, we established a research plan that utilised several qualitative procedures and was multimethodological according to the definition of Morse (2003) [61] (Figure 2). It can be said that such an investigation was the combination of different methodologies, which in this case were qualitative. Thus, according to Harrison and Reilly (2011) [62], our work can be considered a multi-method integrative research project. It can be defined as a triangulated research model due to the involvement of several researchers and the various methods utilised [63].

The utilisation of a qualitative strategy is suited to understanding the interpretations of participants and can be used to explore the creation of meaning related to the phenomena. During qualitative research, the researcher observes the phenomena of the world in their natural environment and attempts to understand them based on the meanings that people assign to them [64].

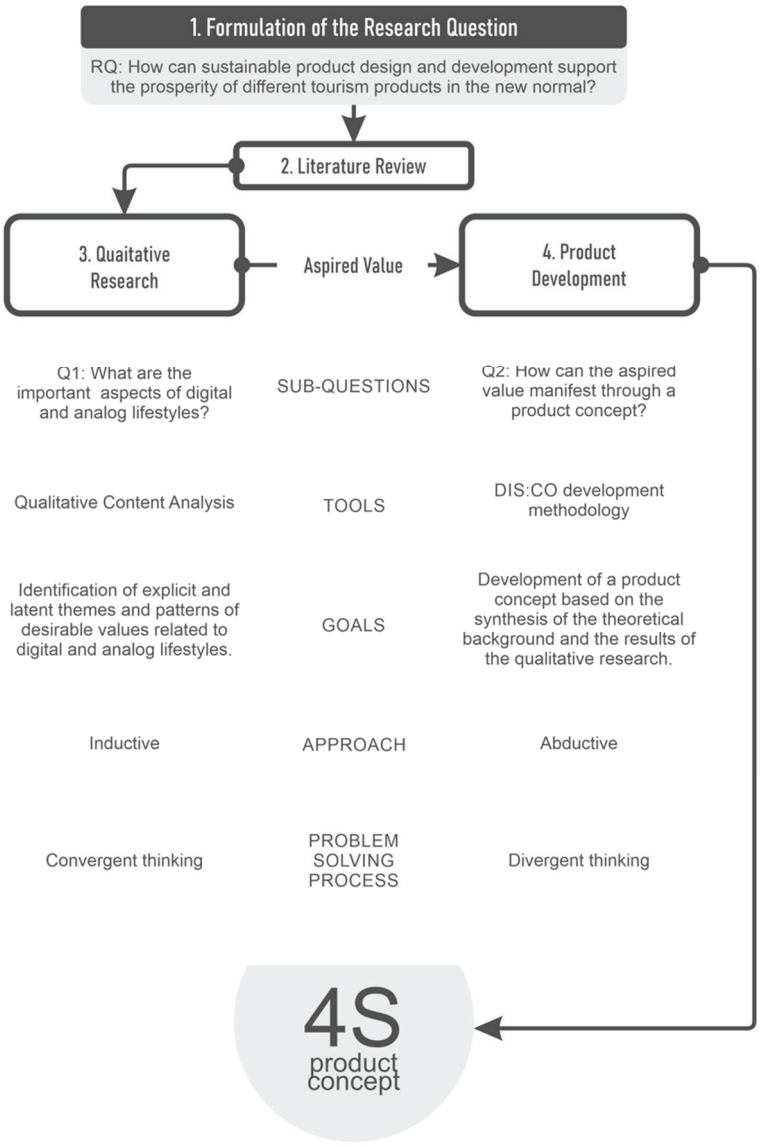

Figure 2. Research design. Source: author's own editing.

3.4. Data Collection and the Characteristics of the Sample

Our qualitative research was conducted on the basis of essays titled "Digital past, analog future" written by our respondents. The collection of the data that formed the basis for the study began before the pandemic, in 2018, and 150 essays were processed by September 2021. The data were derived from the essays of 1–2 pages of higher education students aged 20–25, written either in Hungarian or in English, either typed or handwritten. Due to the transformation of the socioeconomic environment induced by the pandemic, new opportunities arose for utilising our already existing sample. We analysed 100 essays from the pre-pandemic era and 50 from the period between 2020 and the end of data collection. In recent years, the subject of digitalisation has gained heightened relevance worldwide at virtually all levels of the operation of societies. Thus, the sample units of one of our research projects related to analog and digital product creation that was launched before COVID-19 has also been included in this research. As we had data both from before and during the pandemic, we had the opportunity to observe the changes in data patterns between these two periods. After the disclosure of the findings, we highlighted the phenomena that emphasised this change.

3.5. Analysis Phase–QCA

We analysed the data collected during our primary research through qualitative content analysis. The nature of the investigation was inductive, that is, the researcher started from the data and progressed upwards, and any theories were only guidelines. Researchers looked for, organised, and elevated to a more abstract level any patterns, categories, or themes observable in the empirical data. Qualitative content analysis (QCA) is a systematic analytical procedure. Its aim is to let us draw consequences regarding the patterns that are present in the text. This analytical method can be utilised for uncovering subjective interpretations through the identification and coding of themes and patterns found in the data [65]. According to Mayring (2000) [66], it can be said that during the utilisation of the QCA method, texts are analysed within the context of communication, and following pre-determined steps. These steps can be summarised as follows (Figure 3):

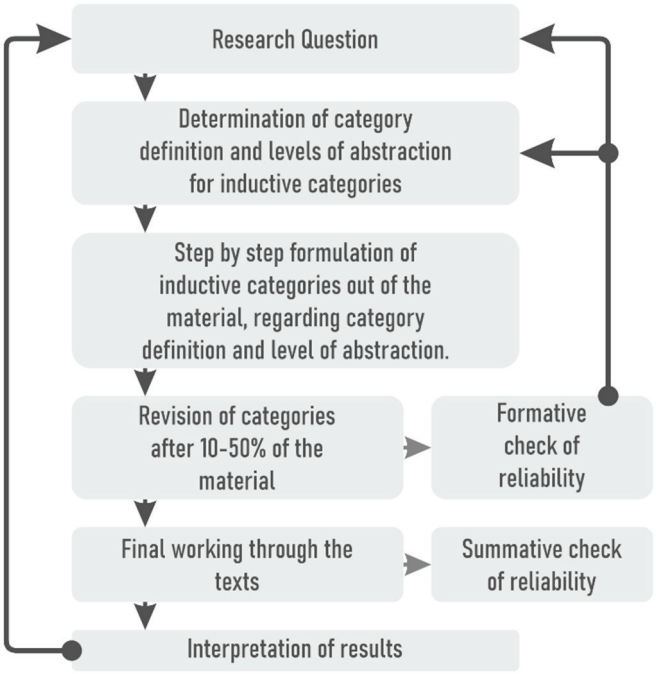

Figure 3. Steps of systematic qualitative content analysis. Source: author's own editing based on [66].

The QCA process is fixed. Raw data are categorised by themes that can be discovered based on patterns observed during the interpretation of the data, and on the basis of the relations between these patterns. Thus, the essence of the inductive analytical process is the careful investigation and continuous comparison of the data by the researcher [67]. As it can be seen in Figure 3, a qualitative content analysis goes beyond the level of words. It relies on the observation of themes and patterns to bring to the surface any explicit and latent content that is hidden in the text. This way, the social reality related to the phenomenon can be extracted in a subjective yet scientific way [65].

The data are coded and analysed manually and in an analog way. During the interpretation of the results, that is, the formulation of the aspired value, interim findings that were conflicted due to the differing outcomes of the three coders were consensually reduced to factors that were relevant for answering *Q1*. As an interpretation of the most relevant themes and patterns derived this way, the aspired value that formed the basis of the product concept was defined, and this was transformed into a product concept through the DIS:CO development framework.

3.6. Development Phase–DIS:CO Development Framework

Designcommunication (DIS:CO) is an approach and practice for designers and creators. Cosovan (2009) [12] refers to it as a philosophy that manifests through theory and practice.

The term is a compound word, in which design is understood as artistic design, creative design, and creative behaviour, while communication is understood as the designer's and creator's creative connection to building intent. The term is a patented expression and procedure. The method, originally distilled from the experiences of design art practice, has contributed to the creation of numerous internationally recognised products, such as the Red Dot Design Award-winning DSI Salt Inhaler, Teqball, Coco Dice, and Nosiboo products [68–71]. DIS:CO, beyond being a contemporary alternative to the widely known concept of Design Thinking [11], is also excellent for scientific research and for developing social and economic innovation [72]. Galla (2021) [73] and Horváth et al. (2018) [74] successfully utilised the method in secondary and university education and research. The utilisation of the method is justified by the fact that DIS:CO is a holistic framework in which the designer's toolkit is built upon the criteria of human needs, technological possibilities, and business success during the development of a creative product or procedure [11] (p. 233). Its most relevant element for the purposes of this study is the three-fold system of relations that can be described the following way (Figure 4):

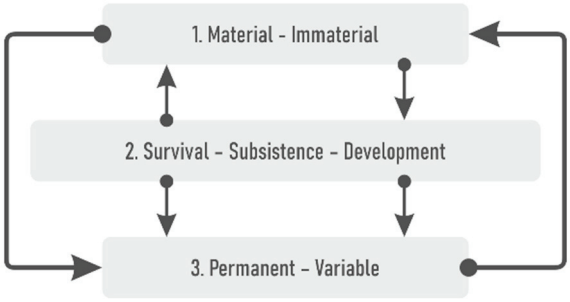

Figure 4. Cornerstones of DIS:CO research and development method. Source: author's own editing based on [12,16,17,70].

During the ritual of designing, the sequential development process of the listed dimensions is carried out in an unfixed order, in an iterative way: investigation of (1) Material–Immaterial qualities, the assessment of how (2) Survival–Subsistence–Development aspects emerge in the phenomenon, and the examination of (3) Permanent–Variable elements. This way, during the design phase, our research findings manifested in the form of a theoretical product concept, providing a basis for practical value creation as well.

4. Discussion

4.1. Findings of the Qualitative Research

We deemed the findings of our research (starting in 2018 and still ongoing) relevant for the formation of our concept. This longitudinal research provides an opportunity for the parallel investigation of pre-COVID-19 and post-COVID-19 results. However, a comparative analysis was not among the goals of the study. We considered the number of mentions and the frequency-of-mention throughout the whole sample, the direct interpretations of the statements of respondents, and the connections of themes observed in the text for the determination of the weight of particular themes, which increased with time. The following are the relevant themes and patterns identified this way, originally from the pre-COVID-19 era but also appearing in the post-COVID-19 era: (1) a rise in analog experience-seeking, (2) the recognition of the importance of in-person contact, (3) a lack of analog knowledge transfer and value creation, (4) the complementary role of digitalisation, (5) the connection between virtuality and separation, (6) topics related to a sustainable community lifestyle.

The definition of the meaning ranges of themes and a few illustrative examples (see Figure 5):

1. Analog experience-seeking: collecting experiences that require mobility, are real-time and are gained in a physical environment. Examples: 14, 7;

2. In-person contact: the reinforcement of personal relationships and the establishment of new ones in real-time and in a physical environment. Examples: 2, 81;
3. Analog knowledge transfer and value creation: the sharing of one's knowledge and experience with no transfer medium between individuals. Examples: 23, 112;
4. The complementary role of digitalisation: digital solutions support the acquisition of and the immersion in in-person experiences, but they cannot replace them. Examples: 56, 14, 99;
5. The connection between virtuality and separation: digital communication platforms can only alleviate the experience of physical distance partially, the quality of relationships changes. Examples: 56, 7;
6. A sustainable community lifestyle: the consideration of the wellbeing and sociocultural values of interrelated groups. Examples: 24, 114

Figure 5. Text-based examples to illustrate the identified themes. Source: author's own editing.

Based on the findings of the qualitative analysis and as a summary of these, the aspired value (the input of the next phase of our research) was determined. During the fourth phase of the research, the DIS:CO product development process, we aimed to create this aspired value through an open problem-solving strategy. As Dorst (2011) [75] (p. 524) describes the development process, "*we have to create a 'working principle' and a 'thing' (product, service, system) in parallel*" that can help create the aspired value we are looking for. We define the aspired value the following way: *Instead of virtual experiences, analog, in-person experiences are desired. Digitalisation should play a complementary role besides an analog (offline) lifestyle, supporting analog experiences*. In our experience-seeking society, besides the safety-related aspect of digital solutions, their role in the acquisition of desired in-person experiences is also particularly valued. Based on the results of this research phase, we were able to shape our concept in the product development phase described below.

4.2. Results of Product Development

The central element of our product development idea was adopted from extended analysis of our previous product concept [10,18]. Keeping with the bridge allegory used in B-bridge, the designer's connection building was built upon the identification of the pillars. Our goal was to integrate the words in the Safe–Secure–Smart tagline as product attributes, surrounded by the holistic approach of sustainability, and this is how the idea of an innovative product that supports tourism emerged. The result of our sequentially progressing research and theoretical creative process was the 4S concept. While it includes the dimensions of environmental and economical sustainability, our product is predominantly built on the idea of community wellbeing and value creation facilitated by sociocultural sustainability.

4.2.1. Safe–Secure–Smart–Sustainable: The Concept of 4S Travelling

The fight against the COVID-19 pandemic is proving to be successful, with vaccinations being utilised worldwide. As a result, tourism, one of the most important strategic sectors, has been able to resume. However, new waves of the pandemic caused by new variants make returning to the pre-COVID-19 state of affairs difficult. It is uncertain if we will ever be able to fully overcome this pandemic. There is also the risk of a global outbreak of another similar virus, which could repeatedly impede the operation of the economy. The current situation requires the introduction of new solutions and new tools and demands that we review and innovatively rethink our existing toolkit. The goal is to create a method, environment, and community lifestyle that is safe for everyone involved and that allows for a sustainable and continuous operation while curbing the spread of the virus. One of the keywords for this endeavour is contactless. As a response, based on our previously created B-bridge concept, we wish to develop a new tool concept that would facilitate fully contactless getting around for tourists of all types with any motivation behind their visit. The device stores data in the central application. These can be shared with a third party, and are part of an authentication protocol that may enable smooth entry to airports, transport vehicles, conferences, and other types of events that have potentially high numbers of visitors and therefore where the risk of infection is consequently higher. Additional data, such as previous illnesses or vaccination status can be added to the data package through an authentication process. The emergence of wireless technologies and the evolution of sensors worn on the human body have paved the way for customisable, wearable health devices. The control systems worn on the wrist continuously provide physiological data and information about the general state of health of the individual. Systems that monitor vital signs reduce health-related costs and improve the quality of life by preventing disease [76].

Tourists can actively use the device in a given destination; it offers various services and a wide range of information through an application. The device supports travel planning and management in its active mode and evokes travel craving in its passive status. The data generated during its use provide essential information for marketing and tourism researchers, and also contribute greatly to the mapping of unconventional tourism. The primary areas in which the product can be particularly helpful are the following: transport, public transport, cultural events, shopping, etc.

4.2.2. Description of the Device

The services and basic toolkit of the device we designed are identical to those of the product we created for the B-bridge concept, with the difference that it includes an additional sensor. This is an analog thermometer that is able to measure body temperature with precision. In the original concept, the device was fixed onto a bracelet, but it could also be fastened to the strap of an existing smartwatch. Utilising available technologies, heart rate values that may foreshadow certain illnesses can be detected on the wrist as well. An example of this is heart rate changes that occur during a state of rest, namely, heart rate variability (HRV). Through its measurement and the averaging of the results,

certain illnesses can be reliably predicted before the onset of symptoms. COVID-19 is one of these illnesses. In this stage, patients, although unaware of their condition, are already able to transmit the disease. Consequently, our device may play a role in combatting and preventing COVID-19 and other viral infections. Through storing the data processed by the device in an anonymous system and where it undergoes further processing, information can be gained about the infection level of a particular location or event, which is useful for users and organisers alike.

A large quantity of personal data is generated through the use of the device, which would be treated as sensitive data, in accordance with moral and security requirements. Stakeholders would be provided the necessary information about this, and accept the terms before they started using the device. The more versatile the available data the more efficient the operation of the system. We established two categories for the incoming and processed data: the first for the so-called anonymous data that ensure the operation of community services, the other category for detailed personal data. These are required, among other things, for organising medical care if needed and potentially for other forms of assistance or position detection. These data would not be public and would only be disclosed to the relevant authorities, with the consent of the user, and may only be utilised in an emergency or if immediate medical care was needed [77].

A worldwide pandemic that induces lockdowns affects human relationships, both on a personal and a community level. Becoming better equipped for managing or preventing a global pandemic requires the cooperation of multiple scientific fields, which can be assisted by digitalisation. We need to collaborate to reach our goal: we need to create a digital environment in which all parties feel comfortable and safe. Ethical and reliable data management is a part of this. We need to make use of the advances of digitalisation in order to be able to retain our analog values.

4.2.3. The Use of the Device in Tourism

The device we designed has the potential to make all touristic segments safer. The possibilities of its practical use will be presented through two theoretical examples. The meetings industry is one of the sectors that suffered severe damages due to the COVID-19 pandemic, and its fast revitalisation is key for the national economy. Each of the themes identified through our qualitative research is present in the field of business events; thus, this area is optimal for illustrating the practical application of the device. We have chosen youth tourism for the other tourism product because the pandemic has also affected the education plans of students in international higher education. Student mobility induces beneficial economic and sociocultural processes in host countries, and therefore supporting this mobility is important.

Theoretical example 1 (tourism product 1): Events contribute to the evolution of tourism and to the economic growth of destinations considerably [78]. The meetings industry, the fastest growing branch of tourism, has been affected by the dramatic changes that occurred in the wake of the sudden outbreak of the COVID-19 pandemic. To comply with the regulations set out by governments, huge numbers of events were cancelled or postponed [23,79], as in the case of the Tokyo Olympics. The strict travel restrictions also affected cultural, business, sports, and mega-events [23], while individual business travel has remained permitted throughout the pandemic. In-person business events could not be held for a long period of time. Subsequently, they could only be held with tight restrictions and some business events were transferred to virtual platforms. With regard to virtual events, both speakers and participants expressed that they missed in-person interactions. The device designed by us is excellent for supporting the participation of business travellers in business events, such as conferences and conventions, because it informs its wearer about their state of health even before the start of the trip, and in the case of illness, the user can connect to the event online, reducing their own and their employer's costs as well as the risk of transmitting any diseases. Beyond the monitoring of the state of health, the device also supports business travellers through additional information and contact

options: the application provides travel-related information (such as the entry regulations of different countries, transport, and accommodation-related information), and it can also be used to contact the organisers of an event. Users can activate the device in their own homes (1st activation point) or at the airport (2nd activation point), and it functions as an active smart device throughout their journey (Figure 6). The device is also fitted with a QR code scanner that facilitates contactless check-in into any event, accommodation, or other activity and, if approved, all data are registered in the system. The application helps with navigation, keeping to schedules, and organising transport if needed, while keeping health safety the highest priority. If the device detects signs of illness during the trip, it notifies the user discreetly and instructs them about the next steps. The user can make the decision whether to share that information and with whom. The application helps organise medical care if needed or navigates the user to the nearest testing centre in the given destination.

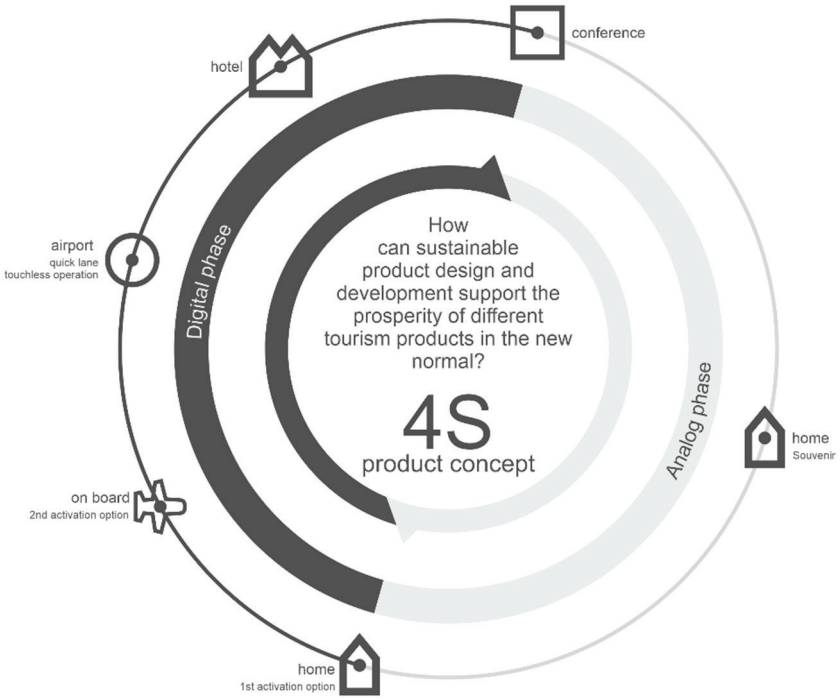

Figure 6. Theoretical example: product use by conference participants. Source: authors' own editing.

Theoretical example 2 (tourism product 2): Youth tourism (with special attention to students in education) plays a prominent role in all big cities [80]. The international mobility of students has grown continuously in recent years; however, this segment has not been left unaffected by the COVID-19 pandemic either [81]. In-person education has been replaced by online learning, especially in the case of universities [82]. Although certain studies [83,84] have found that students, following the initial shock, have adapted to the situation and have even discovered the advantages of online education, a combination of in-person and online education is a more favourable scenario for them [82]. As a result of the changes, many students have adjusted their international education plans [81]. The device designed for students, beyond strengthening their trust in the host country, provides them with practical help in transport, studying, administration, and navigation. Students receive and activate the device in their own homes (activation point), this way it can support them even before and during their travel. The device continuously monitors the student's state of health, and in the case of illness (high body temperature is the most frequent sign of infectious diseases), it notifies them, informs them about the next steps to be taken, and also supports them in connecting to the host country's online education systems. This device is not only useful for international students but can be made available to all students in order to ensure successful operation. This device can replace multiple

devices, as it is capable of storing data and managing bidirectional data traffic. The device facilitates contactless identification and communication efficiently; thus, it can replace student ID cards and library passes (among other things) and frees the parties involved from unnecessary physical contact.

5. Conclusions and Implications

This paper has been written based on a non-conventional research and design approach since qualitative marketing research tools have been utilised and combined through the product development process completed within a DIS:CO framework. In our previous research projects, using explorative research tools, we aimed to identify analog values; the lack of these analog experiences is difficult to manage even for individuals entirely socialised in a digitalised world. Through the coding and analysis of essays written by individuals aged 20–25, in addition to numerous retrograde objects and concepts, we saw the emergence of a concept that appeared with high frequency both in the case of digitalisation-oriented individuals and analog-oriented individuals. This concept was the importance of personal relationships. Human beings are predominantly analog social beings that need in-person contact [85]; the natural penetration of digitalisation had already overshadowed real, in-person personal relationships, and then an even more intensive use of digital devices following the outbreak of the COVID-19 pandemic further widened the distance between members of various groups. The relevance of our project is supported by these findings. It is in the interest of communities to regain the same collective standard of living that we had previously. Our project can also serve this cause, because if the goal is reached, it can facilitate safe community coexistence through minimal compromise, contributing to the general wellbeing of the community and to the stability of tourism—the investigated sector.

Beyond the basic concept, with its extended range of services, this device can also be utilised in tourism segments other than the two theoretical examples discussed, such as health tourism, cultural tourism, sports tourism, and shopping tourism, because cross-border shopping plays an important role in the Hungarian economy [86]. The device facilitates and simplifies entry into countries, transport planning, checking in into accommodation facilities, entering and participating in cultural and business events, and in the case of an emergency, the provision of healthcare.

During the development process, we prioritised staying rooted in the three dimensions of sustainability [48]. During the conception of the device, we defined characteristics that contributed to its sustainability. Its modular layout, the utilisation of durable materials, the high quality of manufacturing, and its reusability guarantee an increased lifespan. The purpose of this is a reduction in its ecological footprint. If new generations of the product will be created during future developments, those will be compatible with previous versions wherever possible.

COVID-19 has awakened humanity to the fragility of the social life and lifestyle of our society. At the same time, the fight against it will hopefully be successful, and we can soon restore our lifestyle and quality of life to its previous level. However, no one can guarantee that another pandemic will not break out. Our product can assist not only problem solving, but prevention as well, hence contributing to sustainability.

6. Limitations and Future Research

Due to the interdisciplinary nature of the presented process that combines research and development, it carries more risks than studies that utilise conventional procedures. We can identify certain limitations, and if they are addressed, other research projects combining similar procedures, or even a possible continuation to this study, can yield better reliability and utility. In conclusion, we wish to highlight three factors that we have identified as limitations.

The first one is connected to qualitative research. As for the production of the sample, the age of respondents remained within a narrow range relative to the whole of the

population; thus, the results gained in this phase provide an insight into the investigated phenomenon only from the perspective of a specific generation. Respondents became acquainted with digital technologies that entered their lives at approximately the same age and through similar socialisation processes. Thus, the significance of these and the attitudes towards them, while being somewhat varied, were presumably homogenous in comparison to the potential consumer segment of the product concept formulated during the design phase. The inclusion of other age groups and subjects, with more varied attitudes towards digitalisation, could contribute to the extension of the 4S concept to a broader audience.

The second potential research direction would be the adjustment of the details of the concept to specific market demands. Throughout the study, we successfully combined knowledge of tourism, a marketing-oriented research approach, and a designer's toolkit, since our primary goal was interdisciplinary value creation. However, a marketing-oriented review of the findings may reveal the fact that although the product concept we have formulated marginally explores the physical evidence and process dimensions of the marketing mix, the currently most developed concept of the product may need to be further supplemented, so that it can constitute a truly marketable product that is created according to scientific standards and supported by research. During the development of the whole of the marketing mix, specific target-market-related market research findings should also be utilised. Such information was not yet available to us in this phase, as the 4S product concept currently only exists in theory.

One of the important novelties the product carries is the interdisciplinary nature of the process through which it was created. Moreover, a noteworthy element is that the topics of tourism services and travel safety occur concurrently in the development of a wearable product. As an experimental approach, it is an interesting finding and useful starting point for value-centred product design and product development. However, to reach the level of social innovation, and to provide a basis for future research, it needs to manifest in a material form. A third future research direction would be the manufacturing of the prototype, the minimum viable product level production and post-production testing of complementary services and conducting research with the involvement of users.

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Subjective Bodily Experiences of Island Cyclists in Different Contexts: The Case of Hainan Island, China

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Abstract: A single subjective bodily experience is at the core of sports tourism activities, but the current literature on sports tourism largely ignores both the continuous and ephemeral experiential processes of individuals in mobile sports activities from a bodily perspective. In this study, we developed a "context–body–perception" framework and selected a sample of tourists from Hainan Island, China, in order to explore the embodied experience of cycling tourists, using a qualitative approach. We found that the contexts encountered by island cyclists could be divided into a human context and nonhuman context. The human context included the companion context, pan-companion context, and host context, and the nonhuman context comprised the natural context, mediated facility context, and digital technology context. The cyclists' physical experiences and perceptions in multiple different contexts were inseparable from each other, and both were embedded in a specific context through the five senses, through the state of body and activity, through emotions and memories, and through interaction with a specific context, all of which formed a dynamic feedback system. Through bodily practices in different contexts, cyclists acquired meaningful representations of their bodies, social relationships, and self-worth. The findings of this study can enrich the study of embodiment in sports and recreation areas, as well as provide an initial foray into bodily research in island-based cycling.

Keywords: bicycle tourism; island cyclists; embodied experiences; contexts; Hainan

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1. Introduction

The development of sports tourism is recognized in many countries as a way to better avoid the seasonality of tourism [1,2]. Bicycle tourism has been one of the most important niche markets for sports due to the greater flexibility, accessibility, and environmental friendliness of the activity itself [3]. It first emerged in Europe and the United States during the late Victorian and Edwardian boom in Irish tourism and has become increasingly popular around the world ever since [4,5]. In the context of tourism, the bicycle is not simply a means of transportation or equipment for sport, but a medium of interaction between cyclists and the environment as well [6]. Furthermore, because most bicycle rides take place through transitions between places, cycling shows great potential for integration with other tourism activities [7]. Although cycling has received much attention within sports research, there are few research perspectives that combine the sport and tourism attributes of cycling.

Another key aspect of cycling and tourism that has received little attention is the cycling mobility experience. Combined with the definition of cycling tourism put forward by Ritchie, the cycling mobility experience refers to the use of bicycles as the main means of transportation during the mobility process, or where bicycles play a very important role during a tour [8]. Current studies have deconstructed various cycling phenomena around the themes of cycling infrastructure [9], the socio-economic impacts of cycling [10,11], cyclists' motivations and

preferences [12,13], and cyclists' embodied practices [14]. Although some scholars have explored the embodied practice aspects of cycling, most of these research findings have focused on the subjective experience more so than on the body of travelers [15]. However, the bodily experience is most memorable and important, which can be triggered by the variability of the environment and encounters with human and nonhuman elements during a ride [16]. These encounters in turn frame diverse contexts, giving rise to different meanings that constitute the whole cycling experience.

Unlike tourism by conventional transportation, bicycle tourism, which is more autonomous and embodied, is an unconventional mobility experience that allows cyclists to relate to a wide range of places and space [17,18]. However, such a research theme has not received sufficient attention [19]. Most previous studies of tourism and transportation have separated travel and transportation; however, the new mobility paradigm challenges this view [20]. It argues that no point or space is completely isolated and advocates a relational turn, emphasizing the connections among elements [19,21]. However, studies on the bicycle tourism experience are still described in a more traditional, static way [3,12]. Bicycle tourism not only has the typical human–land connection characteristics, but also allows cyclists to actively experience the natural and human environment of cycling in depth [17–19]. It also allows them to gain both explicit and tacit knowledge in the process [18]. Therefore, we adopt an unconventional mobility perspective and a relational geography approach to explore the relationship among context, body and mind, and perception in bicycle tourism. This study can further compensate for the neglect of previous studies on the tourism transportation experience. It also complements the study results on the relationship between tourism activities and subjects under the transformation of the new mobility paradigm.

Against this research background, this article attempts to explore further, through qualitative research, which contexts island-based cyclists encounter in their cycling using independent bicycle tourists on Hainan Island, China. What are the processes of the cyclists' embodied practices in these contexts? What kind of meaningful representations does the embodied practice of cycling bring to these cyclists? The specific research process is as follows. First, we found the gap in previous studies based on a literature review and constructed the "context–body and mind–perception" three-dimensional theoretical framework that guides this paper. Second, this study collected data through a mobile ethnographic approach, and the authors also accumulated a large amount of primary data from several Hainan rides. The data cover the types of contexts generated, the outcomes of the physical and mental perceptions, and the learning and understanding of explicit and tacit knowledge in multiple contexts. Finally, we analyzed the themes that emerged from the data in conjunction with the theoretical framework to arrive at our perspective.

2. Literature Review

2.1. The Embodied Experiences: Context, Body, and Perception

The field of phenomenology and the emergence of embodied cognition influenced by phenomenology have pushed people to rethink the role of the body [22,23]. Concern for the concept of embodiment originated from Heidegger's concept of "being" and Merleau-Ponty's concept of "embodied subjectivity", which affirms that the body and mind are one [24]. Phenomenology emphasizes the body as the subject that shapes our perception and cognition in various environmental forms. As Merleau-Ponty argues, the body is not only a part of space, but is also integrated with the mind as a prerequisite for people to perceive space [25].

In the process of understanding space in the context of the body, human beings are capable of producing numerous contexts based on their cognition, and these contexts can be used to help perceive the world through certain rules [26]. More precisely, the term context as used here refers to a tendency to structure different factual elements by combining them in multiple different ways by forming different contexts to reflect different information through different relationships [27]. In the course of their activities, subjects

form different contexts by establishing connections with human and nonhuman elements, and the individual bodily sensations and perceptions formed in these contexts reflect their characteristics [28].

These contexts are not completely neutral but are influenced by the process of embodied practice, subject identity, and cultural contexts as well [29]. This notion of context is in line with what Polanyi calls cognitive conditioning, where he argues that there is a very complex field emergence mechanism behind the cognitive activities that occur in us [30]. The knowledge acquired in such contexts is distinguished between explicit and tacit knowledge [31,32]. In Polanyi's work, tacit knowledge and explicit knowledge are two opposing concepts. The former refers to "silent," "unspoken" knowledge, while the latter refers to "explicit," "articulate," and "clear" knowledge [32]. In contrast to explicit knowledge, which can be expressed in words, diagrams or formulas, the acquisition of tacit knowledge is based on individual behavior [31,33–35]. It is always associated with a specific situation and has unconscious characteristics, and it is difficult to be expressed clearly in words, language, images, and other explicit forms [20,31,36]. Among human practical activities, there is focal and subsidiary consciousness. In his book, *Personal Knowledge*, Polanyi also mentions that the realization of individual skills in cycling is a state of "not knowing how it happens", and in cycling tourism, too, individuals have a great deal of unspoken and unexpressed tacit knowledge [31,36].

While the exploration of embodied contexts is still ongoing, researchers generally accept that the way a subject's body structure, senses, and motor systems operate affects his perception of the world, the way he thinks, and the content of the various contexts he forms about space [37]. For tourists, the "context–body–perception" interaction has also been reported in some tourism studies. Liu argues that honeymooners form their initial impressions of the honeymoon destination through the operation of five senses (the senses of vision, hearing, smell, taste, and touch) [38]. The involvement of the body and the functioning of the bodily senses form the important experiences in honeymoon tourism within the confines of a tourism context, which in turn contributes to the generation of tourism cognition, and the results of bodily functioning and perception, in turn, have a counter effect on this tourism context through the mediation of individual behavior. Thus, the body and mind, perception, and context in the embodied experience of honeymoon tourism are organically integrated. Mertena found that tourists create human and nonhuman contexts during the flow of a train ride as well [39]. Here, the human context includes emotional experiences formed by talking with companions and playing games, the rhythm of the train machinery, and the bodily movement experience brought about by the train track. In this nonhuman context, the train as a transportation intermediary brings the tourist unique experiences when passing through different geographical environments.

In summary, the dynamic relational mechanism established between perception, the body, the environment, and various contexts provides a way of thinking about the process by which humans make sense of the world. Constraints serve as connections between elements of a context, and they may be natural laws, conventions, logical rules, empirical analysis, or law-like correspondences [26]. Thus, the body and a subject's perceptual outcomes are both referents and constituents.

2.2. Bicycle Tourism

Sports tourism experiences are generated by the interaction of the two more fundamental experiences of sport and tourism, and embodied experience is also a particularly important part of the tourism experience [40]. The tourist experience is at the core of what draws people to engage in tourism, and it covers four dimensions: individual emotional experience, experiential learning, physical ability enhancement, and spiritual transformation [41]. The mobile experience of cycling is different from the traditional touring mobile experience [42]. For example, cycling requires more use of the legs, and the visual and auditory sensory experience is a complex, dynamic process [43]. In addition, bicycle tourism gives people a certain sense of control, which is expressed in the individual's active

regulation of body and senses during the cycling process. Take the travel rhythm as an example: the speed of travel depends entirely on an individual's physical capabilities and will. As long as the cyclist wishes, he can interrupt the trip at any time, reduce the cycling speed to zero, and enjoy the scenery.

Differences in cycling type also bring about differences in mobility experiences. For long-distance cyclists, the perception of "space" and "place" plays an important role in the cyclist's embodied tourism experience [44]. Riding not only gives people a mobile perspective on people, things, and objects but also constructs a panoramic mobility experience together with other senses such as touch and smell [45]. Riders can also become emotionally connected through mobility [46]. Furthermore, for cycling mobility, the speed formed by the interaction between the bicycle and the outside world is an important stimulus for the cyclist's emotional arousal. Meanwhile, a change in speed and velocity also can trigger different physical experience output results [47].

In summary, a cyclist's travel experience is complex and dynamic and comes from the continuous process of collision and contact with various elements of that particular mode of travel [48,49]. Although some scholars have focused on analyzing cyclists' embodied experience, their research has been more empirical, which can lead to insufficient theoretical development. Therefore, it is necessary to examine the various contexts that cyclists generate during their activities, from a physical perspective but also from their encounters and perceived outcomes when riding in these specific types of environments.

3. Methodology

3.1. Study Area

For this article, we chose Hainan Island in southeastern China as a case study. Hainan Island is known as the "Hawaii of the East" and is one of the world's most important tropical destinations, with rich tourism resources, well-organized cycling, and excellent infrastructure [50]. As of 2020, including the third top international cycling event in Asia, the "Tour de Island", China's Hainan Island has held fourteen international road cycling races, and its high profile as a result of the "Tour" race has continued to attract cycling enthusiasts from both China and abroad, creating a strong cycling tourism atmosphere. With its newly created, island-wide "Sports Tourism Demonstration Zone", the Hainan Provincial Government has also now incorporated the island-wide cycling tourism industry into its new round of overall tourism planning [50]. Hainan cycling routes are primarily divided into the East, West, and Central routes (see Figure 1), each with its own characteristics and charm. The East route has the most densely populated towns and has a deep cultural heritage; the West route is relatively challenging, slightly less convenient, and has relatively small towns; and the Central route is more difficult to ride and requires climbing up hilly and even mountainous terrain.

Figure 1. Diagram of the Hainan cycling routes.

3.2. Research Framework and Data Collection

From the literature review, it is clear that the physical sensations and inner perception of tourists are inextricably linked to the environment they experience. The embodied experience of a cyclist is influenced by a variety of situations arising from the interaction of subject and object [51]. More precisely, tourists learn about a place through practice and establish relationships with it [52]. This active participation creates a dual relationship between individual and place by using tourists' physical sensations and psychological perceptions as tools. In other words, tourists will encounter different situations in their tour that will affect their emotions, memories, senses, etc. In turn, this multifaceted embodied experience simultaneously keeps the context constantly changing.

This article combines the objective space, body space, and the third space (perceptual space) proposed by Merleau-Ponty, and uses the conceptual framework of an embodied experience, including body and mind, perception, and context (Figure 2), to explore the process of diverse bicycle tourism experiences [25]. Our conceptual framework emphasizes that the interaction between body, perception, and situation influences tourists' meaning construction and cognitive outcomes in tourism spaces and explores the specific effects of diverse situations on tourists' physical experience and perceptual outcomes.

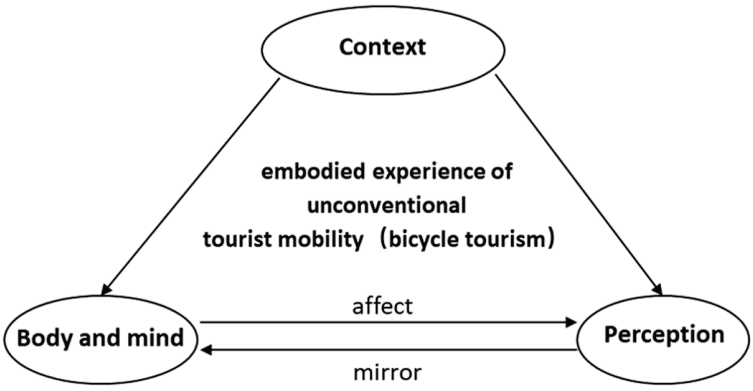

Figure 2. The "context–body–perception" embodied experience framework.

In the conceptual framework we use, the context is consistent with the Gestalt context mentioned by Polanyi. Both refer to the field generated by the subject during the participatory activity. Explicit knowledge and tacit knowledge are mixed in the rider's physical and mental feelings and perception. At the consciousness level, according to Polanyi's view, this paper argues that explicit knowledge in bicycle tourism includes information about the destination, riding skills, and knowledge of other equipment. The tacit knowledge includes the individual's perception of the destination based on his or her own experience, and the individual's unspeakable cycling experience formed through the concrete practice of cycling. The individual's body and the bicycle cooperate during the cycling process. Finally, explicit knowledge and tacit knowledge are interconnected and integrated.

This study focuses on mobile ethnography to collect data. Nonrepresentational theory suggests that there is a lot of information to be found in people's behavior and nonverbal mannerisms [53]. Therefore, to learn more about nonverbal content, a researcher should be physically present in the research setting to pick up on the original intent of the subjects [54]. Furthermore, the mobile ethnography method allows researchers to shift between different contexts and participatory experiences randomly with the cycling "companions" and "pan-companions" with whom they are on the move. This can allow a researcher to conduct semi-structured interviews to obtain tangible representations of physical and psychological feelings, companion relationships, and electronic media use during the ride. It can also help him to observe and collect nonrepresentational content, such as the physical characteristics, emotional changes, and companion emotions of cyclists [55].

The field researcher for this article interviewed and observed a total of 23 cyclists in depth, subsequently excluding 3 invalid samples, to obtain a total of 20 high-quality,

in-depth interview samples for follow-up analysis. The interviewees' information is shown in Table 1. In addition, the authors also self-reflected during several rides and recorded their reflection results, and they were also able to obtain some high-quality web texts from other cyclists' blogs (35 people in total) that involved the sharing of photos, event experiences, and moods and feelings during their rides. The collected original texts were integrated and theorized with text analysis methods, and the key categories extracted from the texts were then linked several times with the analytical framework through qualitative methods to help form generalized conclusions.

Table 1. Profiles of the interviewed cyclists.

Code	Residence	Gender	Age	Traveling Method	Interview Time (Times)
F1-LWL	Guangzhou	male	26	companionship	3 h (2)
F2-XC	Guangzhou	male	24	companionship	2 h (3)
F3-NCC	Beijing	male	26	companionship	3 h (2)
F4-TJH	Shenzhen	male	31	companionship	1 h (1)
F5-NJY	Guangzhou	female	46	personal	1 h (2)
F6-SC	Hangzhou	male	38	companionship	2 h (2)
F7-DDM	Hangzhou	female	34	companionship	1 h (2)
F8-TXL	Guangzhou	male	23	personal	0.5 h (1)
F9-YJ	Shantou	female	39	companionship	1 h (2)
F10-JM	Shenzhen	male	21	companionship	3 h (2)
F11-CYC	Chengdu	male	41	personal	0.5 h (1)
F12-XF	Guangzhou	female	20	personal	2 h (2)
F13-NJD	Shenzhen	male	33	companionship	2 h (2)
F14-DJ	Guiyang	female	21	companionship	3 h (2)
F15-FYT	Guangzhou	male	48	personal	1.5 h (2)
F16-LY	Zhuhai	female	34	companionship	0.5 h (1)
F17-ZMM	Shanghai	female	22	personal	1 h (2)
F18-XB	Liuzhou	male	26	companionship	1.5 h (2)
F19-ZXH	Shanghai	male	35	companionship	1 h (2)
F20-LYH	Changsha	male	24	companionship	0.5 h (1)

4. Findings

4.1. Cyclists' Embodied Experiences in a Human Context

The "companion context" is one of the most important human contexts for cycling. Riding companions are informal groups formed to engage in cycling activities, and the behavior and personality of members have an important impact on the physical and mental experience of the cyclists involved [56]. Importantly, however, not all individuals in such cycling teams have the same purpose and power. For example, the lead rider (F2-XC) controls the team's movement speed and human–ground interaction activities, which may take more energy than simply enjoying the scenery along the ride. The riders in the middle tend to be emotionally stable and their body movement speed is derived from the riders in front of them. Riders at the end of the fleet tend to be tense due to the possibility of disengaging from the team at any time. Because of the unstable nature of cycling activities, the position and power of the cycling team may change with emergencies, and the change in the role of cycling companions may be influenced by the cyclists' physical qualities, age, gender, and family structure [57].

The term "pan-companion" refers to cyclists who have a spatial and temporal intersection with the individual cyclists in Hainan in this study, and encounters between "pan-companions" may occur at nodes or during a linear journey. During a journey, accompanied by pan-companions day after day, pan-companions may become cycling companions. However, in most cases, the physical interaction between them is simply due to their relational distance; for example, a simple social interaction with a thumbs up and a wave while on the road, as F19-ZXH said:

> *Every time we meet cyclists on the road, we will give a thumbs up, shouting to each other to cheer.*

What follows is a typical example of tacit knowledge being transformed into explicit knowledge and changing the individual's behavior. In the process of cycling, cyclists often

experience incidental events that are like "people in the mirror", reflecting on themselves in the flowing landscape composed of others and adjusting their physical ridging behavior, as one of the lead cyclists (F11-CYC) mentioned:

> *In that section of the seaside highway section, we saw the trash left by other cyclists and felt that it would be harmful to marine life, so I reminded my companions to behave [in a] civilized [manner] throughout the ride.*

Additionally, the human context also includes the "host context". Unlike traditional tourism, the large number of stopover nodes in cycling activities promotes the generation of special human–ground interaction experiences [19]. To ensure the completion of cyclists' activities, residents provide materials for cyclists' physical and mental experiences in different venues and bring cyclists rich stimulation for their vision, hearing, smell, taste, and touch. When cyclists enter a series of town nodes from the sparsely populated cycling trails, the first sensation they encounter is the visual change, from the natural landscape to the more human landscape of the town, such as the streets, local food stores, ethnic minority residents, and special transportation, and all become objects of the cyclists' gazes. Sensory experience is accompanied by the accumulation of explicit and tacit knowledge; for example, unlike the food culture of the hometown of cyclists, Hainan's tropical climate helps the locals create unique and delicious dishes that bring wonderful treats to the rider's mouth and help restore and heal the rider's body and mind, as cyclist F12-XF pointed out:

> *After the meal, the tour leader took us to a dessert store to eat Hainan Qing Tonic Liang and mango intestinal noodles, which not only neutralized the greasiness of dinner, but also took away the fatigue of the day.*

Accommodation is also an important part of the cyclists' experience throughout the ride. For cyclists who sleep in the wind, only simple facilities and clean, comfortable accommodation are needed, but for others the services and facilities of the local hostel also bring multiple sensory experiences to cyclists.

4.2. Cyclists' Perceptions in a Human Context

Embodiment theory asserts that a subject's perception is generated by the experience of the body interacting with the environment and that the body plays a key role in this process [58]. In both the "companion context" and the "pan-companion context", travel companions can have a positive arousal effect on unknown and challenging activities. In other words, riding companions and "pan-companions" can help individuals with negative emotions during long rides. In addition, in team riding, the competition and cooperation among riding companions can enrich individual physical practice, strengthen relationships, and form a sense of group identity and shared memories. Both explicit and tacit knowledge plays an equally motivating role here; for example, the explicit knowledge represented by cheers and slogans of encouragement, and the tacit knowledge conveyed by the silent leader of the pioneers. Cyclist F2-XC recalled:

> *There was a long uphill climb that I was ready to give up on, it was already 7 pm, almost dark and I was extremely exhausted. But with the encouragement of my fellow leaders and the encouragement of the group ahead of me, I persevered little by little over the rainforested mountains to reach the destination.*

Of course, in any companion context, conflicts may occur among cyclists sparked by events such as route finding, destination selection, and unexpected accidents during the ride, and negative emotions such as anger, rage, hard feelings, and sadness may occur, affecting the way cyclists behave and feel psychologically among their companions.

In the "host context", tourists can empathize with certain elements of the destination context through diverse embodied practices, triggering their past emotions or memories. Along the long-distance ride in Hainan, the information gained from the various senses of the cyclists in the "host context" always evoked microscopic feelings from the cyclists, contrasting and reflecting on their original life. This is because of the implicit knowledge

embedded in the scenes of island life, which is silently conveyed to cyclists, as cyclist F11-CYC said:

> *On the ride, you can always see the Hainan countryside surrounded by coconut groves. Every house has a hammock, and everyone will go to the teahouse everywhere to drink tea and chat. It seems that people do not have any worries, which reminds me of the leisurely days before I started work.*

Some of the scenes that cyclists see in the "host scenario" make them feel relaxed, comfortable, or full of admiration, and also evoke their memories of a "stress-free" and "leisurely" life. In addition, the individual behavior of the hosts also plays an important role in the emotion generation and memory recall of the cyclists. Sometimes cyclists may even inadvertently participate in local festivals, religious ceremonies, and other folk activities. These host individuals and diverse folk activities can remind cyclists of the similarities and differences in their cultural backgrounds in the context of local images and cultural perceptions.

4.3. Cyclists' Embodied Experiences in a Nonhuman Context

The nonhuman context consists of a natural context, mediated facility context, and digital technology context. First, the "natural context" is one of the most important nonhuman contexts that riders experience. The contemporary natural aesthetics theory believes that people need to perceive the world through the five senses to make the true aesthetic characteristics of natural objects appear [59,60]. Hainan, with its unique natural geographic location and multi-ethnic intersection, has formed a diverse natural landscape that is distributed in different forms in the spatial and temporal range of the Hainan cyclist's path.

However, there are times when natural environmental conditions exceed the limits of the body; for example, in some extreme weather (such as typhoons) cyclists have to leave the field temporarily and give up the physical and mental experience of island riding. In addition, the elements of the natural environment are constantly changing during the flow of the ride, triggering the body to pay attention to the natural environment and driving the body to change the rhythm of its movement. For example, the direction of the mountains, the distribution of the sea, and the status of plants and animals in the activities not only bring cyclists a diverse sensory experience but also limit the position, direction of movement, and forward speed of the cyclists' body, as cyclist F11-CYC said:

> *The section to Changjiang Li Autonomous County was hell for the body: 130 km, headwinds, many slopes, and an overall rising altitude. [I was] so physically and mentally exhausted that I doubted my life, and all the body's senses were numbed in the final sprint.*

Second, a " mediated facility context" in a "nonhuman context" refers to the context created by the cyclist during the bicycle experience. Transportation plays a mediating role in the mobility of a traveler and influences the extent to which he/she is involved in the road space. In contrast to automobiles, the mobility of bicycles can shape the experience of particular human–terrestrial interactions during the cyclist's activity [47]. A cyclist's experience generation is accomplished in part through the bicycle, and this mediated experience is more susceptible to factors such as the weather, road conditions, and the cyclist's abilities. However, a cyclist stays at more nodes during a riding tour compared to mass transit, so the cyclist's body interacts with the external space more frequently, presenting him with more travel options as a result. For example, cyclists are free to choose their riding routes, from national highways, provincial roads, county roads, and even country roads, and they get to form visual, auditory, and taste sensations different from those of mass tourism. In addition, cyclists also commonly experience discomfort in specific parts of the body due to bike overuse, such as wrist, knee, and hip pain, as cyclist F2-XC recalled:

> *On the first day of the ride, after less than 50 km, I started to feel vague pain in my leg muscles after almost a year of no exercise, and my buttocks started to burn because of the hard saddle of the bike. My knees were not ideal even though I had brought knee pads.*

Third, the "digital technology context" also belongs to the "nonhuman context". The rapid development of digital technology, the Internet, and mobile devices has changed travelers' behavior and influenced both the content and methods of travel experiences [61]. As a result, digital contexts require riders to use more explicit knowledge to engage. In particular, a mobile phone, as a vessel for "total media", with various functions such as a camera, Internet, music, and navigation, plays an important role in cyclists' activities. Research has shown that rhythmic music can make exercisers more relaxed and persistent [62], and the "cooperation" between cell phones and headphones can provide cyclists with just such an external rhythmic power. Furthermore, the music, through the auditory system, can have a regulatory effect on the cyclists' functions, spurring the auditory and motor states to interact. Music not only relaxes the muscles and nerves but also gives cyclists a broader spatial and temporal connection. A cyclist's body and mind, perception, and context all fit together in the rhythm of embodied movement to achieve a harmonious state of cycling. In addition to communication devices, some cyclists also carry GoPro sports cameras, bicycle recorders, drones, and other devices. These can provide technical support for recording the whole process of cycling, extending and enriching the limited sensory sensations of the cyclist's body.

4.4. Cyclists' Perception in a Nonhuman Context

Merleau-Ponty argues that we in the world must experience and perceive things with a priori knowledge and a biological body as a mediator [25]. For the cyclist, the "natural context" provides the raw material for perception, while the mediating aspects and digital technologies equipped on a cyclist's body enrich the results of his perception. Therefore, cyclists have the opportunity to feel happy as long as the subject perceives the beauty of nature [63]. The natural context is not only the explicit knowledge of appearance, but also has the potential to bring about unexpected behavioral adjustments in the acceptance of tacit knowledge by the riders. For example, in the process of natural landscape transformation, a rider's body and mind in the repetitive and ordinary monotonous natural landscape are more likely to be affected by the negative feelings of exhaustion and dullness brought about by riding long distances. Cyclists are also more likely to have negative emotions, such as frustration, regret, sadness, feelings of difficulty, and helplessness.

A diverse combination of natural landscapes or landscapes with greater impact than what a cyclist is used to may allow a cyclist to show greater willingness to ride continuously during a ride, and to relax physically and mentally in a wonderful riding environment, as cyclist F6-SC said:

> *On the road to Wanning, the scenery is really great, first the endless blue sea, and then the lush [greenery]. The tropical rainforest behind, in such a shocking scene, feet pedals are also more powerful, and the fighting spirit is also higher even if tired but also uplifting.*

In addition, in contrast to mere static images, the flowing natural landscape during the ride itself can also have a significant impact on an individual cyclist's vision, which is conducive to triggering the psychological tendency of those engaged in cycling activities to want to continue. Because of the special mode of transportation and the formation of the "intermediary context", shuttling in Hainan's various remote corners can also form a different perceptual experience for cyclists who travel there. For example, the end of the journey of the cyclist will not lose the flow of space and may still bestow profound observation and reflection. Cyclist F11-CYC said:

> *After ten days of cycling around the island, passing through villages, towns, and then cities along the way, you can feel the development of the times and the change of people's needs, as if you are witnessing the sculpting process of history for space.*

During long road trips, the bicycle creates a mobile experience of both "connection and separation". The "connection" refers to the cyclist's ability to travel around Hainan by bicycle as a means of transportation, to see the natural and human landscape at a more appreciable speed of movement, to perceive space and the landscape in depth, and develop a love and preference for space and place. As bicyclist F5-NJY believes:

> *I have been in the city for too long, and I feel that riding in such a good ecological environment can make me and nature become one.*

"Separation" is a way of movement in which the cyclist, although deep in the cycling space, always uses the bike as an intermediary to travel and gaze, and there is often a sense of separation from the outside world, as cyclist F19-ZXH said:

> *I am sitting and observing the environment around the bike.*

However, throughout a long ride, a cyclist may also become integrated with the bicycle, gaining a deeper sense of road space and physical experience. The practice of cycling requires coordination between nearly all parts of the body, and during the cycling process, a cyclist's body and mind can gradually become more in tune with the bicycle as intermediary equipment.

Cyclists use their bikes to perceive changes in the road environment as well. Changes in road material, slope, route direction, and type may also trigger emotional changes and memories for cyclists. Additionally, the convenient and low-cost communication method of the Internet, supported by digital technology context, has facilitated cyclists' travel-sharing behavior. The cyclists recorded their images and "self-gaze" during the ride through cameras, cell phones, and other media, while other users of social media liked to comment on what they shared, giving cyclists a sense of accomplishment, satisfaction, and other positive emotions. In addition, the cyclists used electronic products to record the sensations of the body while also strengthening the cyclist's sense of conquest and control over the natural space of the ride. Cyclist F2-XC mentioned:

> *What I read in a magazine said that the motivation for humans to take pictures during travel is similar to hunting activities in the primitive society period. The long lens of the camera is like a pair of wild eyes in the jungle, aiming at the prey, only now the prey is replaced by a photo.*

The space and place in the cycling journey are recorded in multiple media with digital technology support and form a unique cycling space between individual recollection and group memory sharing in the future. With the selection of new landscapes to explore, more riding spaces may be filled with riding places that are full of emotions and subjects' perceptions, thus drawing a treasure map of riding places.

4.5. Value Generation of an Embodied Experience in Different Contexts

In the tropical landscape of Hainan Island, cyclists arm themselves with cycling tools such as bandanas and sunglasses. In this way cyclists can travel through different types of geographic areas and road systems, temporarily distancing themselves from their original social identities and immersing themselves in cycling activities. In a differentiated environment such as this, cyclists can reawaken their anesthetized, mechanized bodies and feel the purest natural projections and reactions of their bodies, such as breathing, muscle aches, and bodily pains. In addition, the body goes through a "rhythm cycle" consisting of a painful period, an adjustment period, a climax period, and a final sprint period during a long ride.

In addition, deep social interaction is important to cyclists in ephemeral spatial experiences [50]. In long-distance cycling, cyclists and their companions gradually construct inner connections and their mutual relationships shift from the weak relationship of strangers to the stronger relationship of acquaintances. Moreover, cyclists open themselves to each other and construct both a self-identity and group identity. Therefore, cycling activities go

beyond physical movement and become a ritual of personal relationship production and emotional connection in the cycling space.

In the process of bodily practice, cyclists experience multiple levels of suffering and pain and generate a new self with a tough character and multiple types of cognition. During a ride, cyclists unconsciously socialize with other cyclists or the host, which involves the exchange of explicit knowledge such as local tourist information. Moreover, a cyclist's body can serve as a social mirror image, and the better body shape and appearance achieved by cycling activities may inspire praise and commendation by other individuals inside the cyclist's social network; that is, the objective experience of cycling can trigger a rider experiencing truth [17] and complete self-growth while awakening body consciousness.

5. Discussion

Because they employ a mode of mobility different from the usual means of travel of the general public, cyclists are freer to choose the content and intensity of human–place connections and to face more complex contexts, resulting in the special embodied experiences. Therefore, this paper explored the types of contexts encountered by cyclists during island cycling, as well as the physical experiences and perceived outcomes encountered by cyclists in different contexts (Figure 3). Our specific findings are reflected in the following areas.

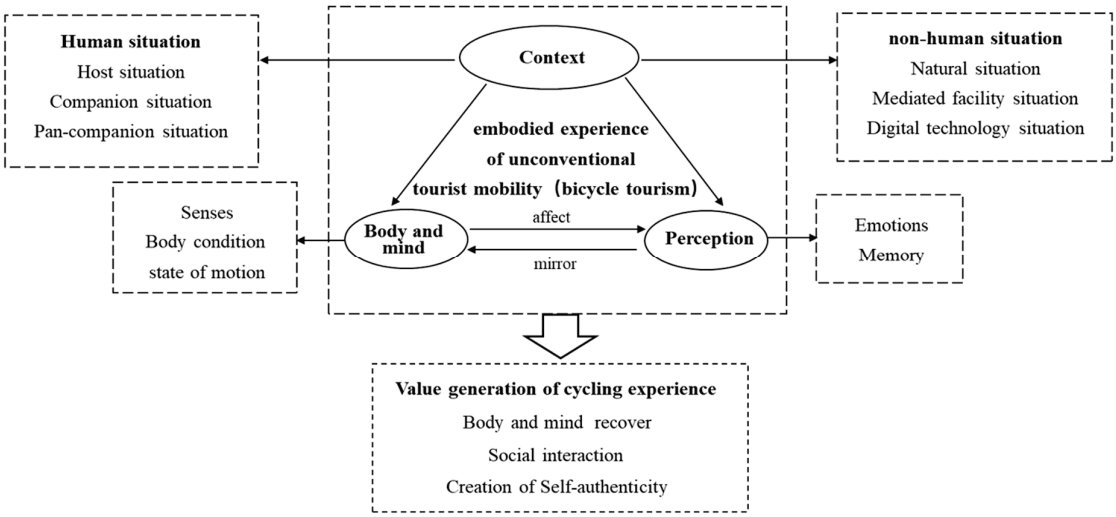

Figure 3. Diagram of the embodied experience mechanism of cycling in Hainan.

First, the contexts encountered by cyclists in the Hainan traffic circle include human and nonhuman contexts, and the combination of these contexts constitute their cycling experience system. The environmental variables that limit cyclists' physical experience and perceived outcomes include the road network characteristics, the natural environment, the social environment, and the building environment. In addition, cyclists gain embodied experiences in mobility ranging from visual experiences to multisensory experiences [19], and this paper also analyzed the micro-practices of embodied senses such as taste, smell, and hearing in mobility experiences one by one. Han found that the main components with the greatest perceived value for cyclists were tourism attractions, accessibility, amenities, and complimentary services [9], and this study identifies the key elements that influence embodied experience and uses this as a basis for classifying contexts into human and nonhuman contexts. Among these contexts, the human context included the companion context, pan-companion context, and host context, and the nonhuman context included the natural context, mediated facility context, and digital technology context.

It is worth mentioning that during the Hainan ride, cyclists gained explicit and tacit knowledge in the embodied experience of different contexts. These two kinds of knowledges are interchanged in certain behaviors. Polanyi argues that an individual's consciousness is composed of focal awareness and subsidiary awareness in the context to which the

behavior is associated [31,32,34–36]. Associated with the bicycle tour context, the "focal awareness" is the target point of the act of cycling, while the body's senses are used as "subsidiary awareness" to serve the "focus awareness" of cycling [31,34]. However, in order to accomplish the action of "cycling", both "focus awareness" and "subsidiary awareness" are indispensable, and it is not necessary to say which is more important. The basis of an embodied experience is based on bodily sensations, and from the above analysis, it is clear that bodily sensations are used as a kind of "subsidiary awareness", which Polanyi calls "tacit knowledge". This "tacit knowledge" is integrated into the action of "cycling", thus forming the embodied experience of the rider's final ride.

Second, as mentioned by Shipway, there is a unique interaction between the cyclist, the cycling environment, and the activity, but the mechanism or process of this interaction has rarely been explored [64]. This paper finds that different contexts generated by the cyclists together with their bodies and perceptions constitute a dynamic system. As for long-distance cyclists, the local community plays an important role in the cyclist's travel experience, as a node for cyclists to resupply and rest [18]. In this study, we also found that hosts are important actors in providing embodied experiences for cyclists, providing them with the basic physical needs such as food, clothing, and shelter. Embodied experiences in a nonhuman context mostly cover the direct and indirect contents of the natural environment, intermediary facilities, and digital technology products that help cyclists gain physical experiences and perception. The natural landscape not only serves to heighten a rider's multi-sensory experience but also limits the direction, rhythm, and energy efficiency of his body, while the changes in the grade and combination of the natural landscape itself can trigger emotional changes. This finding also agrees with Han, Meng, and Kim's research that natural elements, such as plentiful natural resources and weather, are important experiential elements in cyclists' mobile visuals [9,65]. As the main mediating facility during cycling, the bicycle is the main tool for cyclists' mobility and observation, and cyclists gain unique physical and mental experiences by using it to interact with the outside world. In addition, while previous studies have rarely explored cyclists' use of digital technology to enrich a specific context and their embodied experiences, this study expanded cyclists' context perspectives and developed encounters within a digital technology context that not only broaden the cyclists' sensory experiences and physical abilities but also facilitate further storage of the nonrepresentational contents, such as memory and emotions, for the cyclists' subsequent reconstitution of their cycling trips as historical experiences.

Third, there is still a lack of attention paid to the interpretation of the cycling space in shaping the experience of cyclists, but in this paper we made a series of explanations of the cyclists' experience in their relevant space [64]. For example, during the cyclists' entire ride, the places along the route were not only physical spaces, but also generative spaces filled with individual emotions and memories. The cyclists were far away from the space of daily life, free from the atomized and disciplined body of daily life, and returned to the life-state body, a form of embodied practice that Levers called "anti-rhythmic" [66]. Human beings are social animals and need to enter into social relationships. Riding with a partner or multiple partners not only enhanced the emotions of the fellow riders during the ride but also formed beneficial social interactions with many hosts, satisfying cyclists' innate human interpersonal needs. This finding is similar to that of Xu's study where cycling was found to help consolidate old social relationships and possibly also enable new ones to be established during brief social interactions [50]. Unlike the mobile stage deliberately shaped by cycling events, independent cyclists in Hainan, China, were more random and freer in their choice of context. For many individual cyclists, cycling is an embodied practice driven by their random combination of routes, landscape choices, and accompanying intrinsic motivations, and the stage it creates lacks the political intentions of large-scale sports promotion and local showcasing of sports events [45]. Instead, for these riders, cycling is more of a self-actualization process for individuals pursuing their dreams and discovering their true selves.

6. Conclusions

Understanding the different embodied experiences of sports tourism requires exploration of specific sports tourism contexts. Therefore, to explore the embodied experiences of independent bicycle tourists in tropical islands, this study used qualitative methods to analyze the human and nonhuman contexts and their bodily sensations and perceptual outcomes in different contexts. We believe that the cyclist's body and mind are inseparable, and that the two become one in different contexts. Moreover, these unique physical sensations and perceptual outcomes both help cyclists restore their physical and mental rhythms, strengthen social relationships, and discover a new aspect of themselves. This paper further enriches the application of existing embodiment theory in tourism experiences and expands the study of the integration of sports and tourism from a micro analytic perspective. In addition, we also incorporated Polanyi's theory in our study, giving examples of explicit and tacit knowledge that cyclists may acquire during their rides.

Tourism riding experiences, from the embodied perspective, are the result of the interaction of a series of related elements, such as perception, body, and context, in the tourism process. Therefore, tourist destinations that feature cycling may attract more tourists if they optimize the various contexts encountered by cyclists, create a more personalized cycling environment, develop cycling routes, and regularly maintain cycling infrastructure. Moreover, bicycle tourism product providers may want to focus on the design of cycling routes so that they switch between diverse landscapes, highlighting the regional characteristics of the landscape to bicycle tourists. In addition, governments or other entities who wish to promote the bicycle tourism market may want to form a complete spectrum of bicycle tourism products, as high-intensity bicycle tourism activities may not be suitable for all people, and there is a need to develop a diverse range of cycling tourism products to meet the requirements of the different groups.

This paper makes a useful exploration of island-based cycling experiences through a three-dimensional embodied theoretical framework, but the breadth and depth of the original materials obtained in this article are limited. In addition, the article lacks an analysis of the differences in context types and embodied experiences of the three main existing cycling routes on Hainan Island. There are several directions for future research. First, suitable distance and psychological testing equipment can be used to obtain various aspects of the cyclists' physical data during cycling to help reveal the dynamic relationship between cycling distance and cyclists' physical and mental rhythms more scientifically. Second, the similarities and differences in the physical experience and perceived results of individuals under different mobility modes, such as self-driving tours, motorcycle tours, and hiking tours, can also be explored. Finally, further research is needed on the physical sensations of cyclists in various nodal stops to explore the physical and perceptual differences between these stops and the cycling process itself.

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Suitability Evaluation of Popular Science Tourism Sites in University Towns: Case Study of Guangzhou University Town

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Abstract: With the advent of the knowledge economy, universities have increasingly important roles in cities. However, some universities and cities are still fragmented, and popular science tourism is one way to solve this. The purposes and destinations of popular science tourism differ from those of traditional tourism. Consequently, their resources have a high development value for ecological and human resources. However, research on popular science tourism in China is still in its infancy. Here, we studied popular science tourism from a geographical perspective, selecting scale capacity, environmental level, resource level, location, and service conditions as factors to construct a judgment matrix to calculate the weights of indicators at various levels. Analytic hierarchy was used to build a popular science tourism evaluation system for Guangzhou University Town as a case study and the suitability of each tourist destination in the university town was evaluated. The results show that west Guangzhou University Town is more suitable for popular science tourism than the east, which possesses more value for popular science tourism development. Finally, we give recommendations for developing popular science tourism in Guangzhou University Town.

Keywords: unconventional tourism; popular science tourism resources; development suitability; evaluation system; geographic information system; Guangzhou University Town

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1. Introduction

1.1. The Development of Science Tourism and the Role of Universities

With the improvement of education and the cultural level of tourists, traditional sightseeing tourism can no longer meet the personalized and diversified needs of tourists; thus, science tourism, which is a knowledgeable, educational, engaging, and entertaining form of tourism, has emerged to supplement traditional tourism. Traditionally, schools and universities are places where people learn and conduct research [1,2]; however, few consider them to be potential tourist destinations. In spite of this, popular science tourism has emerged with the purpose to gain knowledge and learn more about emerging technologies, rather than entertaining and relaxing; this is also known as "spiritual fulfilling tourism" [3]. Universities are at the forefront of scientific development and can fulfill people's needs; however, universities often do not provide accommodation outside the university grounds. If universities can work with residents of the surrounding area, then university towns can become a new kind of fully serviced tourist destination and become unique growth points for the tourism industry.

In 2015, China set out development goals for the next five years of building a moderately prosperous society, becoming an innovative country, and becoming a world power in science and technology. For these goals, the popularization of science is a key aspect and has great social significance. The "13th Five-Year Plan for Building a National Science Popularization and Innovation Culture" (from here on referred to as "the Plan"), formulated by the Ministry of Science and Technology and the Central Propaganda Department

as part of the "Outline of the National Strategy for Innovation-driven Development" and the "13th Five-Year Plan for National Science and Technology Innovation" emphasizes the importance of the popularization of science. The Plan states that science popularization can enhance the level of social civilization, improve the quality of the ecological environment, promote the spirit of science and popularizing scientific knowledge in society as a whole, raise awareness of science and technology and scientific quality, and improve the ability of the population to solve practical problems and participate in public affairs.

Some scholars have defined science tourism resources to be the key to science tourism [4–6], believing that science tourism resources are "the sum of various natural and social factors that occupy a certain geographical space in nature and human society, and have special scientific and cultural values, and can be attractive to tourists, and can be exploited by the tourism industry, and produce scientific and cultural dissemination effects." Scholars have provided suggestions for the development of science tourism in specific cities, considering the science tourism resources in the area [7–9]. Science tourism industry projects started earlier and have achieved more than universities. Industrial science tourism is the most successful form of science tourism, mainly involving automobile manufacturing enterprises, such as Hyundai in South Korea, Toyota in Japan, Renault in France, and Volkswagen in Germany. However, with the rapid changes in science and technology, science tourism is gradually moving toward cutting high technology. The high-tech café project is a current research hotspot and universities are the best carriers for it [10]. In recent years, with the advent of the knowledge economy, universities have taken on additional functions and responsibilities, such as being sustainable parts of the city's futures, cultural icons and symbols, hearts of urban innovation, and suitable places for employment [11]. Therefore, campuses now emphasize the links among creativity, higher education, and urban life. These physical and functional links with the wider community and urban fabric can help improve the competitiveness, productivity, and cultural strength of a city [12,13] and should be considered before a university or university town is built. Some cities and their universities provide us with good examples, as shown in Table 1.

In general, as well as playing roles in teaching students, universities are important for the development of their respective cities. From the above analysis of the relationship between renowned universities and cities, it can be concluded that the beneficial relationship between cities and universities is mutual [21]. The knowledge economy has had the effect of breaking down traditional boundaries between campus and city. Modern universities are the most fertile intellectual environments and are no longer specialized cells; they are becoming accessible, giving ordinary people access to the most cutting-edge knowledge and technology [22]. In China, universities are still in their early stages of development, with campuses cut off from their cities and are gradually facing the challenge of transformation. One way to help integrate the campus and the city is through science tourism.

For the development of science tourism in China, most scholars in recent years have focused on the existing natural resources in their study areas, such as wetlands and parks, and designed science tourism routes based on these [23–26], while ignoring the role that universities could play in science tourism.

As pioneers of academic science and technology research, university towns are the birthplace of many recent scientific and technological achievements. For example, a university in a university town in Guangdong Province demonstrated the latest technology in pollution control to the public based on its own environmental technology innovation platform [27]. As a result, compared to conventional tourism, science tourism is more focused on the dissemination of knowledge and technology and often offers a more in-depth experience. Moreover, some research show that due to COVID-19, people are now more likely to choose short trips, while focusing more on destinations that are more than just leisure [28,29]. As a result, popular science tourism, especially in a university town that is close to the center of the city, becomes a good choice for most people. Travel companies and universities can design travel products based on various technologies already available,

such as tracking through personal registration information, government, or analysis based on reviews of travel software [30–32].

Table 1. Some famous universities and their role and functions in cities.

University	City	Roles and Functions
Chicago University, Northwest University, and University of Illinois at Chicago	Chicago, United States of America	A leisure center for the city's inhabitants, a central place for the development of the city's scientific and technological strength, an important cultural center and tourist destination for the city. Creates many jobs and contributes to the economic development of Chicago [14,15].
Cambridge University	Cambridge, United Kingdom	A model of city–university integration, the University of Cambridge has broken down the traditional boundaries between campus and city in its construction. The city provides the environment for the university to develop, and the university provides the city with a humanistic foundation and heritage, enhancing its potential for development. In the current and future plans, the University of Cambridge serves as part of the heart of the city, providing services and leisure to the surrounding community, while also using advanced technology to replicate the traditional Cambridge scene, allowing more people to choose Cambridge or Cambridge University as a travel destination [16].
University of Technology Sydney	Sydney, Australia	Located in the heart of Sydney, it has a complete infrastructure and is designed without clear boundaries with the surrounding neighborhoods (i.e., no fences). Therefore, the school provides a recreational space for the surrounding neighborhoods and allows for the initial practice and popularization of advanced technologies, which can be combined with practical technological improvements while promoting them. In addition, the school improves the sophistication of urban governance through alliances with planning and municipal authorities, while also repositioning the city to external investors and knowledge workers [17].
Arizona State University	The city of Phoenix, United States of America	The university is an important part of the development of the City of Phoenix, providing jobs, the latest technology, and training for the city's workforce, as well as providing the nearby community with a recreational area of shopping, dining, and other functions. In turn, the city provides funding, space, and policies to support the university's development [18].
Hönggerberg site of ETH Zürich	Zürich, Switzerland	The transformation from a traditional campus to a community center is a typical example of campus-led regional development. The campus is surrounded by a high density of housing and shops, providing a recreational space for the surrounding population (e.g., Leerpark Dordrecht, West) and promoting high-tech experimentation [19].
Washington University	Seattle, United States of America	The University of Washington has strong ties to the surrounding community and downtown. It is also a center for weekend recreation for city residents. As part of the urban landscape, the University of Washington provides residents with a place to relax and promotes all aspects of the campus and gives citizens a taste of the latest technology [20].

University towns have considerable potential as foundations for science tourism. Guangzhou, an innovative city in the southern coastal region of China, is equipped with many excellent educational resources at all levels, from primary schools to universities, owing to its advanced level of economic and social development. However, these resources are in urgent need of development and are expected to be planned based on local realities [33]. In addition, some scholars have pointed out that tourism can have edifying and practical functions [34] and science tourism, as a form of tourism that integrates knowledge and tourism, is better suited to these functions. If university towns are included in the design of popular science tourism routes, the distance between the public and universities can be reduced. Subsequently, the advantages of university towns in promoting science to the public can be introduced.

In Guangzhou, representative science resources, such as the South China Botanical Garden and the Guangdong Science Centre, have been developed in recent years, gradually becoming essential attractions for science tourism in Guangzhou; however, universities do not currently play a role. Guangzhou University Town, which contains many universities and resources for science tourism, is a pioneer in the development of university towns in China. Using Guangzhou University Town as the starting point for science tourism using university resources in China, its influence on science tourism can be used to inform other university towns in China on how to promote science tourism and expand the scope of science tourism in China. In addition to university resources, Guangzhou University Town contains a wealth of other types of tourism resources, such as Guangdong Science Centre, Lingnan Impression Park, and the Wetland Park, making it easy to explore the linkage between university resources and other natural or humanities and social science resources in the development of science tourism.

In general, science tourism outside of China is more developed than that in China [35,36], which is still in its infancy. Although science tourism projects started earlier in certain countries, these are mainly industrial projects, and they are gradually moving towards high technology. During our survey, we found that though some universities held these activities for a few years, there is a lack of data about science tourism in universities, especially visitor data. This is due to the fact that most universities do not pay attention to registering and keeping data on the number, age, and gender of visitors when organizing science tourism, but only as a basis for verifying the presence of visitors. It can be found that the current university science tourism, as an emerging unconventional tourism project, is in great need of formal guidance and training in terms of supervision, record keeping, and other areas.

There is an urgent need to strengthen theoretical research and technical improvements to fully explore the potential of the science tourism industry and to enhance the value of science popularization.

1.2. Land Suitability Evaluation

In terms of land suitability evaluation, different scholars have provided unique insights. In his theory on land suitability evaluation, McHargue advocated that a suitability analysis should be carried out according to the natural properties of the land to ensure the value of the land to the natural environment and introduce the economic value of the land. This viewpoint is also applicable to the suitability evaluation of science and technology tourism sites [37].

At present, suitability assessments of tourism sites generally begin from the perspectives of mountain topography, climate comfort, and land use [38], mainly from a natural standpoint to examine its impact on various aspects of tourism. Suitability assessments have been used for assessing pension tourism [39], urban greenways [40], and rural development [41]; however, there has been few studies on popular science tourism. In terms of methodology, geographic information system (GIS) has been used as the primary tool for evaluating the suitability of tourism development from the perspectives of tourism comfort [42], tourism competitiveness [43], and ecological sensitivity [44]. Previous studies generally evaluated tourism from a single perspective; however, some studies combined

various factors to form a set of evaluation criteria and applied these criteria to assess suitability for development in a specific area of science tourism. In contrast to previous studies where weighting was based on expert assignments, the assignments in these studies were made using the hierarchical analysis method, with experts adjusting the weights objectively. The difference in importance of each element in the evaluation system can be derived and can be combined with the spatial analysis method and buffer zones to provide references for the construction of supporting facilities for science tourism sites, as well as provide a more objective and comprehensive evaluation of existing science tourism sites. Therefore, this paper will take universities as the carriers of science tourism, explore their unique science resources, and objectively evaluate their science value and development potential.

Taking Guangzhou University Town as a case study, this study combines science tourism with tourism resources to evaluate the suitability of science tourism sites, focusing on university resources for science tourism. The weights of each factor are determined by constructing matrices, which are then combined with hierarchical analysis to evaluate their potential for development and use. Popular tourism sites are then graded, and several tourism routes are designed to provide a theoretical basis for the rational development of popular science tourism in Guangzhou University Town and to determine the types of tourism activities and scale that university towns can provide in popular science tourism.

2. Overview of the Study Area, Research Methodology, and Data Sources

2.1. Overview of the Study Area

At present, although Guangzhou's tourism industry is highly developed, the number of attractions developed in recent years is relatively small and the focus is on cultural tourism (e.g., the construction of the "Super Wenheyou"). Guangzhou University Town is located in the eastern part of Guangzhou, on the island of Xiaoguwei, Xinzao Town, Panyu District, with a planned area of 43.3 km^2. The university town houses ten universities, historical and cultural heritage, and museums. It is currently the most significant investment project among university towns in China [45]. The rich tourism land resources in the town are the basis for tourism development, as well as the basic agglomeration unit for spatial tourism organizations. Lingnan history, ancient folk culture, Guangdong Science Center, and university construction in Guangzhou University Town complement each other, forming rich and diverse tourism resources in the city [46]. The landscape resources of university towns are classified as cultural tourism and historical sites [47]. The functions of the tourist sites in the university town include sightseeing tourism, which contains Lingnan vernacular and Lingnan folk culture and special tourism, such as enriching knowledge and increasing the experience of tourism [48,49]. Therefore, Guangzhou University Town has high scenic quality and aesthetic value, extending and assimilating the city's historical and cultural resources on three levels: material cultural layer, behavioral cultural layer, and conceptual cultural layer [50]. Figure 1 is a schematic diagram of the distribution of various blocks in Guangzhou University Town.

2.2. Evaluation Index Selection

The quality of science tourism sites mainly depends on the indicators of the extended attributes of tourism resources, tourism areas, and location conditions within the tourism sites [51]. In this study, based on existing evaluation methods [52–56], combined with relevant graphic information collected by the natural resources and planning departments and relevant textual information, the evaluation factors of different scales were selected from the macro and micro perspectives and combined with the actual situation of the university town area to establish an evaluation system for the development of science tourism sites. The following five items were selected as indicators for the evaluation of the quality of popular science tourism sites in Guangzhou University Town: (1) scale capacity, including the ratio of the area of land available for tourism to the area of all tourism land (expressed as S1); (2) environmental level, mainly the vegetation coverage of tourism sites; (3) resource level, including natural science popular tourism resources and humanistic

science popular tourism resources; (4) service conditions, including infrastructure (communication, power supply, water supply), service conditions (accommodation and other services), and equipment conditions; and (5) location conditions, including accessibility and traffic conditions (road conditions, convenience, safety).

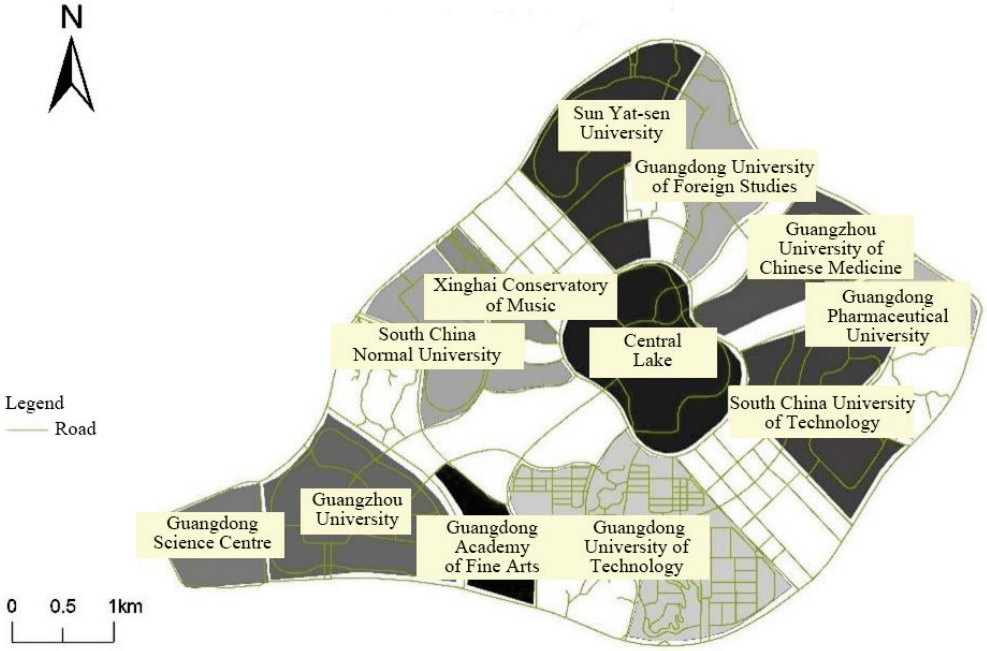

Figure 1. Distribution of areas of Guangzhou University Town.

2.2.1. Size and Capacity

The tourism environmental capacity was determined according to the area capacity method considering theories in ecology, environmental protection, tourism, sociology, economics, and education, and national regulations and relevant norms, which determine tourism environmental capacity (e.g., Environmental Protection Law of the People's Republic of China) [57–62]. The three methods of estimating tourism environmental capacity are the area capacity method, the route capacity method, and the chokepoint capacity method. Each of these methods are more applicable to different tourism scenic areas and tourism environments. Therefore, when conducting tourism environment capacity estimation, it is necessary to first determine the type of tourism functional area or tourism environment and then determine the basic parameters according to the characteristics of different tourism environments. Science tourism in Guangzhou University Town includes ten famous universities, cultural monuments from the Han and Tang dynasties to the present day, and other high-quality resources. The attractions are mainly distributed in blocks and the touring method is primarily based on land, so it is suitable to use the area capacity method for estimation.

$$C = (A/a) \times D$$

where C is the daily environmental capacity in person-times, A is the visitable area in m^2, a is the reasonable area or minimum area that each visitor should occupy in m^2, and D is the turnover rate (time the site is open, or the time required to complete the site).

The area capacity method calculates the daily environmental capacity of the touring area according to the formula based on indicators, such as the tourist area of the science tourism area, space reasonably occupied by visitors, opening hours, and time required for touring.

2.2.2. Environmental Level

Combined with relevant studies [63–66], since the vegetation in the university town is arranged by each university according to the campus pattern and the needs of science popularization, the normalized vegetation index (NDVI), a method of calculating the vegetation coverage degree by combining the red and near-infrared bands according to the spectral characteristics of vegetation, was used to calculate the vegetation distribution of Guangzhou University Town and to assess the greening degree of each science popularization tourist site.

$$NDVI = (NIR - R)/(NIR + R)$$

where NIR is the reflection value in the near-infrared band and R is the reflection value in the red band. The calculated NDVI index is less than 0 for water bodies, 0 for buildings, and greater than 0 for vegetation and these values can be used to classify the land use of Guangzhou University Town into these three types.

2.2.3. Resource Level

The resource level refers to the current science tourism resources in the tourism area. Combining the results of recent research on science popularization tourism resources in China [67] and the characteristics of the object and the scale of the study, the science popularization tourism resources in this study were defined as either facilities with knowledge science popularization value (e.g., science popularization bases, exhibition halls, ecological gardens, and historical and cultural sites) or activities with knowledge science popularization value in fixed places (e.g., student bijou exhibitions, stalls displaying the achievements of associations). Popular science tourism resources are an essential indicator for assessing whether a tourist destination has the value of popular science tourism. The importance of popular science tourism development in tourist destinations with popular science tourism resources is often higher than that in those without popular science tourism resources. If a tourist destination has fewer science tourism resources, it is necessary to invest in tourism development to enhance the value of tourism in the destination.

2.2.4. Service Conditions

Combined with the characteristics of science tourism in Guangzhou University Town and based on the principles of scientificity and operability, this study used catering as an evaluation factor to evaluate the level of service conditions in each block of Guangzhou University Town. Considering that universities differ from traditional tourism industry subjects, some elements from previous studies on science tourism [25,68] were not suitable as reference factors for evaluation. However, since popular science tourism has tourism at its essence, catering was included in the evaluation of service conditions as the evaluation standard. The primary method of the assessment was the use of Arcadia. The preliminary evaluation method used ArcGIS tools to create three levels of buffers on each tourist area and overlay them with the dining area to obtain the distance between each tourist location and the nearest dining area.

2.2.5. Location Conditions

In evaluating the location conditions of science tourism, the convenience of transportation plays a crucial role as it affects tourists' choice of science tourism destination [69–71]. Guangzhou University Town is included in a four-in-one urban transportation system, which includes "Guangzhou highway transportation (Beijing-Zhuhai Expressway and Central City Express Line), rail transportation (Metro Line 4 and Metro Line 7 'cross intersection'), general road transportation, and broadband network information transportation". The diverse transport needs of university towns can be met to the greatest extent possible within these network systems. The university town is ideally located in a central position between some of Guangzhou's major scenic spots, such as the Whampoa Military

Academy, Yu Yin Shan Fang, Bao Mo Yuan, Xiang Jiang Safari Park, Chang Long Happy World, Pazhou International Convention, and Exhibition Center, and Guangzhou Bio Island, making it a unique tourist location. Therefore, this study used GIS to calculate the nearest distance by road from each plot of Guangzhou University Town to University Town North Station, University Town South Station, and Nansha Express University Town Exit to analyze the locational relationship.

2.3. Determination of Evaluation Index Weights and Consistency Test

2.3.1. Construction of Judgment Matrix

We used the "1 to 3 scale method" [71–76] to construct the judgment matrix, with 1, 2, and 3 indicating that the indicator is equally important, more important, and obviously more important than the other when comparing two indicators; the inverse shows the opposite comparison of the two indicators. According to the evaluation hierarchy model, judgment matrices of the suitability of science tourism sites and the location conditions were constructed. Professors from several schools and organizations, including Guangzhou University, South China Human Geography, Urban Development Research Centre, and Nanning Normal University, were then invited to discuss and determine the final assigned values (Table 2).

Table 2. Hierarchical model and index weights for the suitability evaluation of popular science tourism in Guangzhou University Town.

General Objective A Level	Evaluation Indicator B Level	Evaluation Factor C Level
Suitability of the science tourism site	Service conditions (0.143)	Catering (0.143)
	Location conditions (0.143)	Higher Education Mega Centre North Station (0.047)
		Higher Education Mega Centre South Station (0.047)
		Highway entrance and exit (0.0047)
	Scale capacity (0.143)	Environmental degree (0.143)
	Resource level (0.428)	Number of attractions (0.428)
	Environmental level (0.143)	Vegetation cover (0.143)

2.3.2. Calculating the Weights of Each Evaluation Index

The nth root of the product of the elements of each row of the judgment matrix were calculated to obtain the square root vector T_i:

$$T_i = \sqrt[n]{\prod_{k=1}^{n} X_{ik}}, (i = 1, 2, ..., n) \quad (1)$$

where n is the number of evaluation factors and X_{ik} (i = 1, 2, . . . , n; k = 1, 2, . . . , n) is the judgment value obtained by comparing the relative importance of the ith indicator with that of the kth indicator.

The square root vector T_i was normalized to obtain the relative weight value of each indicator in the layer close to a particular indicator in the upper layer.

$$W_i = \frac{T_i}{\sum_{i=1}^{n} T_i}, (i = 1, 2, ..., n) \quad (2)$$

2.3.3. Consistency Test

The results obtained using the hierarchical analysis method were tested for consistency across the judgment matrices to ensure the reasonableness and reliability of the results.

The maximum characteristic root λ_{max} was calculated using:

$$\lambda_{max} = \sum_{i=1}^{n} \frac{1}{nW_i} \sum_{i=1}^{n} X_{ij} W_j \quad (3)$$

Consistency indicators were calculated using:

$$I_C = {}^{(\lambda_{max} - 1)} \Big/ _{(n-1)} \quad (4)$$

Stochastic consistency ratio R_C was calculated using:

$$R_C = {}^{I_C} \Big/ _{I_R} \quad (5)$$

I_R is an average random consistency indicator. If $R_C < 0.100$, the judgment matrix passed the consistency test. The R_C of the evaluation hierarchy model constructed in this study was 0.000, which passed the consistency test.

2.3.4. Calculation of Suitability Scores

Based on the weights of the obtained evaluation indicators, the scores of the different evaluation factors for each tourism site in the university town were determined. The sum of the indices for each tourism site was derived according to the following formula:

$$A = \sum_{i=1}^{n} P_i A_i \ (i = 1, 2, ..., n) \quad (6)$$

where A is the index sum of the evaluation factors of a tourism plot, P_i is the weight of the ith evaluation factor, A_i is the score of the I evaluation factor, and n is the number of evaluation factors. Once the evaluation factor index and the evaluation factor of each plot were obtained, the potential level criteria could be assigned separately to determine the level of each plot.

2.4. Data Sources

This study used 2018 index data of Guangzhou University Town obtained from geographic data platforms, including 2018 Guangzhou Landsat 8 remote sensing images obtained from the geospatial data cloud free download, with an accuracy of 30 m × 30 m, fieldwork, and questionnaires. Data on science resources were collected from the official websites of universities during university town and field visits. Data on tourism resources were collected by visiting tourist attractions in the town and recording the opening situation and number of attractions. The dataset contained nearly all the data on science and tourism resources. After researching the distribution of catering, it was found that due to the strict management of the university town, almost all food and beverage outlets were concentrated in several areas, as discussed in Section 3.4.

Interviews with pedestrians were obtained through field research conducted on multiple days from November to December 2020. We counted the number of people at the main entrances and exits of each university during weekends during the same period to ensure the scientific validity of the data. In addition, we randomly distributed questionnaires and collected 120 valid questionnaires through various means. The results of the questionnaire are presented in Section 3.6.

3. Results

3.1. Comparative Analysis of Daily Environmental Capacity

The environmental capacity of science tourism in Guangzhou University Town was calculated according considering the minimum area of 601 m^2 per visitor as stipulated in the Planning Code for Scenic Areas; the number of visitors that can be accommodated in each plot is shown in Figure 2, with a total capacity of 129,108 visitors per day. The areas with high daily environmental degrees were mainly located in the Central Lake, Guangdong University of Technology, Guangzhou University, Guangzhou Chinese Medicine and Pharmaceutical, and Sun Yat-sen University plots. The Guangzhou University, Sun Yat-sen University, and South China University of Technology plots had advantages in terms

of visitor capacity, whereas the Guangzhou Academy of Fine Arts and the western part of Guangzhou International Innovation City plots had the lowest daily environmental capacity and could not accommodate many visitors, which is a disadvantage for these plots as prospective science tourism bases.

Figure 2. The daily environmental capacity of Guangzhou University Town (601 m^2 per person).

3.2. Comparison of Environmental Level

Table 3 of the land-use of Guangzhou University Town shows that the proportions of the areas of vegetation, buildings, and water bodies in Guangzhou University Town are 40%, 52%, and 8%, respectively. The total proportion of green areas and water bodies was 48%. Overall, Guangzhou University Town has high vegetation cover and a high degree of greenery, which is suitable for tourism and leisure.

Table 3. Land use of Guangzhou University Town.

Tourism Block	Vegetation (%)	Buildings (%)	Water Bodies (%)
Overall	40	52	8
Guangdong Science Centre	18	66	15
Lingnan Impression Park	67	28	4
The second Mausoleum Museum of the Southern Han Dynasty	70	29	1
Guangzhou University	22	68	10
Guangdong University of Technology	36	48	16
Guangzhou Academy of Fine Arts	22	56	22
South China University of Technology	24	65	11
Guangzhou University of Chinese Medicine—Guangdong Pharmaceutical University	15	76	9
Guangdong University of Foreign Studies	15	78	7
Sun Yat-sen University	23	72	5
Xinghai Conservatory of Music—South China Normal University	30	61	9
Guangzhou International Innovation City West	38	53	8
Central Lake Park	50	35	15
Wan Jutou Wetland Park	76	23	1
Chikan Wetland Park	77	22	1
Bei Gang Wetland Park	76	17	7

The land use of each plot shows that the environmental levels of natural science resources were significantly higher than those of human science resources. The highest percentage of vegetation was found in park-type plots, such as Wan Jutou Wetland, Chikan Wetland, and Bei Gang Wetland, all located in the outer ring. The Guangdong Science Centre, International Innovation City West, and various other universities had lower percentages of vegetation. The plots with the lowest greenery rate were Guangzhou University of Chinese Medicine, Guangdong Pharmaceutical University, and Guangdong University of Foreign Studies.

3.3. Distribution of Science Tourism Resources

The science tourism resources table distribution shows that human science tourism resources are the most critical science resource in Guangzhou University Town. The current natural science tourism resources in the university town are scarce and the degree of development is low. The plots of Guangdong Science Centre and Lingnan Impression Park are rich in science tourism resources. They have the lowest development difficulty and investment cost for developing as science tourism bases. The plots of Guangzhou University, Guangzhou University of Chinese Medicine—Guangdong Pharmaceutical University, Central Lake Park, and Xinghai Conservatory of Music—South China Normal University have some science tourism resources. In contrast, the Wan Jutou Wetland, Chi Kan Wetland, and Bei Gang Wetland plots have the lowest science tourism resources and are the least developed and, therefore, have the most severe difficulty in developing science tourism (Table 4).

Table 4. Distribution of Popular Science Resources in Guangzhou University Town.

Tourism Plots	Science Resources	Total Number
Guangdong Science Centre	Low Carbon and New Energy Vehicles Science Experience Hall, People and Health Hall, Green Home Hall, Innovation Space Hall, Digital Paradise Hall, Materials Park Hall, Transport World Hall, Children's World Hall, Experiments and Discoveries Hall, Lingnan Science and Technology Exhibition, Flying Dreams Pavilion, Sense and Think Pavilion, Science Square, Robotics Lab, AR Lab, 3D Printing Creative Design Lab, Solar Cell Production Lab	17
Lingnan Impression Park	Old Wine Shop, Old Barber Shop, Lion Dance Club, Lingnan Art and Culture Exhibition, Canton Embroidery Museum, Nun's House, Guangdong Broadcasting Museum, Old Newspaper House, Big House, Old Cinema, Old Photo Gallery, Guangdong TV's "Chen Mengji" Filming Base	12
The second Mausoleum Museum of the Southern Han Dynasty	Southern Han History Exhibition Hall, Archaeological Research Specimen Showroom, Public Archaeological Simulation Centre	3
Guangzhou University	Planetarium Science Base, Optoelectronic Science Base, Science Building North Building Student Works Exhibition, School History Exhibition Hall, Clubs Achievement Exhibition, Performing Arts Centre, He Shijie Gymnasium	7
Guangdong University of Technology	Industry 4.0 Experimental Base, Society Achievement Exhibition, Cultural Exchange Centre, Creative Center of Guangdong University of Technology	4
Guangzhou Academy of Fine Arts	Art Museum Sculpture Branch, Art Museum of Guangzhou Academy of Fine Arts, Association Achievement Exhibition, Liang Mingcheng Sculpture Garden	4
South China University of Technology	Exhibition of students' innovative design works, exhibition of club achievements, South China University of Technology Library	3

Table 4. *Cont.*

Tourism Plots	Science Resources	Total Number
Guangzhou University of Chinese Medicine -Guangdong Pharmaceutical University	Guangdong Pharmaceutical University Human Science Education Centre, Guangdong Pharmaceutical University Chinese Medicine Herbarium and Medicinal Botanical Garden, Guangdong Digital Home Interactive Application Engineering Laboratory, Guangdong Museum of Chinese Medicine, Guangdong Pharmaceutical Society Achievement Exhibition, Guangdong Chinese Medicine Society Exhibition	6
Guangdong University of Foreign Studies	Octagon House, Club Achievement Display	2
Sun Yat-sen University	Statue of Dr. Sun Yat-sen, Forest of Three Quotations, Society Achievement Exhibition	3
Xinghai Conservatory of Music-South China Normal University	Xinghai Conservatory of Music Concert Hall, Conservatory of Music hall of South China Normal University, Beigang Villagers' Traditional Residence, Sports Park of College town Campus of South China Normal University, Xinghai Club Achievement Exhibition, Club Achievement Exhibition of South China Normal University	6
Guangzhou International Innovation City West	Guangzhou National Archives, Guangzhou International Innovation City Exhibition Hall, Guangzhou Patriotic Education Base	3
Central Lake Park	Guo Long Guo Clan Ancestral Hall, Bauhinia Garden of Guangzhou University Town, Central Lake Cultural Square of Guangzhou University Town, Guangzhou Literature and Art Creation Centre, Sports Centre of Guangzhou University Town	5
Wan Jutou Wetland Park	Waterfowl Habitat Wetland	1
Chikan Wetland Park	Waterfowl Habitat Wetland	1
Bei Gang Wetland Park	Waterfowl Habitat wetland	1

3.4. Location of Tourist Sites and Catering Areas

The catering distribution map (Figure 3) shows that catering areas in Guangzhou University Town are primarily distributed between the central ring and the inner ring, and that the tourist plots located in this zone have good catering service conditions. All university plots have catering areas and, thus, had the best catering service conditions. Among non-university plots, the plot of Central Lake Park, a relatively high-traffic park in the middle of the island adjacent to several universities, had a catering area within 100 m. The second Mausoleum Museum of the Southern Han Dynasty is close to the living quarters of the South China Normal University and the Guangdong University of Industry; as a result, catering areas can be found within 200 m. The Guangzhou International Innovation City West is close to the Guangzhou Academy of Fine Arts and Guangdong University of Industry and, thus, has catering areas within 300 m. Most of the remaining plots, such as Lingnan Impression Park, Wan Jutou Wetland Park, Chikan Wetland Park, and Bei Gang Wetland Park, are located on the edge of the outer ring, but the living quarters of the major universities are generally located between the inner and middle rounds. In addition, several villages with catering areas are located between the center and outer rings, making it difficult to reach catering areas within 300 m from these plots.

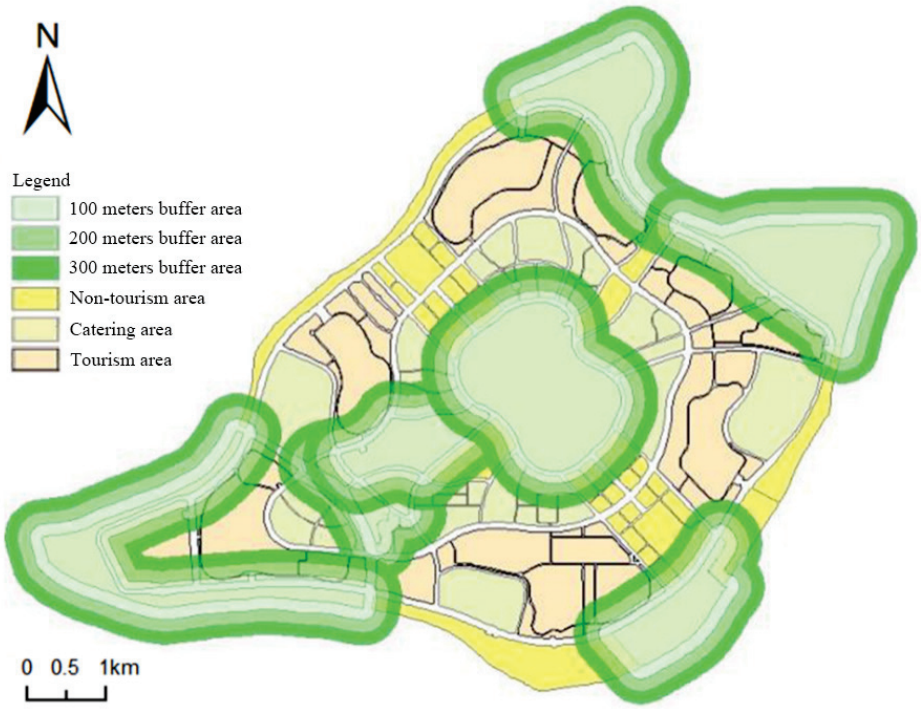

Figure 3. Distribution of catering areas of Guangzhou University Town.

3.5. Accessibility of Tourist Areas

The location table of the Guangzhou University Town tourist area (Table 5) shows that Central Lake Park has the best location conditions and is particularly close to the metro station of Higher Education Mega Center south and north. In contrast, the plots of Guangdong Science Centre, Guangzhou University of Chinese Medicine—Guangdong Pharmaceutical University, Wan Jutou Wetland Park, Chi Kan Wetland Park, and Bei Gang Wetland Park were far from the metro station and highway exit, giving them the worst location conditions and making them relatively inaccessible for tourists.

Table 5. Guangzhou University Town Tourism Area Location.

Tourism Plots	Higher Education Mega Centre North Station	Nansha Harbour Expressway	Higher Education Mega Centre South Station
Guangdong Science Centre	4.4	2.8	4.5
Lingnan Impression Park	3.3	4.6	1.5
The second Mausoleum Museum of the Southern Han Dynasty	1.9	2.1	2.3
Guangzhou University	2.9	0.8	2.5
Guangdong University of Technology	2.9	2.9	0.8
Guangzhou Academy of Fine Arts	3.8	1.1	2.3
South China University of Technology	3.3	3.3	0.8
Guangzhou University of Chinese Medicine—-Guangdong Pharmaceutical University	2.7	4.2	2.6
Guangdong University of Foreign Studies	1.7	4.3	2.5
Sun Yat-sen University	0.9	3.7	3.1
Xinghai Conservatory of Music—-South China Normal University	1.1	2.2	3
Guangzhou International Innovation City West	2.9	1.7	2.4
Central Lake Park	1.1	2.6	1.7
Wan Jutou Wetland Park	4.3	3.5	5.5
Chikan Wetland Park	2.7	5.4	3.9
Bei Gang Wetland Park	3.5	7.2	3.6

3.6. Synthesis of Evaluation Results and Validation

3.6.1. Comprehensive Analysis of Evaluation Results

In this study, through field research, data analysis, expert empowerment, and theory on science tourism resources and supporting facilities, such as transportation and catering of universities and tourist attractions in the university town, a three-level system of potential level (level 1), landscape resource category (level 2), and functional type (level 3) was used to evaluate the science tourism sites in Guangzhou University Town. According to the actual situation of the university town, three tourism place potential levels were determined, that is, tourism places with high (Class I), medium (Class II), and low (Class III) tourism potential (Figure 4). Each university town site was scored according to the evaluation mentioned above. Then, the sum of the evaluation factor scores of the university town sites was calculated. The average sum of the sites' scores was used as the criterion for the corresponding potential level. The sum of the scores for each factor was the weighted index sum. Tourist sites with sums of evaluation factor scores higher than 3.1 were classified as Class I, those with scores from 2.4–3.1 were Class II, and less than 2.4 were Class III.

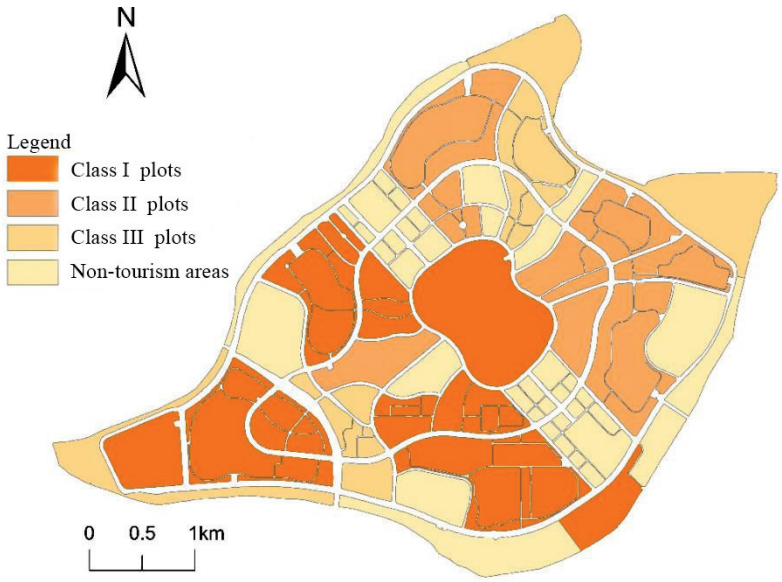

Figure 4. Adaptability evaluation results of popular science tourism destinations in Guangzhou University Town.

The results of the suitability assessment of science tourism sites in Guangzhou University Town are shown in Figure 4. The Grade I science tourism sites were the plots of Lingnan Impression Park, Guangdong Science Centre, Guangzhou University, Guangdong University of Technology, Xinghai Conservatory of Music—-South China Normal University, and Central Lake Park. Class II science tourism sites were the plots of Guangzhou Academy of Fine Arts, Sun Yat-sen University, Guangzhou University of Chinese Medicine, Guangdong Pharmaceutical University, and South China University of Technology. The remaining plots were Class III science tourism sites. The overall spatial distribution shows a generally higher science tourism suitability score to the west of the central lake than to the east and a rough northeast–southwest symmetry.

3.6.2. Comprehensive Verification of Evaluation Results

Grade I tourist sites had more obvious advantages in terms of science tourism resources and catering service conditions than Grade II and III tourist sites, and these were reflected in several factors with higher weights in the evaluation list, especially the number of science tourism resources.

In addition, the convenience of transportation was an essential factor affecting the rating of science tourism sites. For example, although the plot of Guangzhou University of Chinese Medicine–Guangdong Pharmaceutical University was comparable to Class I tourism sites in terms of science tourism resources, it is far away from important transportation hubs, such as metro stations and highways, and so did qualify as a Class I tourism site. The overall traffic layout of Guangzhou University Town has three ring roads: an inner ring, middle ring, and outer ring, and the two subway stations in the south and north of the university town are symmetrically distributed. However, the Nansha Harbor Expressway is in the southwest of the island and has a very close traffic connection with downtown Guangzhou; therefore, science tourism sites in the southwest of the island, such as the plots of Guangzhou University and Guangdong Science Centre, had relatively more convenient road transport and their scores in terms of location conditions were relatively higher.

This study found that some Class I tourist sites were not reasonably developed, and that the development of universities is still in the early stages. Field research to different science tourism locations and supporting facilities was conducted on the weekends and 12:00–13:00 noon peak times to study the flow of people and average values from several visits were used. The average peak flows of Central Lake Park, Guangdong University of Technology, Guangdong Science Center, Gogo Xintiandi Shopping Center, and Chikan Wetland Park were 482, 8, 102, 2712, and 2 people, respectively. These results show that the number of people going to universities for tourism activities is much lower than that of other Class I tourist destinations, such as the Guangdong Science Center. This shows that science tourism in universities still needs to be developed and implemented.

In addition, this study conducted a research questionnaire on the current transportation situation, tourism resources, tourism experience, food service, and publicity of the university town from the perspective of having traveled to Guangzhou University Town/living in Guangzhou University Town/not having traveled to Guangzhou University Town, to understand the 120 respondents' awareness and participation. Fifty-five of respondents had visited various science tourism sites, while 17, who had not visited, said they had not heard of any science tourism sites on the island. Sixty respondents thought that the popularity of science tourism in the university town was average and needed to be improved. Regarding travel options to various attractions, 55 tourists who had visited the city said they used buses, subways, and cycling more often to get to the university town. The results shows that the most common duration for popular science tourism is roughly one day, which shows the same trend as other unconventional tourism, such as visiting friends and relatives tourism (VFR) [77]. We suggest that this is because the purpose of traveling is different from conventional purposes. While VFR may not have clear goals for traveling, for popular science tourism, people are determined to learn rather than relaxing. This has been dubbed "travel craving" by some scholars [78].

The overall satisfaction rate for the convenience of transportation on the island was 3.84, indicating that there is still a need to strengthen the construction of public transit and public roads to provide more convenient and fast travel conditions for tourists. In addition, respondents usually dined in commercial areas, such as Gogo Xintiandi (the commercial center) and various dining halls in the university. However, the overall satisfaction with the general dining conditions in the university town was 3.71, indicating that there is much room for improvement in the dining conditions. The questionnaire shows that more people preferred the center of Lake Park, Guangdong Science Center, and Lingnan Impression Park due to their rich tourism resources, various characteristics, and convenient transportation. At the same time, wetland parks, such as Wan Jutou, Chi Kan, and Bei Gang were almost unattended because of their remote location and relative inaccessibility in terms of transportation conditions. Most visitors spend half a day in these science tourism places, with only a few cases of two days or more. Based on this, Guangzhou University Town's science tourism planning should focus more on enriching playable resources to attract more off-island and foreign tourists.

4. Discussion

4.1. Suggestions for Science Tourism Development

This paper suggests the following for the development of science tourism in Guangzhou University Town:

1. More roads and public transportation systems should be built to strengthen the connections with the city and improve the layout of transportation in the university town to be more symmetrical. Although the town has a complete public transportation system, the current connection between Guangzhou University Town and downtown Guangzhou is limited to two methods: by car through Nansha Port Expressway and Guanzhou Tunnel or by subway through Metro Line 7 and Line 4 of Higher Education Mega Center North and South Station. In general, the road layout is asymmetrical, and the subway station is in the center of the University Town traffic circle, meaning that areas at the edge of the university town do not benefit from the convenience and have greater commuting times. Therefore, the future infrastructure development of the university town should focus on the development of roads, the construction of highways similar to the Nansha Port Expressway in the northern part of the University Town, and the opening of subway stations, such as "University Town East and West," which can balance the uneven traffic and distribution of Guangzhou Metro stations. These developments would also better connect the university with the Guangzhou Beltway, resulting in the university town being less isolated.
2. Efforts should be made to improve supporting service facilities on the island, plan the layout of service facilities and break the boundary to form a piece of the area with nearby villages and islands. There is some land near the universities in Guangzhou University Town that still need to be developed. The places providing catering, services, accommodation, and leisure in Guangzhou University Town are limited and are mainly concentrated in the Gogo Xintiandi shopping mall, the general commercial center, and the natural villages. Universities can only provide certain catering services and the provision of other services is more limited. Compared with the shopping malls, the natural villages provide different quality of services. The quality of services offered by universities and colleges varies, making it difficult to attract tourists to stay overnight and extend their visits. Therefore, the spatial distribution and types of land to be developed should be fully considered. Comprehensive shopping malls, parking lots, hotels, and other service facilities should be constructed for several sites that are evaluated as Class I tourist sites but have relatively low traffic (e.g., Guangdong Science Center) and those with fewer resources in terms of spatial distribution (e.g., wetland parks, northern areas of university towns). At the same time, the university town should break its boundaries between it and nearby villages and islands (Xiaozhou Village, Changzhou Island), strengthening the connections between them. This would result in the economy of the area growing rapidly and becoming an important part of the city.
3. The range of guest source radiation should be expanded. The primary source of tourists for Guangzhou University Town is Guangzhou citizens, nearby villagers, and students in the university town. While nearby villagers and students are the main groups, the university town should aim to attract more tourists from outside the island. First, the university town should increase publicity and establish a tourism company led by the government to integrate all the science tourism resources and hold activities to promote the university town science tourism, such as a college in Guangzhou University Town hosting a geology summer camp. This would attract more people from Guangzhou and the surrounding areas to visit for weekends, leisure and vacation, recreation, and fitness. Second, the university town should build more complete scientific, educational, cultural, health, and sports facilities and use the Internet and other means to attract more tourists.

4.2. Outlook

This paper attempted to build a suitability evaluation index system for science tourism in Guangzhou University Town from the perspective of tourism mode. However, there were some limitations. First, many indicators affect science tourism in university towns and the results differ when different indicators are chosen. Second, the evaluation method had some uncertainties. The subjectivity of scoring weights is difficult to avoid and can affect the accuracy of the final evaluation results to varying degrees. Therefore, this requires improvement in subsequent research. Third, the evaluation of the suitability of science tourism is extremely critical in the tourism planning of Guangzhou University Town; however, because of the enormous workload of surveys and calculations, there is much information not readily available, which will lead to errors in the estimation of the number of visitors in the planning period. If this error is too large, construction planning for water, electricity, tourist beds, commercial service facilities, and other facilities becomes meaningless, and the general layout loses its basis. Therefore, it is a demanding and challenging task, but is one of great significance.

As previously discussed, university towns have the potential to be important parts of popular science tourism because they have tourism resources that are suitable for fulfilling the curiosity and demand of many people. Although university towns are built in many cities and some leaders are aware of the value of these university towns, most remain to be developed. Some environmental and social questions also need to be considered because there are not only universities and students in the university town but also villages and residents. The development of science tourism can bring social problems, such as conflicts between students, teachers, residents, and outsiders and insufficient coordination of city administration can lead to environmental damage and the accumulation of rubbish. These issues need to be considered for the development of science tourism at university and non-university tourism sites. Thus, managing this type of unconventional tourism needs great consideration. Moreover, it cannot be ignored that human traffic flow is massively different between holidays and regular times. Therefore, how the government aids merchants during the summer and winter holidays to survive in the off-season should be discussed.

5. Conclusions

This study used remote sensing data and field investigation to analyze the resource value and environmental level of tourism sites considering five factors: scale capacity, ecological level, resource level, location condition, and service condition. We constructed a set of indicators to evaluate the suitability of the science tourism sites in Guangzhou University Town by combining the hierarchical analysis method and the opinions of experts to assign weights to the five factors. The suitability of the development of science tourism sites in Guangzhou University Town was evaluated through measurement and field surveys, and the main findings were as follows.

1. In the classification of the suitability of the development of popular science tourism sites in Guangzhou University Town, the five evaluation indices had higher weights in terms of resource level and location conditions. This means that the resource level was most critical factor affecting the evaluation of popular science tourism sites, followed by service conditions. In the future, the development of science tourism sites should prioritize the resource level of the region; however, other elements should still be considered.
2. Overall, the grades of popular science tourism sites of the western part of the University Town were higher than those of the eastern part, demonstrating the uneven development of the western and central regions of the University Town and the eastern regions. This uneven development is particularly evident in the number of tourism resources and the grades of popular science tourism sites, which is due to the more developed transportation in the western part.
3. The degree of development and use of tourist sites does not only depend on the abundance and characteristics of resources but also on a range of socioeconomic,

locational, and environmental conditions associated with tourism development. The development of science tourism in university towns should optimize the layout of transportation, catering, and other elements while also improving the infrastructure and service level in areas rich in attractions. They are combined with the actual situation in the town of Guangzhou University.

4. Popular science tourism is an essential part of the developing industry of unconventional tourism and Guangzhou University town is rich in resources for this industry according to our survey and dataset. Our questionnaire revealed that people prefer to only stay for one day when visiting university towns. Therefore, we suggest that the most suitable duration for popular science tourism is one day, which shows the same trend as VFR, another kind of unconventional tourism.

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Cemeteries as a Part of Green Infrastructure and Tourism

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Abstract: The world's population and the proportion of it living in cities and urban areas has exploded in recent decades. In the European Union, 62% of the population lives in urban areas and 80% in suburban areas, and these proportions are projected to increase further in the coming decades. It has long been researched and proven that 'urban greenery' can play a major role in mitigating the so-called urban heat island effect, and during the COVID-19 pandemic the role of daily recreation has come to the forefront. The combined memorial, recreational, and touristic use of cemeteries can help to ensure their economic management, and thus the long-term preservation of their value. In international tourism the model of managing cemeteries as tourist attractions already exists; however, this is not yet part of conventional practice. In addition to traditional cemetery tourism (e.g., visiting the graves of celebrities or enjoying artistic treasures and values), cemeteries are used as venues for events and sports activities. In Western Europe forest and park cemeteries have been established since the 19th century, and their large green areas and open spaces are a prerequisite for their use as public parks. Thus, the use of cemeteries as public parks is a common if quite specific practice. Our aim with this article is to identify the green space values of Budapest's cemeteries, in addition to their well-known cultural and architectural significance, as well as to define the potential and means of their involvement in tourism-related activities. Another aim of our study is to raise awareness of green cemeteries within the tourism profession as potentially wider tourist attractions. We consider it important to draw the attention of decision-makers to the significance of the greenspace values when preserving or reusing closed cemeteries. Based on our work, other major cities in Hungary can identify and exploit the touristic and green space potential of their cemeteries.

Keywords: cemetery; tourist attraction; green space; urban green infrastructure; cemetery tourism

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1. Introduction

The role of urban green infrastructure or urban green areas is growing in cities as a result of population growth and urban intensification. In recent years, the COVID-19 pandemic has amplified the importance of open spaces for the local population, who spend more time in parks and other green spaces available in close proximity to their home. Cemeteries, similar to urban parks, represent an important part of the urban ecosystem, being the remaining semi-natural habitat of many species of plants and animals. However, there is no equivalence between cemeteries and public parks: while their functions and uses are similar in many respects, specificity could be mentioned as well. Cemeteries are part of the urban green infrastructure network, however, their use is limited in both time and in function. Although the use of cemeteries and parks has converged in recent decades, significant differences nevertheless exist between them (Figure 1).

While the use of cemeteries for recreation and tourism purposes is not yet considered conventional, the rise of 'green needs' can be expected to increase their role in the future. On average, four million people visit Budapest cemeteries every year, and on the All Saints' and All Souls' Day the number of visitors can reach 1–1.5 million individuals over 2–3 days.

However, no general statistics are available on the number of visitors coming to cemeteries with targeted touristic and recreational aims.

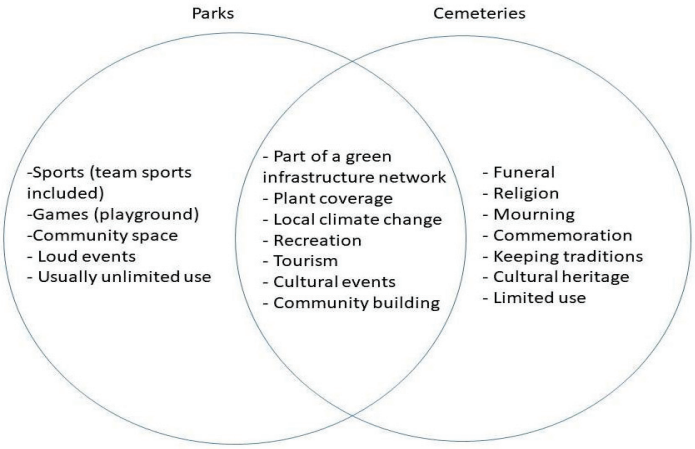

Figure 1. Differences between the functions of cemeteries and public parks (edited by the authors).

The value of cemeteries for the tourism sector lies in both the cultural aspects they offer and in the vegetation and green spaces that frame their physical realities, which can offer many services. "There are many types of cemeteries. As many as man and his follies," writes Károly Eötvös [1] (p. 175). The layout, the use of materials, and the way of commemoration can vary from simple wooden headstones to massive stone carvings and sculptures. In Hungary, there are several legendary cemeteries where families commemorate their deceased relatives according to special traditions, and these sites have become tourist attractions. In Szatmárcseke (HU), the graveyard with its nearly 600 dark headstones representing a man's head or a man lying in a boat is a unique sight [2]. In Balatonudvari, near the national road crossing the village, the local cemetery is protected due to its heart-shaped tombstones carved in white limestone [3] (Figure 2). The cemeteries in the region of Őrség (a cultural landscape area in Hungary near the Slovenian border) are a reminder of a unique burial tradition in the country. In Kercaszomor and other settlements in this region there exist some old and unique wooden headstones that were once erected for Calvinist deceased. This tradition is now extinct, and cemeteries with these sights are today only a tourist attraction [4]. In Hajdúböszörmény, in the former Calvinist graveyard known as the Nyugati Cemetery, we can see typical 19th century gravestones with their boat-shaped headstones [5].

In addition to cemeteries that are special due to their burial traditions, there are other tourist attractions related to memorial places in the country: the Historical Memorial Site of the Mohács Battle, the Budaörs Military Cemetery and Peace Park (Deutsch-Ungarischer Soldatenfriedhof) [6] (Figure 3), the British Military Cemetery in Solymár, the Turkish memorial tomb of Gül Baba in Budapest (Gül baba türbéje) [7], and the Old Christian burial chambers site in Pécs, which is on the Unesco World Heritage List [8].

1.1. Theoretical Background

In previous works, the authors have dealt with religious tourism [9,10] and the development, structure, and history of cemeteries [11–13]. This study now focuses on the role and potential of cemeteries for recreation and tourism. To this end, we conducted a literature review on cemeteries and recreation and cemeteries and tourism.

1.1.1. Cemeteries and Recreation

"Today, cemeteries are more than a place of reflection. They are a place of beauty and a place of history" [14]. A cemetery is a green open area [15], a "garden" with architectural and sculptural elements. It performs an ecological function and it is a permanent element of the landscape. It offers a chance for survival to many species of plants and birds, especially in cities, and natural "monuments" are often found among the many trees [16]. Because of

their characteristics and location, throughout history cemeteries have often had a secondary function in addition to their primary one [17,18]. In the Middle Ages, church graveyards were often the central points in cities, and were the sites of fairs and festivities as well as being used for local parliaments, trials, preaching, miracle play performances, folk rites, executions, and demonstrations; however, the cemetery has always been a place of solemnity.

Figure 2. Heart-shaped gravestones in the cemetery of Balatonudvari. (Photo: Imola Gecséné Tar, 2016).

Figure 3. Tourists in the German–Hungarian Military Cemetery in Budaörs. (Photo: Imola Gecséné Tar, 2018).

The majority of historical cemetery complexes are park-type areas, and are endowed with recreational facilities: clean air, silence, limited urbanization, aesthetic landscape features, and favorable climatic and bioclimatic conditions [16]. Visiting cemeteries can therefore be an opportunity for recreation. "It can be a place to get one's thoughts rested and let them stretch themselves out. So, it is very good mentally. Yes, good to the eye and good for the head." (man in his 40s visiting the Old Town Cemetery) [17] (p. 1). As cities become denser, green spaces are in danger of decreasing. Evensen et al. [19] (p. 76) argue that "in densified parts of cities the cemetery may be the closest greenspace accessible for every-day use" [20] (p. 2). This may have consequences for how urban cemeteries shift from being burial spaces to becoming spaces for recreation [17,18].

1.1.2. Cemeteries and Tourism

In the twentieth century, people began to travel to sites associated with death out of curiosity rather than because of their philosophical or spiritual connotations, thus initiating the origins of dark tourism. Dark tourism is the act of travel and visitation to sites, attractions, and exhibitions that have a connection to real or recreated death, suffering, or the seemingly macabre as a main theme. Tourist visits to former battlefields, slavery-heritage attractions, prisons, cemeteries, particular museum exhibitions, Holocaust sites, and disaster locations all constitute the broad realm of 'dark tourism' [21].

Cemetery tourism (thanatourism) is a specific sub-section of dark tourism that is becoming increasingly popular [22]. Tourists wander through burial grounds with the aim of discovering the artistic, architectural, historical, and scenic heritage that often abounds in cemeteries. The changing perception of cemeteries from a place for burial towards a cultural heritage space provides several opportunities for tourism. It enables the community to explore the development of products and services that help the destination to gain new income while preserving its heritage [23].

Cemeteries are more than just resting places for the dead; they serve a practical purpose, serve as historical markers, reflect cultural values, and impress visitors with their gorgeous designs and much more. Many people find cemeteries particularly interesting for these and other various reasons. Most cemeteries welcome the public free of charge, and many offer thematic maps, brochures, smartphone apps, audio tours, or guided tours that highlight notable graves, statues, monuments, chapels and other architectural structures of the site [14]. There are many books that have been written on the topic in recent years, for example, Stories in Stone: A Field Guide to Cemetery Symbolism and Iconography, by Douglas Keister; Beautiful Death: Art of the Cemetery, by David Robinson and Dean Koontz; and Your Guide to Cemetery Research, by Sharon DeBartolo Carmack. Today, many tourist guide books include cemeteries which may attract different groups of travelers and inspire the development of newer cemeteries.

One of the 45 European Cultural Routes of the Council of Europe is the European Cemeteries Route, certified in 2010. The European Cemeteries Route refers to cemeteries as 'places of life', environments that, as urban spaces, are directly linked to the history and culture of the community to which they belong and where people can find many of their references [24].

1.1.3. Summary of the Literature Search

Based on the literature review, we have summarized the possible functions of cemeteries, which are shown in Figure 4. Many people see cemeteries as somber places with little connection to the local environment and community; however, we believe this could not be further from the truth. Cemeteries bring families together and provide insight into local history.

We have analyzed in detail the role that cemeteries can play and the needs they can meet for both local people and tourists. The basic and primary function is burial and commemoration. All other functions can only be carried out with this in mind and subordinate to it. The secondary function is linked to the recreational needs of the local

population through the preservation of local natural and architectural assets. The tertiary function is to satisfy the needs of tourist visits.

Figure 4. Diverse functions of cemeteries (edited by the authors).

1.2. Presentation of the Sample Area: Green Infrastructure and Cemeteries of Budapest

In the Middle Ages, the greenspace areas of Pest and Buda developed in a similar way to those of other European cities. Within the castle walls and the city-enclosing walls, castle gardens, manorial gardens, and many small kitchen gardens were erected, while outside the walls the large meadow fields and forests enriched the landscape. The medieval cemeteries were located within the town, around the churches.

Hungary's development was severely set back by a century and a half of Turkish occupation during the 16–17th centuries. Despite this, Pest and Buda developed gradually, although in different ways. Within the walls of Buda's castle the free open spaces had been used up, and both the expansion of other urban areas and property rights were regulated according to political and military defense. In contrast, after the Turkish dominance there was more intensive development at Pest, with construction and a greater pace of transformation, although at that time civil governance was far away from creating public green spaces or parks [25]. In the area of today's Budapest the practice of burial around churches had ceased after the Turkish conquest, and cemeteries similar to the present ones started to be developed in different parts of the city.

In the 18th century, due to the large number of newcomers the development of the suburbs around Pest began. At that time, few public spaces were created in the densely built-up urban areas. With the advance of civilisation, the demand for public green spaces rose, just as in other European cities. As more and more city dwellers became increasingly detached from their peasant life, they were keen for recreation and leisure. Thus, the city mayor proposed the creation of a new forestry zone, which later became the first public park in the capital (today's Városliget), as well as a promenade (Városligeti allee) connecting the urban areas to the new recreational zone. This provided a pleasant open space for the entertainment of the citizens of Pest and its surroundings. In Buda the royal gardens were open to the public, although on a limited basis, and new pleasure gardens (Városmajor, Horváth garden) were created in the late 18th century. In addition to gardens, the linear axes, alleys, promenades, and walkways played an important role in the early days of the development of public open greenspace [25,26].

The regulations on the removal of cemeteries issued in 1777 led to the opening of several new cemeteries in Buda and Pest. Two new cemeteries were opened in Buda, though both were closed at the end of the 19th century [27] (pp. 4–5) [28] (p. 235). In Óbuda, the cemetery surrounding the parish church ceased to exist in 1744. Instead, two new cemeteries were opened in 1780, along with one for the Jewish population of Óbuda [27] (p. 7). In the 18th century there were several cemeteries in Pest, and from the second half of the 18th century onwards new cemeteries were established outside the city walls. In

the 1790s the first central cemetery in Pest, the Váci Road cemetery, was opened; it was eliminated around 1910. There was a Jewish cemetery next to it as well [27] (pp. 8–10).

In 1846 the Pest City Council decided to replace the old cemeteries with a large central cemetery. The Kerepesi cemetery (now National Graveyard on Fiumei Road) was opened on 15 June 1847. In 1885 the entire ensemble was declared an ornamental graveyard. In 1874, the City Council handed over a part of the Kerepesi cemetery to the Israelite community. Burials took place in the separate Jewish cemetery section in Salgótarjáni Street until 1950, and it has been preserved as a closed protected cemetery. In 1972 a tender was launched for the arrangement of the cemetery and the landscaping process, which is ongoing today. Today this cemetery has a special status as a national pantheon, although it continues to be possible to carry out public burials there [27] (pp. 10, 14, 16, 31), [28] (pp. 235–236, 238–239).

The Parliament of 1872 voted for the unification of Pest, Buda, Óbuda, and Margaret Island. The newly unified capital sacrificed for the development of its metropolitan character, following the European (Viennese and Parisien) models by removing its rural character by building new residential areas, representative axes, squares, and public institutions. In 1873, the afforestation of Gellért Hill was started. After the construction of the Chain Bridge, the Buda Hills as green open spaces have become accessible to the citizens of Pest and increasingly popular as a recreational destination. On the other hand, the hillsides were gradually urbanized by new villa areas, replacing traditional orchards and vineyards damaged in the Phylloxera epidemic [25].

Several new large cemeteries were opened in the merged capital. In Buda, the Németvölgyi cemetery was opened in 1885; it was intended to be an ornamental graveyard for all time, similar to the Kerepesi cemetery. Despite this intention, the cemetery operated for an unusually short period. The Németvölgyi Orthodox Jewish cemetery, which was opened in 1890 and used until 1961, stands on a small plot of land surrounded by a high fence. In 1894, the Farkasréti cemetery was opened in Buda, which is still in use today; it is the resting place of many famous Hungarian people. The Farkasréti Jewish cemetery is wedged between the two parts of the Christian cemetery [27] (pp. 5–6, 53, 58). A new public cemetery and a new Israelite cemetery were opened in Óbuda; however, these have now been closed down [27] (p. 7). In Pest, the expansion of the Kerepesi cemetery became impossible with the opening of the Jewish cemetery on Salgótarjáni Road, and a site for the new public cemetery had to be found elsewhere. On 1 May 1886 the New Public Cemetery of Rákoskeresztúr, Hungary's largest cemetery at 207 hectares, was opened. In 1891 the Kozma Street Jewish cemetery, Hungary's largest Jewish graveyard, was established next to the New Public cemetery, with the Rákoskeresztúr Orthodox Jewish cemetery adjoining it on the northern side [27] (pp. 32, 35, 44) [28] (p. 236).

The Fortepan photo collection contains photographs from the beginning of the 20th century until the change from the Soviet regime in Hungary in 1989, thus, the cemeteries in Budapest have been photographed beginning in the early 1900s. When we reviewed these photos, we found that the oldest photo analyzed was taken in 1900 in the National Graveyard, formerly called as Kerepesi Cemetery. There is a difference in the use of the two cemeteries from the very beginning: in case of the National Graveyard, the archive contains almost exclusively pictures of the burials and graves of famous people, while in the Farkasréti Cemetery it is the funeral motifs that appear in large number, of which the most striking is a horse-drawn hearse. For both cemeteries there are almost no photographs that do not show some form of vegetation, usually tree alleys or massive woody vegetation in the background. In the case of the Farkasréti cemetery, there was one photograph where the spatial structure and alleys were clearly recognizable (see Figure 5) in addition to the main motif of the funeral process.

Figure 5. Alleys such as this one define the structure of the Farkasréti cemetery (Photo: Fortepan/Horváth Miklós dr, ID N°129338, Date: 1955).

At the turn of the 19–20th century the function and use of public parks evolved, with crowds from various social levels, coming to walk, play skate, and seek active or passive outdoor recreation. At this time, the general condition, maintenance, appropriate use, and thus popularity of the green spaces in the capital were all outstanding. Many public parks as well as the largest urban parks were enriched and transformed with newly integrated functions such as early childrens' playgrounds [25]. In 1910 the Óbuda cemetery, which is still in use today, was opened, and a Jewish cemetery was opened next to it in 1922 [27] (p. 68). In 1919 the Budapest Municipal Cemetery Institute (Budapest Székesfővárosi Községi Temetkezési Intézet), the predecessor of the existing Budapest Funeral Institute (Budapesti Temetkezési Intézet, BTI) began its operations. From 1949 onward, the cemeteries previously owned by the Catholic church were taken over by the capital [28] (pp. 236, 239).

Budapest gained its current extension in 1950 when several surrounding small villages were annexed to the capital and the present-day outlying districts were formed. The previously independent municipalities had their own cemeteries; therefore, in 1950 Budapest possessed 87 cemeteries [28] (p. 236). In the 1950s, several small cemeteries were closed. Most were liquidated, although some cemeteries were reopened in the second half of the 20th century; in some cases, urn cemeteries were built on their sites. Those former village cemeteries that were suitable for expansion remain in operation today [12].

After the Second World War and from the 1950s onwards, development and settlement of housing estates began in earnest, along with the creation of significant public greenspace. At that time, these residential areas had a wide range of functions as public green spaces and a very high green surface ratio. On the other hand, the number of touristic developments in the urban forests increased dramatically [29]. After the change of regime in 1989 the structure of the city became more dense and the role of green spaces, including cemeteries, became more important, mainly due to the loss of former industrial areas and their conversion into office buildings and housing estates (Table 1).

Today, there are fifteen public cemeteries and four Jewish cemeteries in use in Budapest (Figure 6, Table A1). The public cemeteries are managed by the Budapest Funeral Institute, with the exception of the National Graveyard on Fiumei Road (Kerepesi cemetery). Due to its special status, this latter has been managed by the National Heritage Institute since 2016. The operating Israelite cemeteries are managed under ecclesiastical care. The closed cemeteries are partly municipality-owned and partly church-owned, and their management is mostly unresolved.

Table 1. The changing role of cemeteries and other urban green spaces (by authors, 2021).

Period	Urban Green Areas	Cemeteries
until the end of the Turkish occupation	small vegetable gardens, private residential gardens, extended agricultural land	cemeteries next to churches, burial places
1700s	increasing density of urban development leading to an emerging need for public green spaces and parks	cemeteries appear on the outskirts of the settlement, independently of churches
1800s	first public parks, large boulevards with alleys, afforestation, public squares and pedestrian areas with numerous trees	large new cemeteries established on the outskirts of the city. with the burial function remaining primary
1872–1945	more leisure activities in public parks; the first public playgrounds	large new cemeteries opened on the outskirts of the city due to rapid urban development, in which the graves of famous people become urban pilgrimage sites.
1945–1990	in parallel with the construction of housing estates, public green spaces around them are created; the first protected green areas are designated in the city, and park woodlands become significant	former village cemeteries around Budapest annexed to the capital by the creation of peripheral areas (many of which have been dismantled, although a few remain in use today), either as extensions or as urn cemeteries; cemeteries popular for recreational purposes thanks to attractive mature vegetation
1990s	new residential and office developments created on brownfield sites, increased building density, growing demand for open greenspace	tourist use of cemeteries, mainly guided walks around the graves of famous people and tertiary usage such as classical music concerts and exhibitions
2020	pandemic closures have pushed people even more towards urban green spaces, for which demand has increased, and many have become overused	during lockdowns, people spend part of their recreational time in cemeteries, and mourning also 'attracts' more and more people to cemeteries

Figure 6. Overview map of functioning cemeteries in Budapest. Cemeteries managed by BTI (Budapest Funeral Institute) [30]. Functioning cemeteries (green): 1. Angeli Road Urn Cemetery, 2. Cemetery in Budafok; 3. Cemetery in Cinkota; 4. Cemetery in Csepel; 5. Cemetery in Pesterzsébet;

6. Farkasréti Cemetery; 7. Old Cemetery in Kispest; 8. Cemetery in Kispest; 9. Cemetery in Pestszentlőrinc; 10. Megyeri Cemetery; 11. National Graveyard on Fiumei Road (from 2016 managed by NÖRI); 12. Óbudai Cemetery; 13. Cemetery in Rákospalota; 14. Tamás Street Urn Cemetery; 15. New Public Cemetery in Rákoskeresztúr; 16. Cemetery in Csömör (outside the administrative boundaries of Budapest). Closed cemeteries (red): 1. Cemetery in Rákosszentmihály; 2. Véka Street Cemetery; 3. Cemetery in Albertfalva; 4. Ganz Street Cemetery; 5. Nagykőrösi Road Cemetery; 6. Göcsej Street Cemetery; 7. Bocskai Street Cemetery.

1.3. Green Infrastructure Network of Budapest and the Role of Cemeteries in the Capital Today

In Budapest, as in other major European cities, the effects of climate change are increasingly noticeable and are expected to intensify in the coming decades. Forecasts indicate an increase in the number of heatwave days and tropical nights, which will make everyday life much more difficult for city residents [31].

The so-called urban heat island effect is a microclimatic phenomenon in large cities, where the temperature in built-up urban areas is significantly higher than in the suburban and rural areas surrounding the city. The causes of this phenomenon are complex; the most important are:

- lack of natural evaporative surfaces
- concrete and asphalt surfaces in cities absorb more solar radiation than they reflect
- vertical surfaces increase the absorption of radiation
- human activity generates heat in many different ways
- pollutants greatly modify the atmosphere
- changes to meteorological conditions such as wind direction, humidity, visible sky, precipitation, and radiation conditions [32–34].

Around 65% of Budapest's territory (34 thousand ha) is covered by green space and vegetation, and almost 2% of the city's territory is parkland; 40% of these green areas are managed by the Municipality of Budapest (420 ha), while the rest are owned or maintained by the district municipalities. Nearly 6000 ha, or 11% of the city's territory, is forested. The distribution of green spaces in Budapest is not even; in some inner-city districts (VI, VII) there is less than 1 m^2 of public park per inhabitant, while in the suburban districts there is good coverage of green spaces thanks to park forests. In Budapest, there is an average of 25 m^2 of forested parkland and only 6 m^2 of public park or garden per inhabitant. There is uneven use of green spaces, with well-positioned parks with cultural and historical value being constantly overcrowded [35].

Cemeteries play a dominant role in the urban structure due to their large surface area and, as a result of their function, their typically high proportion of green space. In addition to their memorial function, cemeteries represent a significant green space value, their green spaces being a key element of the capital's green space system [36] (Figure 7).

Both functioning and closed cemeteries are an important part of the capital's green infrastructure network. Cemeteries play an important role in the green infrastructure network of Budapest both because of their size (467 ha) and because of their high proportion of green space. The proportion of green space in cemeteries is well above the 40% defined in the OTÉK (Országos Településrendezési és Építési Követelmények, the National Town Planning and Building Requirements), even if the vegetation on the graves is not taken into account. The National Cemetery on Fiumei Road is the second-largest cemetery in Budapest, with the highest green cover (67%) [37]. For the cemeteries in operation, the Green Space Intensity Value ranges from 58% (Budafok cemetery) to 91% (New Public Cemetery), which is very high for the city. This value is largely influenced by the large mature trees in the cemeteries. Both the proportion of green areas and the ZFI value are higher for closed cemeteries; however, in many cases they are affected by the presence of weed species due to lack of maintenance, which negatively affects their use and value.

Figure 7. Chestnut tree alley in the National Graveyard on Fiumei Road (Photo: Imola Gecséné Tar, 2021).

Green spaces in cemeteries provide a range of ecosystem services to the population, such as improving air quality, enhancing the local climate, and providing aesthetic and recreational value [38]. In Hungary, the recreational use of cemeteries is not considered conventional; however, many people take advantage of the recreational opportunities offered by cemeteries. In addition to commemorative structures, almost all cemeteries have valuable mature tree species, tree lines, and rich biodiversity, which makes cemeteries an important part of biodiversity conservation [39,40]. In many cemeteries, both cemetery managers and visitors are already making serious efforts to preserve biodiversity; for example, in Farkasréti cemetery, bird feeders and bird boxes have been installed in several places (Figure 8).

The use of cemeteries as public green spaces contributes to the green coverage of the capital. The Action Area X of the Radó Dezső Plan, approved in 2021, concerns the cemeteries of Budapest, with the objective of "Protection, quality renewal and continuous professional maintenance of green infrastructure; development of an ecological approach to burial; efficient development and co-planning of public cemeteries; recreational use of functioning cemeteries; public use of closed cemeteries; temporary use of disused cemeteries as green spaces." The main tasks related to the achievement of these objectives, which are relevant to the present research, are "Better use of the recreational potential of existing cemeteries; public use of closed cemeteries; temporary green infrastructure use of disused cemeteries" and "Promotion of alternative burial methods; designation of urban areas suitable for forest burial" [35] (p. 62). The Capital intends to complete the planned improvements to the cemeteries by 2027.

Figure 8. "Bird feeder" in Farkasréti cemetery (Photo: Ágnes Sallay, 2021).

1.4. Touristic Activities in Cemeteries

For thousands of years, cemeteries have had the fundamental role of providing a burial place for the deceased and a place of remembrance for the bereaved. This primary function has been complemented in recent decades by secondary and tertiary functions such as providing adequate green spaces for local climate, recreation, and tourism [41]. This expansion of functions has implied a number of conflicts; how can all these traditional and new functions be managed in parallel? How can the primary needs be fully satisfied alongside the secondary and tertiary functions? Can the duty of remembering the deceased persons in cemeteries be reconciled with tourism? In many cases, the human need to say a dignified farewell to the dead has been eroded during the COVID-19 pandemic, traumatizing society and increasing the demand for cemetery use. The lockdowns due to the pandemic have affected the way cemeteries are used, with many people finding cemeteries a suitably quiet place to relax and remember their loved ones; even if they were not buried in the cemetery, they could visit in proximity. For those cemeteries where the green assets and vegetation were well established, the cemetery has become a place to meet nature (Figure 6).

In many places throughout Western Europe, the daily recreational use of cemeteries by the local population has become a general need and constant demand; in addition to the traditional walking activities in cemeteries, other forms of exercise such as running (in many places with separate tracks available on site), silent sports such as yoga, and dog walking are allowed under regulated conditions.

Among the tertiary touristic functions, guided walks are the most widely accepted, with visitors introduced to the values and stories of the cemeteries, mainly built heritage and grave marker interpretation. The natural or green values of cemeteries are rarely highlighted; rather, the guides include ideas about the flora and fauna of the cemeteries in

other guided walks, for example in Highgate cemetery. Other tourism-related uses have been raised and implemented in different cemeteries; theater performances and concerts are more and more commonly organized, although these activities divide society and often provoke opposition from the local population, for whom the cemetery is a place of remembrance. There are various guided tours in the largest cemeteries of Budapest, where visitors can learn about the local history, the gravestones, and the famous people who rest in these cemeteries (Table 2). However, there are only a minority of guided tours that interpret the cemeteries as green spaces, presenting their living flora, and there are very few guided walks especially offered for children.

Table 2. The topics of guided walks in the largest cemeteries of Budapest (author's table with use of [42–44] sources).

Organizing Institute or Company	The Name or the Theme of Walks and Guided Tours
Sétaműhely Ltd.	Trees and headstones—guided walks in the Farkasréti Cemetery On the trails of Kohanites
Imagine Budapest (Sétapálca Ltd.)	A past encased in stones—a tour of the Salgótarjáni Street Jewish Cemetery
Nemzeti Örökség Intézete (NÖRI) National Heritage Institute	Parcels of artists "Faster, Higher, Stronger"—Olympic medalists in the National Graveyard "On hidden pathways"—cycling tour in the National Graveyard on Fiumei Road Celebrated gipsy violinist First World War—Military tombs 19th century's prime ministers Musician souls The artists of the "Nyugat" generation Under the spell of "Thália" The masters of Hungarian painting The death cult of the socialism The secrets of the plot 301—What do the graves tell us? The Prime Ministers of the 20th century Inventors and engineers In the footsteps of great travelers The gravestone artworks of Béla Lajta in the Jewish cemetery on Salgótarjáni Street Budapest, Budapest, so wonderful The life of an artist in sculptures Sacred depictions in funerary art of tombs In the footsteps of the Piarist Fathers and their disciples Mausoleums and the National Graveyard on Fiumei Road Those doomed to oblivion—Specific interpretation walk Graves in the garden—plants and symbols in the cemetery "That soul in me..."—Literary walk in the cemetery Immortal art—Sculptors and sculptures Remembering 1848–49 Ferenc Deák and his generation Memento '56 History of the Jewish cemetery on Salgótarjáni street Women, Muses, Destinies Women on the trail of success Gastro moods Family walk with the little ones Go, Hungarians! Athletes and sports leaders Irregular school lessons in the cemetery Secrets of an oasis in the heart of the city—The National Graveyard on Fiumei Road (guided walk in English language)
Budapesti Temetkezési Intézet (BTI) Budapest Funeral Institute	Guided walks in the Farkasréti, Óbudai and Rákoskeresztúri Cemeteries

The touristic use of cemeteries in Western Europe was already evident in the early 2000s. The Südwest-Kirchhof in Stahnsdorf, in the immediate vicinity of Berlin, is one of the first representatives of a landscape-style forestry cemetery, and the third largest in Germany. The cemetery, which was almost abandoned at the end of the Second World War, was the subject of a strategic plan, a programme drawn up in the early 2000s by the cemetery's advocacy association. After recognising the cemetery's cultural, historical, and artistic importance along with its natural value, the primary objective was to bring it back into public consciousness while introducing new ways of usage. Attracting community programmes, frequent invitations of the press, and a widespread sensitisation and awareness to unique burial opportunities have brought the result that the cemetery has now been reborn. It has become a popular destination for Berliners, as have, the cemetery gardens in the city center, which are operating as active elements in the green space infrastructure as a place for recreation. The function of the funeral chapel has been extended to include cultural functions such as conferences, exhibitions, and concerts. The cemetery employs volunteers and trainees who contribute to the success of the actions through their maintenance, research, and guide work. The cemetery's management has discovered and uses the opportunities offered by the media and the internet; periodic press conferences on the cemetery's cultural and historical significance, its artistic values, its current events, and even a promotional film have all been regularly created [11,45].

In terms of touristic use, the Central Cemetery of Vienna (Zentralfiedhof Wien) is a particularly successful example. In addition to the traditional use of the cemetery for burial and commemoration purposes, a number of improvements with diverse goals have been made in recent years:

- Classical music and rock concerts have been organized
- Sports facilities were developed, e.g., a running track was arranged in the cemetery,
- and electric bicycles for hire and carriage rides are offered as new services
- Regular night-time opening during the month of October to give visitors a night-time view of the cemetery
- Music walks offered, with live music accompanying the walkers
- Painting course offered, where visitors can create their own artwork souvenir of the cemetery
- A cemetery museum has been opened where visitors can learn about the history of the cemetery and the famous people buried there
- Nature-focused guided walks and camps for children
- A café and gift shop have been opened at the cemetery gate

The cemetery has responded to emerging digital needs as well; anyone can take part in a self-guided walk with a QR code (Hearonymus programme), and if required, visitors can find out information about the available burial places from a digital database. Visitors can even open a digital memorial link for a deceased loved one, with the possibility of storing commemoration materials, photos, and videos about them.

All these improvements to the Central Cemetery of Vienna have been carried out in close and regular consultation with the public, taking into account their opinions and requests, to the great satisfaction of the people of Vienna as shown by the fact that the cemetery was awarded the "best place in Vienna prize" in 2020 [46].

Following foreign trends, alternative ways of using cemeteries have already appeared in Hungary. The best example of this is the National Graveyard (Fiumei Road Cemetery), where visitors can take part in numerous thematic walks which introduce them to the stories of emblematic persons buried in the cemetery and of other people with interesting background histories. A more 'sporting' form of visit is exists where tourists can sign up for a bike tour of the cemetery. In this largest cemetery of Budapest, it is common to see mums walking with baby strollers, young people picnicking or studying, or sportsmen exercising, running, or cycling. Because the cemetery was designed and executed as a large green park area from the beginning of its creation and is planted with many valuable trees and alleys, the recreational popularity is not surprising. The urban wildlife established in

this cemetery is quite rich, and the site is comparable to a large-scale arboretum with its 56 hectares. It is important to mention the Memorial Museum operating in the National Graveyard, where visitors can learn about different aspects of Hungarian cemetery culture and burial traditions through permanent and temporary exhibitions [13].

2. Materials and Methods

This research focuses on the cemeteries of Budapest, analyzing them based on data collected during site visits and a research process employing relevant photograph and map sources. The theoretical foundations were established through literature sources on the following topics: (1) cemeteries–recreation and cemeteries–tourism relationship; (2) green spaces–green space infrastructure and the history of cemeteries in Budapest; (3) tourism activities in cemeteries–opportunities and foreign models. The main questions of our study were then formulated as follows: (1) what are the motivations of visitors for visiting cemeteries, and what are the values of each cemetery related to visitor motivations? and (2) what are the cemetery visiting habits and needs of the Hungarian population?

To answer the first question, we used literature sources to prepare an aggregation of cemetery visitor motivations followed by a survey of the attractions associated with these motivations in each cemetery. Visiting a cemetery can be either the main purpose of a trip or a secondary purpose, as a complementary part of it. As cemeteries have a wide range of attractive aspects, there are many motivations for visiting them; using the work of Tomašević (2018) [47], Moreno (2018) [48] and Pécsek (2015) [49] as a starting point, we defined the following motivation categories based on literature research and our own experience:

(1) Basic motivation: visiting family graves. This includes visiting, searching one's own or others' family roots and genealogy. A place of confrontation with mortality.
(2) Cultural motivation: the cemetery as an open-air museum, a repository of material and spiritual treasures.
    (i) Graves of famous people (kings, presidents, politicians, artists, writers, poets, actors, scientists, etc.)
    (ii) Architectural curiosities (emblematic constructions, crypts, mausoleums, etc.)
    (iii) Sculptural curiosities
    (iv) Places of interest, or a place of personal interest (e.g., the cemetery is featured in a film or a book), ideal for practicing a hobby (e.g., photography, painting)
    (v) A "must see" place, i.e., it is on the World Heritage List or on Tripadvisor
(3) National sentiment: visiting memorial parks, military cemeteries; participating on different on-site memorial events
(4) Admiration/love of nature: visiting cemeteries as other parks and arboretums. Special botanical and garden architecture interests, or more generally, a reason for escaping from urban pressures and providing relaxation and recreation
(5) Education and research: visits driven by an interest in history and culture. Visitors especially come to learn more about the history of the cemetery, the place where it was established, and the people who are buried there
(6) Religious motivation (pilgrimage): visiting graves of significant religious/ecclesiastical personalities (e.g., popes, church leaders) or tombs of religious and/or historical significance (e.g., the tomb of Jesus in Jerusalem). A place of confrontation with mortality
(7) The cemetery is an open-air leisure site with organized programs; visiting a concert or a performance in a cemetery
(8) No motivation: unplanned visits. No specific interest in the special features and offerings of the cemeteries. Curiosity, "let's see what we can find here" attitude

To answer the second question, we conducted a questionnaire survey in September–November 2021 among the population of Hungary with the intention of uncovering their cemetery visiting habits. In Hungary, the number of visits to cemeteries associated with All Saints' Day and Day of the Dead is high [50]; therefore, the questionnaire was distributed during this

period. We hoped this recent experience would increase the response rate and lead to more accurate answers. The questionnaire was completed in electronic form and was available online at https://forms.gle/PaZcbcRFidn4G1wKA (accessed on 1 November 2021). We wanted to know how often people visit cemeteries and for what reasons. We asked what activities not related to the basic memorial functions of cemeteries respondents considered to be acceptable.

The structure of the questionnaire can be found in the Appendix B. The questionnaire consisted of certain main questions and diverse supplementary questions. The main questions directly addressed the research topic, while the supplementary questions were asked in order to increase the reliability of the information obtained. For this reason, these latter were general demographic questions used to determine gender, age, education, etc. The questionnaire included open, semi-closed, and closed questions. In the case of the closed questions, respondents were asked to tick one of the pre-selected options. Semi-closed questions included an 'other option' category next to the offered ones, which allowed respondents to complete the list themselves if they did not find a suitable pre-written answer(s). Another example of a semi-closed question is where, in addition to yes/no answers, respondents were asked for the reasons behind their choice. For open questions, respondents were given the opportunity to formulate their answers in their own words.

The sampling was completely random. No attempt was made to limit or influence completion or to narrow down the pool of respondents. The aim was to obtain as wide a range of ages and interests as possible filling out the questionnaire and to determine the overall aspects of the typical visit. Due to the COVID-19 pandemic, we distributed the questionnaire online through professional and personal platforms, websites, and social media. The survey was successful, as 213 people completed it. Our objective was achieved in that the respondents were diverse in terms of gender, age, place of residence, education, and employment background.

In order to increase the reliability of the survey, another questionnaire was included for those who organized or led visits to cemeteries (Appendix C). This was used as a control, as some of the questions overlapped with the questionnaire for the general public. From these responses we gained better insight into the opportunities and problems from a tourism-specific point of view.

3. Results

With appropriate promotion, urban cemeteries could become an integral part of urban green tourism, as has already been the case for cemeteries abroad, e.g., in Paris and Prague. Visitors to urban cemeteries spend relatively long periods of time, even several hours, at these sites. The offered leisure activities, such as walking, photography, etc., contribute to a positive visitor experience. The traditional authenticity of cemeteries in terms of their extension, spatial structure, architecture, landscaping, artistic value, and local historical background, is sufficient to maintain their tourist appeal and visitors do not expect major improvements to infrastructure or attractions. Thus, from the visitor point of view, cemeteries do not require any major investment to enhance their attractiveness other than promotion of their highlights and conservation of their existing value (Figure 9).

3.1. Results of Research on Visitor Motivations

Visiting a cemetery might be the main purpose of traveling or a part of regular touring, or a primary or secondary motive for traveling, and might be driven by emotions of variable intensity. During our research we identified eight motivating elements in visitors to Budapest cemeteries. We identified the potential tourist attractions within each motivation category; then, through written sources, maps, and field visits, we identified which cemeteries in Budapest have which tourist attractions (Table 3).

Figure 9. Guided walk in the National Graveyard on Fiumei Road (Photo: Imola Gecséné Tar, 2021).

Table 3. Visitor motivations, with related attractions and values in the cemeteries of Budapest (edited by authors, 2021).

Visitor Motivations	Attractions	Representative Cemeteries
1. Basic motivation	tombs and crypts of families	All functioning cemeteries
2. Cultural motivation		
2.1. graves of famous people	graves of kings, presidents, politicians, artists, writers, poets, actors, scientists, etc.	National Graveyard on Fiumei Road Farkasréti Cemetery New Public Cemetery in Rákoskeresztúr Farkasrét Jewish Cemetery Óbudai Jewish Cemetery Kozma Street Jewish Cemetery Salgótarjáni Street Jewish Cemetery
2.2. architectural curiosities	emblematic constructions, crypts, mausoleums, etc.	National Graveyard on Fiumei Road Farkasréti Cemetery Kozma Street Jewish Cemetery Salgótarjáni Street Jewish Cemetery Budafoki temető
2.3. sculptural curiosities	cross, statue, carving	National Graveyard on Fiumei Road Farkasréti Cemetery Óbudai Cemetery Salgótarjáni Street Jewish Cemetery Óbuda Jewish Cemetery Budafoki Cemetery Kisszentmihályi Cemetery
2.4. places of interest, or a place of personal interest, ideal for practicing a hobby (e.g., photography, painting)	the cemetery is featured in a film or a book	
2.5. a "must see" place	it is on the World Heritage List or on Tripadvisor	
3. National sentiment	memorial parks, military cemeteries graves being attached to wars, monuments of wars	National Graveyard on Fiumei Road New Public Cemetery in Rákoskeresztúr
4. Admiration/love of nature	Special botanical and botany or zoology value	National Graveyard on Fiumei Road Farkasréti Cemetery New Public Cemetery in Rákoskeresztúr Óbudai Cemetery
5. Education and research	curiosity of settlement history	National Graveyard on Fiumei Road Salgótarjáni Street Jewish Cemetery Closed cemeteries outskirt, earlier communal cemeteries
6. Religious motivation (pilgrimage)	tombs of religious and/or historical significance, calvary	All Jewish Cemetery National Graveyard on Fiumei Road
7. Local	organised programs, concert, or a performance	National Graveyard on Fiumei Road
8. No motivation		All functioning cemeteries

It is important for cemetery managers, travel agency staff, and tourism organizations to use standardized classification categories in order to target and reach visitors with the right interests. An important role in promotion should be TripAdvisor ranking; the high position of cemeteries as places to visit in several destinations proves the significance of cemeteries as tourist attractions. Cemeteries should make a proper and thorough analysis of all possibilities in order to increase their attractiveness and accessibility as well as awareness about their cultural, historical and natural importance. Further research could be aimed towards practical implementation of the cemetery concept as a tourist attraction with a focus on travel agents and local authorities and on enhancing their understanding of cemeteries as tourist products which can enable them to create new programs and find new markets.

3.2. Results of Questionnaire Survey

The results of the two questionnaire surveys are presented separately in the following subsections.

3.2.1. Results of Visitor Questionnaire Survey

The majority of respondents were aged between 25 and 60 years (25–40 years 21.6%, 40–50 years 31.5%, 50–60 years 26.8%), female (83.6%), with a university/college degree (84%) and living in Budapest (54.9%) or in the Budapest agglomeration (14.6%). According to our survey, 37.1% of respondents visited a cemetery only once a year and 15.5% even less frequently; 29.1% visited quarterly, and 13.6% monthly.

First, we wanted to know whether the frequency of respondents' visits had changed due to the pandemic closures. For the majority (73.2%), there was no change; 23.9% visited cemeteries less frequently, and only 2.8% visited more often. Those who went to the cemetery more often than before were asked why. They were given the option of indicating more than one answer and were given the option of giving an individual answer; 32% expected to find peace of mind from their visits, 28% increased their knowledge by visiting the cemetery, 24% were able to walk and move around the cemetery at a reasonable distance during the closure period, and 18% had a cultural programme.

The purpose of the visit was explored from several perspectives: (1) Why do people usually visit cemeteries? and (2) Do they visit cemeteries during their travels? In both cases, several answers were possible, and individual answers were possible as well. The answers were quite varied. The primary purpose of the visit was "to visit the graves of my loved ones/relatives", at 81.7%; 21% and 27% of respondents, respectively, chose "to remember the deceased" (not necessarily in the cemetery where they are buried), "to visit the graves of famous people" (Figure 10), "to see the statues and buildings in the cemetery", and "to walk around, to relax". Individual responses included an interest in cemetery culture, walking the dog, chestnut/peanut picking, learning about the history of the village, peace and quiet, and greenery.

Of the respondents, 35.7% did not visit cemeteries during domestic trips. The rest (based on multiple choice) mainly visited the graves of relatives and friends (36.6%). Visiting historical sites (28.2%) and the graves of famous people (24.4%) were popular as well. The interest in visiting works of art (17.4%) and vegetation (17.8%) in the cemetery were almost the same, while 10.8% said they visited buildings/construction. Individual responses included "just looking around", "for the atmosphere" (tranquility + green), "to visit cemeteries that are unique/special in some way", "for cultural purposes", "to learn about local history", "as a tourist attraction", and "for the gravestones/inscriptions".

Fewer people visited cemeteries when traveling abroad, with 44.6% of respondents not visiting cemeteries. The majority of people who visited cemeteries abroad went to historical sites (35.2%) or to the graves of people they know (26.3%). Individual responses were dominated by the desire to learn about the cemetery culture of other countries and to visit unique/special/noteworthy cemeteries, as well as by the desire for green space and a peaceful atmosphere.

Figure 10. The tomb of János Arany in the National Graveyard on Fiumei Road (Photo: Imola Gecséné Tar, 2021).

Of the respondents, 40.8% had visited a cemetery for recreation. In addition to walking (74%) and sightseeing (74%), reading (5.2%) was the most common activity (multiple choice). Individual responses varied widely in their choice of activities, including photography (statues or Halloween), sports (running, cycling), guided walks, birdwatching, and concerts.

Of the survey respondents, 31.9% had attended a cemetery-related event. Based on individual responses, these includes any kind of commemoration (national holiday, World War II, Day of the Dead), wreath-laying, and guided walks. An equal number of respondents attended theater events and concerts. Only 10.8% participated in an event unrelated to the basic function of the cemetery. These included interesting events such as a photo lessons, drawing, nature walks, "the night of nightingales", book readings, exhibitions, and concerts, of which the latter two were the most frequently mentioned.

Well-kept cemeteries are important to visitors (92%), and this influences the time they spend there (65.7%). In terms of vegetation, the presence of trees/woods is considered the most important (93%, based on multiple choice), while shrubs (61.5%), grassy areas (60.6%) and flower beds (53.5%) play a significant role.

To conclude the questionnaire, we asked respondents what conditions they thought should be met in order for a cemetery to be suitable for recreation. Several answers could be ticked, and individual comments were possible. Of the answers we offered, the highest-ranked was green space (79.3%), followed by good accessibility (57.3%), open space between graves (57.3%), and a closed cemetery (11.7%). Among the individual responses, several respondents said that they did not consider cemeteries suitable for recreation. However, there were many constructive suggestions. Respondents felt it was important that recreational activities should not in any way interfere with the primary function of the cemetery and those who go there to commemorate the deceased. Several respondents mentioned basic infrastructure elements such as water supply, toilets, lighting, benches, waste bins, and security. They stressed the importance of being close to nature and the view, tidiness, well-kept graves, and the existence of quality green spaces. The creation of a park-like greenspace and memorial garden as a recreational area could be an important aspect of cemetery planning in the future. However, the first and most important thing to do is to change attitudes.

3.2.2. Results of Guide Questionnaire Survey

The questionnaire for tour guides was filled in by seven respondents, most of them contracted guides for the managing companies of Budapest's cemeteries (NÖRI and BTI), which provide regularly-conducted guided walks in the cemeteries they manage (namely,

National Graveyard on Fiumei Road, Jewish Cemetery on Salgótarjáni Road, Farkasréti Cemetery, Óbuda Cemetery, and Budafok Cemetery). The responses clearly showed that guided tours of cemeteries are in increasing demand among Budapest residents and tourists alike. Visitors go on guided walks mainly due to the cultural aspects of graves and memorials of famous people buried there and the stories associated with them, and additional attractions such as artistic sculptures and buildings make for a very charming experience. The wildlife, both flora and fauna, in the cemeteries are an additional attraction that adds color to the walks. During touristic use of cemeteries, the operators pay particular attention to ensuring that the main functions of the cemeteries are not compromised; thus, guided walks are organized during periods when burials are not in operation. During the guided walks, several companies use equipment such as earphones to provide adequate audibility while ensuring that loud speech does not disturb people visiting and caring for the graves of their loved ones.

Cemetery guides declare that the tourist potential of these facilities depends largely on the maintenance level of the green spaces which, especially during the growing season, provides an attractive background for the graves; in the summer, the shade of the trees makes the walks more pleasant for visitors. The development of appropriate infrastructure is essential for touristic exploitation; accessibility, parking, and restrooms are needed in sufficient quantities and quality. In the local metropolitan context of Budapest, a need for gift shops and catering facilities has not yet been formulated by visitors.

In addition to the primary functions of cemeteries, professional guides consider thematic walks and cultural activities (e.g., exhibitions, concerts) as possible secondary uses for memorial parks and graveyards.

4. Discussion

The responses to the two questionnaires show that people in Hungary are not yet open enough to attending activities in cemeteries other than attending and caring for the graves of their deceased relatives or commemorating honorable persons. This is somewhat contradicted by the fact that many people and a wide variety of programmes have taken part in cemeteries, which shows that people are not closed to the possibility. A change in attitude, as mentioned by one of the respondents, may be a reason for that, as we may currently be in an early phase of slow transformation. However, the variety of organized programmes listed in the questionnaire responses shows that cemetery managers are open to new potentialities. The Budapest Funeral Institute is explicitly open to challenges, although they are aware that changes should be made slowly and steadily, as sudden reforms can have the opposite effect [51]. A free small train tour has been organized in the Fiumei cemetery to complement the already-existing irregular school lessons. While the Day of the Bells took time to become established, people gradually accepted the idea of alternating childrens' programmes with light music and instrumental concerts in a cemetery. The Fiumei út Cemetery is a popular place for people to walk, push a pram, play ball with their children, or just lie on the grass with a blanket. It is home to the Museum of Funerary Art, Hungary's only specialized collection of funerary and memorial art. The crematorium in Csömöri Graveyard has a café where relatives can 'wait' for their loved ones to be buried in peace.

Our research clearly shows that the advanced types of cemetery tourism forms in Hungary belong today to the unconventional category. The touristic use of cemeteries is a non-conventional tourism industry sector because cemetery visitors mostly visit graves without using registered tourism services, but they still strengthen the tourism service industry by travelling to the site and using other services near the cemetery. Meanwhile, the responses indicate that this issue should be discussed and convenient options and solutions acceptable to all parties should be explored.

Nevertheless, we can state that there exists real cemetery tourism in Hungary. Not only do cemeteries in the capital increasingly appearing on the list of tourist attractions; those in the countryside with an interesting history and local graves of famous Hungarian

people do as well. According to Gábor Móczár, Director General of the National Heritage Institute (NÖRI), the main activity of facilities such as the National Graveyard is no longer to provide burial services; it is rather to present the diverse cultural values and promote dignified remembrance. For foreigners, the biggest attraction in cemetery tourism might be exploring and enjoying the local works of art. In June 2021, the NÖRI joined the Association of European Significant Cemeteries, a European network of historic and thematic cemeteries that includes the two cemeteries they manage (the National Graveyard on Fiumei Road and the Jewish Cemetery on Salgótarjáni Road). At the same time, the managing institution has joined the European Cemeteries Route, a more operational European cooperation community in terms of mutual travel programs, funding, and professional contacts, which has put Hungary on the map of European cemetery tourism in this respect [52]. A free app called FiumeiGuide has been developed which, in addition to presenting 150 priority highlights in the graveyard, currently allows users to plan their own personalized thematic tour.

The answers to the main questions of our study were provided by the capabilities and constraints identified during our research on the touristic use of Budapest cemeteries.

(1) In terms of tourist attractions and sights, the surveyed cemeteries are well-endowed. However, there is an urgent need to collect and identify these assets and values as thematic tourist attractions and to make their relevant information available to visitors. It is important to bear in mind that the cemeteries were not created for tourism purposes. They have gradually become tourist attractions throughout history. Thus, their primary function should not be negatively affected by their use for tourism and recreation. Although cemeteries are not yet conventional touristic destinations in Hungary, they have the potential to become more attractive in the future; their natural, built, and spiritual value and the tangible and intangible heritage they involve reinforce each other. Thus, cemeteries can be identified as open-air recreational areas with several attractions, where the past and present of a settlement as well as its development can be explored in a relatively small area during an individual or guided walking tour. Another beneficial factor is that most municipal cemeteries are open for a wide range of hours and are usually free of charge for visits. Attractiveness can be further enhanced by improving organized cultural programs and events on site. Depending on the cemetery, this could be the development of an existing attraction or the creation of a new one by unique or complex product improvement. This latter may include singular interventions as enhancements of the immediate surroundings around a main attraction, as well as any green space development.

(2) We have found a number of shortcomings in the tourist infrastructure of the cemeteries surveyed on the basis of both our personal site visits and the questionnaire responses. Tourism infrastructure in this case refers to the whole of the welcoming facilities, i.e., those infrastructural elements that can be used by the general public and that enable touristic activities. The improvement of basic tourism services and their background infrastructure is essential and covers, in particular, the development of utilities and pathway systems in a graveyard. This is important for the needs of both tourists and everyday visitors. For recreational and touristic purposes, it is important to provide the essential conditions for a longer stay. For example, there is a fundamental need to provide more benches and basic services such as restrooms. Improving accessibility in general is usually linked to complex touristic and infrastructural development, and is certainly a critical issue. The development of other services that serve mainly tourists, such as souvenir shops, should be preferably developed only after basic service needs have been satisfied.

(3) There are major gaps in the use of visitor management tools. In the case of historic cemeteries, reconciling their original function with touristic uses requires due diligence. Problems related to touristic use can be avoided or solved by using appropriate management methods. For example, problems are often caused by lack of infrastructure (toilets, cleaning facilities, catering facilities), resulting in pollution

and litter issues, or by tourists/visitors disturbing mourners and commemorators with their constant presence, talking, or general loudness. Solutions could include the preparation of visitor management tools, planning the movement of visitors in advance, better managing the potential negative impact of visits, and avoidance or mitigatation of negative consequences. Passive exhibition techniques appropriate to the character of the cemetery may be good practice for visitor education, although in most cemeteries only an overview map of the cemetery layout is displayed. There are rarely any signs or printed materials (brochures, guides, and more detailed special publications) providing information on the specific values and attractions of the cemeteries and visualizing their locations. For larger cemeteries, it is necessary to develop thematic itineraries for guided tours or self-exploration walks. During self-guided tours, visitors can follow a pre-edited brochure along the way.

5. Conclusions

Based on our research, we can conclude that cemeteries, as green open spaces in major cities, play a highly-important role in urban greenspace systems and infrastructure such as local climate control, daily recreation, and tourism services. Cemeteries provide profoundly essential ecosystem services for both the residents of surrounding urban areas and for visitors. Among the ecosystem services provided by cemeteries, their regulating services have a main role in the adjustment of climate issues, while their cultural services contribute to the preservation of traditional and cultural heritage aspects as well as to the recreational and touristic function of these sites.

The green surfaces of cemeteries are traditionally defined by tree alleys which delimit the pathways separating the burial plots, as well as by grassland areas and flower beds between the graves; these are, as a whole, important for visitors. As the vegetation becomes older and larger in well-established and maintained sites, the shading effect of trees becomes increasingly important, as they provide tolerable urban climate conditions for visitors in the summer. Large cemeteries with mature trees can have temperatures during the summer several degrees lower than in the surrounding areas, providing a pleasant resting place for visitors. Our questionnaire research clearly shows that the level of maintenance and care for the vegetation in cemeteries is essential for both visitors and tourist guides, two target groups whose opinions must not be neglected.

Despite the recognised green value of urban cemeteries, the presentation of their semi-natural vegetation and habitat is unfortunately little-developed in Hungary, although this could help to diversify guided walks and even enlarge environmental education functions in these cultural complexes. However, any tourist development should prioritize the fundamental needs of the local population, namely, unhindered commemoration and care of graves. Hopefully, in the short term and with the right development accompanied by public education, remarkable cemeteries with significant green spaces can play a satisfactory role in future green tourism in urban areas in Hungary.

The use of cemeteries for tourist purposes must remain in balance with their traditional memorial function. We have examined the possible tourist exploitation of different types of cemeteries (e.g., closed/inactive or active cemeteries, gridded, and landscape-style cemeteries) within an ethical framework (Figure 7). We have found that in addition to their architectural and artistic value, the green surface intensity of a cemetery largely contributes to their wider potential for tourism uses.

The greenspace potential of a cemetery consists of several factors. If the vegetation cover and plant use are adequate, the ecological importance of the area is evident. However, only cemeteries with a sufficient size and maintenance level are suitable for other green space functions such as recreation purposes. Cemeteries with a smaller area may be suitable for daytime recreation, while cemeteries with a larger surface area can be visited from a greater distance, similar to urban public parks. It is important to note here that the primary memorial function of cemeteries should not be compromised, which is why closed cemeteries are more suitable for recreation than functioning cemeteries. It is important to mention that, even in a closed cemetery, recreational activities should be allowed only after

due consideration. Walking, reading, and quiet contemplation do not disturb a functioning cemetery; however, certain sports activities and noisy programmes that attract large crowds are not even conceivable in a closed cemetery. Some non-intensive sports (e.g., running, yoga) or cultural events that attract fewer people and do not result in damage either physically or spiritually may be allowed in a closed cemetery.

The recreational and touristic use of cemeteries are partly interconnected, as the green potential of a cemetery determines the interest in the cemetery (e.g., visits for botanical values). In terms of tourist use, priority should be given to those cemeteries in Budapest that can already offer other attractions in addition to their primary function. A cemetery is most attractive for tourism if it has suitable potential beyond its original function, i.e., visitors seek out its special architectural, natural, or artistic values, the burial places of famous people, or sites of cultural and historical interest.

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Abbreviations

NÖRI	Nemzeti Örökség Intézete—National Heritage Institute
BTI	Budapesti Temetkezési Intézet—Budapest Funeral Institute
MAZSIHISZ	Magyarországi Zsidó Hitközségek Szövetsége—Federation of Hungarian Jewish Communities

Appendix A

Table A1. Operating cemeteries in Budapest: an overview table (by authors, 2021).

Operating Public Cemeteries			
Name of the Cemetery	**Location in Budapest**	**Cemetery Management**	**Features**
Cemetery in Óbuda (Óbudai temető)	3rd district	BTI	guided tours
Tamás Street Urn Cemetery (Tamás utcai urnatemető)	3rd district	BTI	urn cemetery on the site of the former Békásmegyeri cemetery
Megyeri Cemetery (Megyeri temető)	4th district	BTI	extension of the former village cemetery
National Graveyard on Fiumei Road = Kerepesi cemetery (Fiumei úti sírkert = Kerepesi temető)	8th district	NÖRI	national pantheon, guided tours
New Public Cemetery in Rákoskeresztúr (Rákoskeresztúri Új Köztemető)	10th district	BTI	the largest cemetery in Hungary, guided tours
Farkasréti Cemetery (Farkasréti temető)	11th district	BTI	the largest cemetery in Buda, guided tours
Cemetery in Rákospalota (Rákospalotai temető)	15th district	BTI	extension of a former village cemetery
Cemetery in Cinkota (Cinkotai temető)	16th district	BTI	extension of a former village cemetery

Table A1. *Cont.*

Operating Public Cemeteries			
Name of the Cemetery	**Location in Budapest**	**Cemetery Management**	**Features**
Cemetery in Pestszentlőrinc (Pestszentlőrinci temető)	18th district	BTI	extension of a former village cemetery
Old Cemetery in Kispest (Kispesti Öreg temető)	19th district	BTI	reopened former village cemetery
Cemetery in Kispest (Kispesti temető)	19th district	BTI	extension of a former village cemetery
Cemetery in Pesterzsébet (Pesterzsébeti temető)	20th district	BTI	extension of a former village cemetery
Cemetery in Csepel (Csepeli temető)	21st district	BTI	extension of a former village cemetery
Cemetery in Budafok (Budafoki temető)	22nd district	BTI	former village cemetery
Angeli Road Urn Cemetery (Angeli úti urnatemető)	22nd district	BTI	urn cemetery on the site of the former Nagytétényi cemetery
Operating Jewish cemeteries			
Name of the cemetery	Location in Budapest	Cemetery management	Features
Jewish Cemetery in Óbuda (Óbudai izraelita temető)	3rd district	MAZSIHISZ	
Jewish Cemetery in Kozma Street (Kozma utcai izraelita temető)	10th district	MAZSIHISZ	the largest Jewish cemetery in Hungary
Orthodox Jewish Cemetery in Gránátos Street (Gránátos utcai ortodox izraelita temető)	10th district	MAZSIHISZ	
Farkasréti Jewish Cemetery (Farkasréti izraelita temető)	11th district	MAZSIHISZ	

Appendix B

Questionnaire on the use of cemeteries (visitor questionnaire)

I. Questions about the respondent:

- age: 18–25 y, 25–40 y, 40–50 y, 50–60 y, 50–70 y, 70 over
- sex: female/male
- education: 8 primary school, secondary school, university/college
- place of residence: Budapest, Budapest agglomeration, large city, medium-sized city, small town, village, other options to define:

II. Questions on cemetery visiting habits:

- How often do you visit a cemetery?
- weekly
- several times a month
- on a quarterly basis
- yearly
- less frequently

III. Has the frequency of your cemetery visits changed due to the pandemic closures?

- yes, I've been there less often
- yes, I have gone there more often
- No, it has not changed

IV. If you went to the cemetery more often during the closures, what was the reason? (multiple answers are possible)

- I expected spiritual comfort from the visits

- It was possible to walk and move around the cemetery at a reasonable distance during the closures
- The visit to the cemetery provided a cultural programme
- I expanded my knowledge with what I saw in the cemetery
- other options to define:

V. What is the purpose of your visit to a cemetery? (multiple answers are possible)

- visit the graves of my loved ones/relatives
- remember the deceased (not necessarily in the cemetery where they are buried)
- visit the graves of famous people
- get to know statues, artworks and buildings in cemeteries
- for walking and relaxing

VI. Do you visit cemeteries when you travel in your home country? (you can tick more than one answer)

- yes, I mainly visit the graves of relatives and friends
- yes, I visit cemeteries as historical sites
- yes, I visit the graves of famous people
- yes, I visit artworks and statues in cemeteries
- yes, I visit buildings and other architectural elements
- yes, I am interested in the green surface and vegetation of cemeteries (protected and special species)
- yes, other options to define:
- no

VII. Do you visit cemeteries when you travel abroad? (you can tick more than one answer)

- yes, I mainly visit the graves of relatives and friends
- yes, I visit cemeteries as historical sites
- yes, I visit the graves of famous people
- yes, I visit artworks and statues in cemeteries
- yes, I visit buildings and other architectural elements
- yes, I am interested in the green surface and vegetation of cemeteries (protected and special species)
- yes, other options to define:
- no

VIII. Have you ever visited a cemetery for recreational purposes?

- yes
- no

IX. If yes, what were you doing there? (multiple answers are possible)

- walking
- reading
- contemplating
- doing sport activity (e.g., running)
- other options to define:

X. Have you ever participated in a cemetery-related event (e.g., commemoration, other ceremony)?

- yes
- no

If yes, what was it?

XI. Have you ever participated in an event not related to the cemetery's core function (e.g., concert, exhibition, bird ringing activity, etc.)?

- yes
- no

If yes, what was it?

XII. Is the maintenance of the cemetery important to you?

- yes
- no

XIII. Is the time spent in the cemetery influenced by the current physical condition of the cemetery or by the abundance of green spaces there?

- yes
- no

XIV. What kind of vegetation do you consider important in a cemetery, apart from the plants on the graves?

- trees, alleys
- flower beds
- shrubs
- grasslands

XV. What conditions do you think must be provided by a cemetery to be attractive for recreation? (multiple answers are possible)

- good accessibility
- it should be a closed cemetery (with no more active burials)
- free space between graves
- good coverage of green areas
- other options to define:

Appendix C

Questionnaire for tourist guides on the use of cemeteries

I. In which cemetery do you usually organize guided tours?

- National Graveyard on Fiumei Road (Fiumei úti temető/Kerepesi úti temető)
- Farkasréti Cemetery (Farkasréti temető)
- Jewish Cemetery in Salgótarjáni Road (Salgótarjáni úti zsidó temető)
- other options to define:

II. How often do you organize guided walks?

- weekly
- once a month
- several times in a month
- a few times a year

III. Do you organize guided walks specifically dedicated to the cemetery/ies or as part of a more complex tourist programme?

- I organize themed cemetery walks on different sites
- I also bring tourists to cemeteries on my sightseeing walks.
- I organise walks only in the National Graveyard on Fiumei Road (Fiumei úti temető/Kerepesi úti temető)
- I organise walks only in the Farkasréti Cemetery (Farkasréti temető)
- I organise walks only in the Jewish Cemetery on Salgótarjáni Road (Salgótarjáni úti zsidó temető)
- other options to define:

IV. How many people visit cemeteries with you each year?

- Under 100 people
- Between 100–200 people

- Between 200–500 people
- More than 500 people

V. What age group of people usually takes part in your organized walks?

- mostly aged between 18–30
- mostly aged between 30–50
- mostly aged between 50–70
- mostly over 70

VI. What are the main elements you are showing during your walks? (multiple answers are possible)

- the graves of famous people
- the statues in the cemetery,
- notable buildings
- old/notable trees
- other options to define:

VII. During guided trips abroad, are you taking groups to a cemetery?

- yes, we visit historical sites
- yes, we visit the graves of famous people
- yes, we visit works of art and statues in cemeteries
- yes, we visit them for their architectural values (e.g., buildings)
- yes, I highlight the vegetation of the cemeteries (protected and special species)
- no, I don't have these kind of activity

VIII. Is the maintenance of a cemetery important for your interpretation as a guide?

- yes
- no

IX. What kind of vegetation do you consider important for guided walks in a cemetery, apart from the plants on the graves? (multiple answers are possible)

- trees, alleys
- flower beds
- shrubs
- grassland areas

X. Is the time spent in the cemetery being influenced by the current condition of the cemetery or by the amount of green space?

- yes
- no

XI. What services would be needed in cemeteries for guided groups? (multiple answers are possible)

- parking places
- restroom, toilet
- benches
- souvenir shop
- catering facilities
- other options to define:

XII. Would you organize any events in the cemeteries that are not strictly related to the primary function of the cemetery?

- yes
- no

XIII. If yes, what would it be?

- concert

- exhibition
- theatre performance
- other options to define:

XIV. What conditions do you think must be provided by a cemetery to become a suitable place for recreation? (multiple answers are possible)

- having good accessibility
- being a closed cemetery
- having enough free spaces between graves
- having good coverage of green spaces
- other options to define:

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The Changes in the Demographic Characteristics and Spatial Structure of Tourism Demand in the West Balaton Region's Spa Cities

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Abstract: The last two years, the period of the pandemic, have brought a significant change in the tourism of Hungary, which has been developing unbroken until then. The year 2019 broke all the peaks that were interrupted by the pandemic. This particularly affected our spa towns of international significance, including the examined settlements, Hévíz and Zalakaros. The aim of the study is to show what changes have taken place in the development of the number of visitors in the cities that have been based mainly on foreign traffic until then, what territorial reorganization has taken place in terms of sending areas, and what new target groups with modified attitude have emerged. In this study, we analyzed in detail the databases of the National Tourist Data Center, which has been operating since July 2019, and the monthly database of the Hungarian Central Statistical Office. The special, so-called unconventional tourism is carried out on the one hand by the methodology of statistical data collection and on the other hand by the explored tourism behavior. According to our results, it is clear that due to the domestic traffic, a completely new target group (age group and status) appeared in the two spa towns, their sending areas affected the metropolitan suburban zones, and the target group was high-status, younger guests. In our opinion, this offers a new opportunity for spa towns to generate more sustainable, future-oriented guests with a focus on local values, creating a new supply structure and image, as well as messages.

Keywords: medical tourism; Hungary; postcovid; change of tourism supply; sustainable way; change of visitor flow

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1. Background

The need for sustainable tourism arose long before the COVID-19 global epidemic. As early as 2005, United Nations published a guide on sustainable tourism, which still provides the basics of the sustainable goal developments of the World Tourism Organization. The guideline—written within the framework of the United Nations Environment Program—addresses policy-makers and calls attention to creating sustainable tourism development projects and policies in order to protect the environment and local areas from overconsumption and exploitation [1]. Thus, the focal points of the World Tourism Organization's work regarding sustainable tourism development are the following: Optimal use of the environment, maintaining healthy ecological processes, respecting the host communities, and ensuring viable economic operations [2]. The United Nations also designated the year 2017 as the International Year for Sustainable Tourism Development in order to encourage the policy-makers to contribute to the United Nations Sustainable Development Goals (SDGs).

The threat of over-tourism seems real and more pressing than ever, even in the light of the coronavirus epidemic. Moreover, the epidemic—as a magnifier—actually exacerbates

the problems that already existed regarding the tourist's overconsumption. While the lack of tourists meant economic difficulties and hard times for international tourism, it also gave the opportunity for locals to regain back their living space. There was already a tension between the ambitious tourism development projects and the long-term sustainability, and a lot of the development projects left out social relations. When these kinds of projects met with failed regulations of natural resources, that made the situation even worse. The role of globalization in tourism growth is unquestionable. The unlimited access to information, the modernization of transport, free markets—that led to the expansion of international hotel chains—and the significant demand for touristic services had a huge impact on tourism growth [3]. UNWTO's Tourism Dashboard shows incredible growth between 2009 and 2019. While in 2009, the UNWTO registered 897 million international tourist arrivals, in 2019, this number was 1466 million [4]. 2009 is an important year, as according to UNWTO, this was the year when international tourism receipts exceeded the number of international tourist arrivals permanently [5]. Not to mention the non-conventional aspects of tourism mobility like one-day visitors, VFR tourism, which can hardly be detected in tourism statistics and is difficult to measure.

The rapid urbanization, affordable travel and visa services, technological advances, and new business models are all behind this rapid and monumental growth [5]. The cheap flight tickets and constantly growing air transportation made the exotic destinations more reachable, and new consumer trends have appeared too. The considerable demand for touristic services accelerated development and made long-haul and foreign travels extremely popular.

The constantly increasing demand exceeded the level of sustainable tourism development. It is a legitimate question whether the socio-economically more vulnerable settlements, and especially the people living there, can actually benefit from the increasing demand. Different strategy-making levels have detached tourism as an economic sector from socio-economic and environmental impacts. Before the COVID-19 pandemic, there was already a call for more sustainable, smart, and local cities. Sustainability has gained greater importance as it contributes to today's cities by making the lives of residents easier and offering sustainable and responsible management of natural resources [6]. This backs up an argument about the carrying capacity of a tourism destination: What is the maximum number of visitors that is acceptable without destroying the environment and bothering local communities [7]? Carrying capacity is linked to the tourist activities done within the region. These impacts have to be within the ecological carrying capacity of the given territory [8].

The economic contribution of tourism has become so significant that the collapse of the industry has pointed out some serious problems that the COVID-19 pandemic could change in terms of sustainable tourism development. On the other hand, these changes should have been done long before the crisis, as the excessive growth means more vulnerability in the case of those countries and settlements where the main source of revenue is mass tourism.

The pandemic brought lockdowns, social distancing, travel bans, flight cancellations, and numerous health and safety risks, which obviously decreased the number of travels. The pandemic shows signs that it could bring long-term changes in the industry and re-imagine sustainable and responsible tourism [9]. Achieving sustainable tourism and, at the same time, maximizing growth is always a challenge [10] as usually, the cheap and convenient options are not the sustainable ones. It is also important to note that the tourism sector also significantly contributes to global greenhouse gas emissions [11].

Due to the lockdowns and difficult travel regulations during the pandemic, the demand for domestic products has emerged. Tourists who usually choose long-haul and foreign travel routes were forced to travel within the country borders. This phenomenon led to more rational consumption. Tourism consumption starts when the traveler leaves his permanent home until he arrives home [12]. It would be naive to expect rational behavior regarding sustainability from tourists who spend their free time, which often ends up in unreasonable decisions regarding the type of transportation, accommodation, shopping,

and sightseeing. Despite the COVID-19 pandemic, the younger generation still considers that the waste situation, pollution, use of non-renewable resources are the main challenges that sustainable tourism faces [13]. Domestic travels—forced by the crisis—resulted at least in less air pollution. Nevertheless, distance is a critical factor in tourism. Variables such as gender, time factor, education, number of children, seasonality, and weather, largely determine the distance of the travels [14].

In the case of a small country like Hungary, where domestic flights do not exist, it seems to be more environmentally friendly. Achieving high-value tourism is an old desire in Hungary's tourism, which means attracting high-spending tourists and increasing the revenue from tourism expenditure instead of increasing the number of tourists. This could result in much more sustainable growth.

The Hungarian Tourism Agency is a governmental organization responsible for the development and public administration of tourism in Hungary. The organization's main mission is to gain competitiveness of Hungary as a tourism destination and to promote the country in order to be more attractive for international, domestic, and business travelers. The Hungarian Tourism Agency defines the tourism development strategy, supervises the utilization of EU funds and domestic budgetary sources dedicated for tourism development and manages the tourism brand of Hungary [15]. As part of the governmental tasks, the organization issued the National Tourism Development Strategy in 2017, which includes all the guidelines regarding the tourism development in Hungary until 2030. The strategy was updated in 2021 due to the COVID-19 circumstances, and the National Tourism Development Strategy 2.0 version was born. The strategy places a strong emphasis on sustainability and responds to the ever-changing trends in tourism. Due to the destination approach, territorial aspects are also prominent, providing a framework for defining the profile of each touristic region. This also helps specific regional branding. According to the strategy's vision, by 2030, the tourism sector in Hungary will be the driving force for sustainable economic development by achieving quality experience, innovative solutions, and a strong national tourism brand. The strategy dedicates a whole chapter to sustainability as a strategic direction, in line with international standards. One of the long-term goals is the introduction of a trademark developed along sustainability criteria that is widely applicable in the tourism sector. Sales efficiency is essential for sustainable growth. In addition to this, professional marketing activities are indispensable to exploit the potential of domestic tourism. Data-driven and targeted marketing is needed as it is extremely important to restore demand as soon as possible after the significant decline in tourism as a result of the epidemic crisis [16].

It can be clearly stated that tourism has many social and economic effects and advantages. This is especially true for the field of spa and health tourism, that generates longer stays and, therefore, high expenditures. Spa and health tourism is extremely important in countries like Hungary, which are on the one hand, weak in natural resources but, on the other hand, rich in natural thermal water. Under the territory of Hungary, there is a presence of 70% of thermal water, which is a remarkable gift. There are many settlements spread across Hungary that are blessed with thermal water that differ in terms of size, accommodation facilities, and faculties.

This study reveals two different dimensions of tourism typology. One of them are the characteristics of the receiving areas (Hévíz and Zalakaros), and the other are the characteristics of the visitors on the demand side. According to Candela and Figini [17], it is debatable that the destinations are at the core of the tourism system, and they also argue that choosing a destination is at the center of decision-making. Health tourism, that is examined in this study, is one of the most popular tourism products in Hungary, which can be spotted in those settlements where thermal water is available. Analyzing its generated effects is quite important in the context of the changes caused by the COVID-19 pandemic. Previous studies have already examined the socio-economic changes in the case of bath regions, e.g., the case of Kehidakustány, another well-known spa settlement in Hungary. It turned out that those cities which are successful in health tourism have the possibility to

gain a higher level of income, which results in a major economic role [18]. Obviously, higher income also contributes to the social development and satisfaction of the local society.

2. Data Collection and Research Methods

Our study uses quantitative methods based on secondary analysis of tourism statistics. There are several possible methods for measuring tourism demand. In the case of Hévíz and Zalakaros, which are typically multi-day destinations with a relatively long stay of the guests, accommodation statistics provide reliable information on the volume of tourism demand. The primary source of the examined data is the National Tourism Data Center (NTAK) database. The digital platform operating under the supervision of the Hungarian Tourism Agency allows the anonymous traffic statistics of all accommodation establishments in the country to be displayed in real time. From the data received directly through the accommodation management software, analyses are made to make the data-driven decisions needed to support the tourism profession. NTAK also has a significant role in the whitening of the tourism sector, as the territorially competent local governments and the National Tax and Customs Office also have an overview of the data areas that are relevant to them. The NTAK receives statistical data from the individual accommodation management, catering and ticketing software. For our study, we obtained data gathered between 1 January 2020 and 31 December 2021. To present the accommodation offer of Zalakaros and Hévíz, the capacity data of the accommodations registered in the NTAK digital platform (number of accommodations and offered rooms), which operates with complete coverage in the two settlements. To examine the characteristics of tourism demand, guest traffic data were aggregated according to the age groups and place of residence of guests, in the case of both Zalakaros and Hévíz. Regarding the applied methodology, it was a challenge that the NTAK database would be completely operational only from the beginning of 2020, therefore, the analysis examining the multi-year perspective is based on the freely available database of the Hungarian Central Statistical Office (CSO), which is limited to changes in the volume of tourism traffic and does not cover the demographic and geographical characteristics of domestic demand. As, unfortunately, there are no detailed data on the spatial pattern of domestic demand for the period before the Covid, other alternative methodological approaches are warranted to investigate this in the future.

3. Study Area

The research focuses on two Hungarian spa towns—Hévíz and Zalakaros—due to their international importance. They are located in the western part of Lake Balaton Touristic Region, the most important tourist destination in Hungary (Figure 1). The tourist area of Lake Balaton has the largest accommodation capacity after Budapest (60,600 rooms) and, accordingly, the most visited rural tourist area, with a total of 5874 thousand guest nights, of which 67.38 percent are domestic, 32.62 percent foreign (31% German, 11% Czech, 11% Russian and 10% Austrian). Its main tourist products are waterfront holidays and thermal baths (source: CSO 2019). Lake Balaton has appreciated in recent years, and by the summer of 2021, we could see the operation of the previous successful years almost entirely.

The area has a quite good location and geographical position: The accessibility of the area is mainly determined by the E71 (M7) motorway and Hévíz-Balaton Airport, which is of exceptional importance for the West-Balaton destination, but the north-south transport possibilities need to be improved.

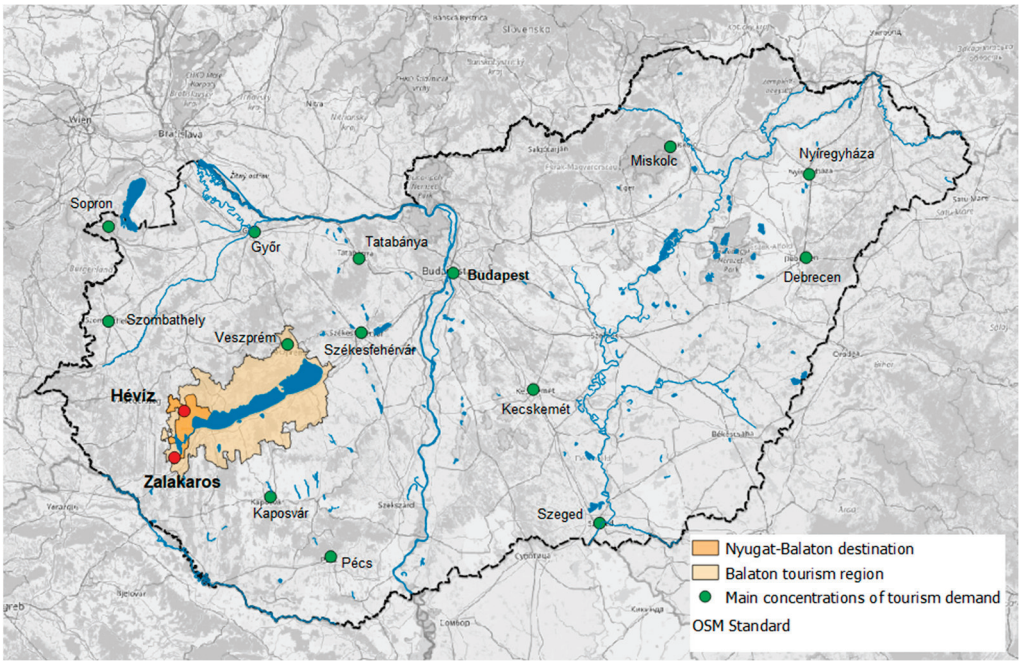

Figure 1. The sample area of the research.

Hévíz, as a small town, has approx. 4800 inhabitants, with international second-home owners—mostly German and Russian—as well. The basis of tourism in Hévíz is the world-famous and unique Lake Hévíz and the medical tourism services based on it. The lake has a water surface of 44,400 square meters and is the world's largest naturally warm, biologically active spa lake. The medicinal water erupts from the spring crater at a depth of 38 m, its average summer temperature is 33–35 °C, but it does not fall below 23 °C in winter, so it is suitable for outdoor swimming all year round. The water contains sulfur, alkali bicarbonate, slightly radon ingredients, which can primarily cure various rheumatic, musculoskeletal, and gynecological diseases [19]. The central spa was built in 1795 on the initiative of Count György Festetics, the owner of the area. In recognition of the development, Hévíz was declared a spa settlement in 1911. On 1 January 1952, the Hévíz State Spa Hospital was established in the buildings of the spa, which is now the St. Andrew's State Rheumatology and Rehabilitation Hospital. Due to this, Hévíz has become the largest spa in the country for the treatment of musculoskeletal rheumatic diseases. In 2015, Hévíz created its own trademark for the accreditation of therapies based on the healing effects of Lake Hévíz. Institutions that have the necessary professional, medical background, and medical infrastructure for the treatment (e.g., spa pool, weight bath, mud packer) are entitled to wear the trademark. There are currently nine certified spa hotels under the trademark that provide treatments under sanitary conditions under medical supervision. The last 30 years saw a greater development than ever before: Many new restaurants and hotels have been built. Recent spa and accommodation developments have aimed to increase the quality of care for patients recovering here.

Zalakaros—with approx. 2100 inhabitants—has also become one of the most important Hungarian international spa destinations. The flourishing of the settlement can be clearly linked to the construction of the spa. In 1962, during the hydrocarbon exploration in Zala, hot thermal water was found in the settlement. The spa opened in 1965, and the settlement underwent a significant development, the plans for the development and arrangement of the village and the recreation area were completed in a decade. The year of 1975 was decisive, when the building of the indoor bath was handed over, so the seasonal nature of the bath in Zalakaros ceased to exist and the basic conditions for the medical utilization of the thermal water were established. In the following years, the spa continued to expand, and new pools were built, significantly increasing the water surface. In 1978, the Granite

Spa was declared a recognized spa. The spa developments of the last 10 years have focused on the needs of the guests with children, families and young adults looking for wellness and adventure bathing, pushing the development of medical products into the background. In parallel with this, the capacity of tourist accommodation has been constantly increasing, new hotels and private accommodation have been established in the settlement.

4. The National Significance of the Two Cities, Based on Visitor Traffic and Capacity Data

The region of Western Balaton is one of the most visited destinations in Hungary. Hévíz and Zalakaros are the two most important spa resorts in the country in terms of available accommodation services. There were 653 accommodation establishments in Hévíz in July 2021, offering a total of 3920 rooms, while in Zalakaros, there were 2332 rooms available. The offer of both settlements is dominated by hotels, with more than half of the capacity being supplemented by private accommodation and other accommodation. Despite the fact that the attractiveness of both settlements is focused on medicinal water, the two settlements address fundamentally different target groups. Hévíz is an internationally known spa town with a significant foreign tourist turnover (675.3 thousand), while Zalakaros was the number one medical tourist destination in the country in terms of domestic tourism in 2019, with 508.1 thousand domestic guest nights. In the years before the epidemic, more than half of Hévíz's guest traffic was generated by foreign tourism, while in Zalakaros, less than a quarter of the guests were foreign (Figure 2).

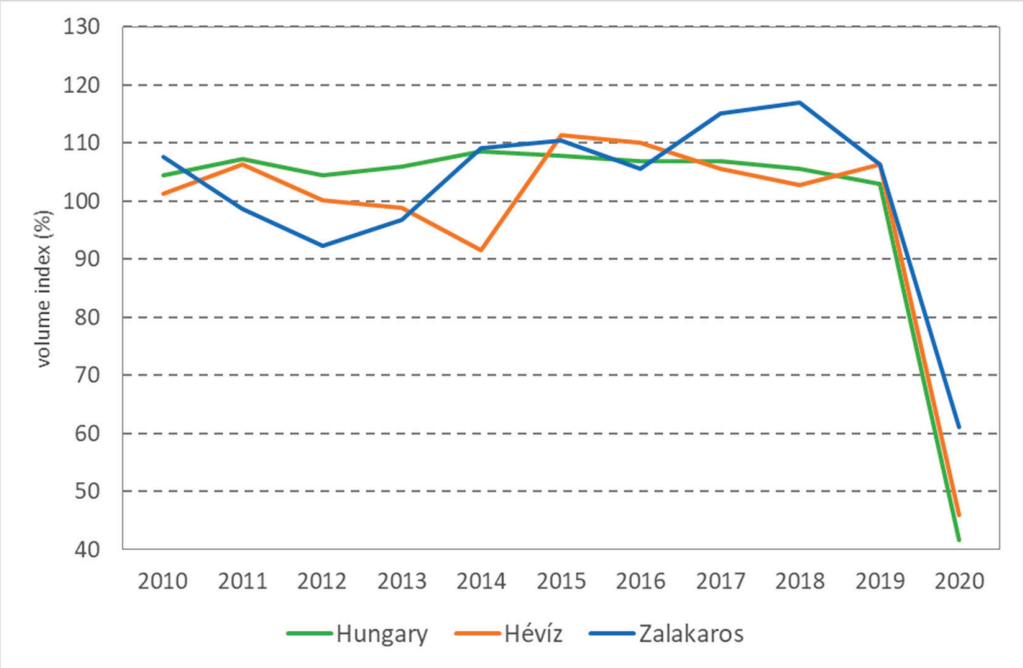

Figure 2. Volume index of the number of guest nights registered in commercial accommodation establishments between 2010 and 2020. Own editing based on the CSO Information Database.

5. Impact of the COVID-19 Epidemic on Tourism in the Region

Before presenting the changes caused by Covid, it is worth looking at the state of the Hungarian tourism sector and the two settlements before the pandemic started. The 2010s were about the prosperity of the Hungarian tourism industry, with a steadily increasing performance year by year. Concentrating on the two settlements examined, the guest turnover of Hévíz increased by more than a fifth, the growth of the tourism performance of Zalakaros exceeded 60% in the period between 2010 and 2019. In 2020, the Covid epidemic hit the Hungarian tourism sector hard, causing serious economic and social changes, especially in areas with a strong tourist profile, such as the West Balaton region. The negative effects

of the epidemic on tourism performance were severe in both settlements. According to the data from the Hungarian Central Statistical Office, the number of foreigners visiting Hévíz fell by almost a fifth in 2020 compared to 2019, but there was also a decrease of about 40% in the case of domestic demand. In Zalakaros, the foreign guest turnover decreased by almost 70%, while the number of domestic guest nights decreased by about 30%. Due to the drop in demand and the uncertainty surrounding the conditions of international tourism, the spa settlements had to reach new target groups after the lifting of the epidemiological restrictions. In our analysis, the national, demographic, spending, and territorial characteristics of the volume of guest traffic in Hévíz and Zalakaros for the period following the outbreak of COVID-19 are presented.

6. Results

In 2020, compared to previous years, a drastic decline in foreign demand could be observed, and based on turnover data, the number of foreign guests returned only partially to the two settlements in 2021. In the case of Hévíz, with the loss of the previously dominant foreign target groups, domestic demand gave approximately two-thirds of the guest nights in 2020 and 2021, while the share of domestic demand continued to grow in Zalakaros, which has traditionally been strong on domestic guests (Table 1).

Table 1. Share of domestic and foreign market in guest turnover (%).

	Hévíz			**Zalakaros**		
	2019	2020	2021	2019	2020	2021
Domestic	41	69	65	76	89	86
Foreign	59	31	35	24	11	14

Source: Own editing based on the CSO and NTAK databases.

The common feature of the guests of the two settlements is the high proportion of guests using wellness and health tourism services (MTÜ, 2016). In addition to the similarities, however, the two spa towns address significantly different target groups. Nearly two-thirds of Hévíz's guests are people over the age of 45, whose main motivations are rest and health. In contrast, Zalakaros is characterized by a younger group of guests, with more than 60% of guests in Zalakaros under the age of 45. A significant proportion are couples between the ages of 35 and 45, who often arrive on long weekends, and those who go on family vacations to Zalakaros. The twenty-year-olds are underrepresented in both settlements. It can also be said that the demographic characteristics of foreign and domestic demand are significantly different for both settlements. In the case of foreign markets, well-defined target groups can be observed (Figure 3).

The base of Hévíz's foreign target market is provided by the senior age group, which can be characterized by a long stay and is looking for high-quality health tourism services. Two-thirds of the income from foreign tourism of accommodation establishments in Hévíz is related to people over 55 years of age, mostly people over 65 years of age. In Zalakaros, however, foreign guests are mainly couples between the ages of 35 and 44, who are primarily attracted by wellness services. More than half of Zalakaros' income from foreign tourism can be attributed to this age group. The group of foreign visitors to the two settlements is not homogeneous, different foreign target groups can be identified on the basis of nationality, length of stay, demographic characteristics, and spending habits.

The German market provides a significant part of the senior population visiting the area. The German seniors visit both settlements in large numbers, spending six to seven days at the destination. As the only place in Hungary, one of the dominant target groups of Hévíz is the Russian guest group, which is mainly a group of solvent, middle-aged, and elderly couples with a long stay. Russian demand is quite concentrated in Hévíz, there is no interest in the wider region. The number of Russian guests has been declining in recent years. By far, the German and Russian guests spend the most on accommodation. Due to the geographical proximity and the good value for money of the destination, many people

come to the area from the border areas of Austria. In the case of the Czech and Slovak guests, it can be clearly observed that the older age groups visit Hévíz, while a higher proportion of people between the ages of 35 and 44 visit Zalakaros. Guests from the Czech Republic, Poland, and Slovakia are not only looking for premium accommodation, they have a significant need for mid-range services as well. Czech guests are characterized by average, Slovak and Polish guests by low unit spending, although the number of active families with medium and higher status is increasing from the Czech and Slovak sending markets. The stagnation or moderate decline of the sending markets (Germany and Russia), which provide the largest volume of guest traffic in the region, may be offset by the growth of these markets, which have additional potential and are less concentrated in Hévíz and visit the wider destination in large numbers (Table 2). Other countries sending a significant number of guests include Ukraine, Switzerland, and Romania, which also have growth potential. In the pre-Covid period, groups of visitors from outside Europe, mainly from China and Israel, which generated a significant amount of traffic in Hévíz, almost completely disappeared from the region in 2020 and did not return in 2021.

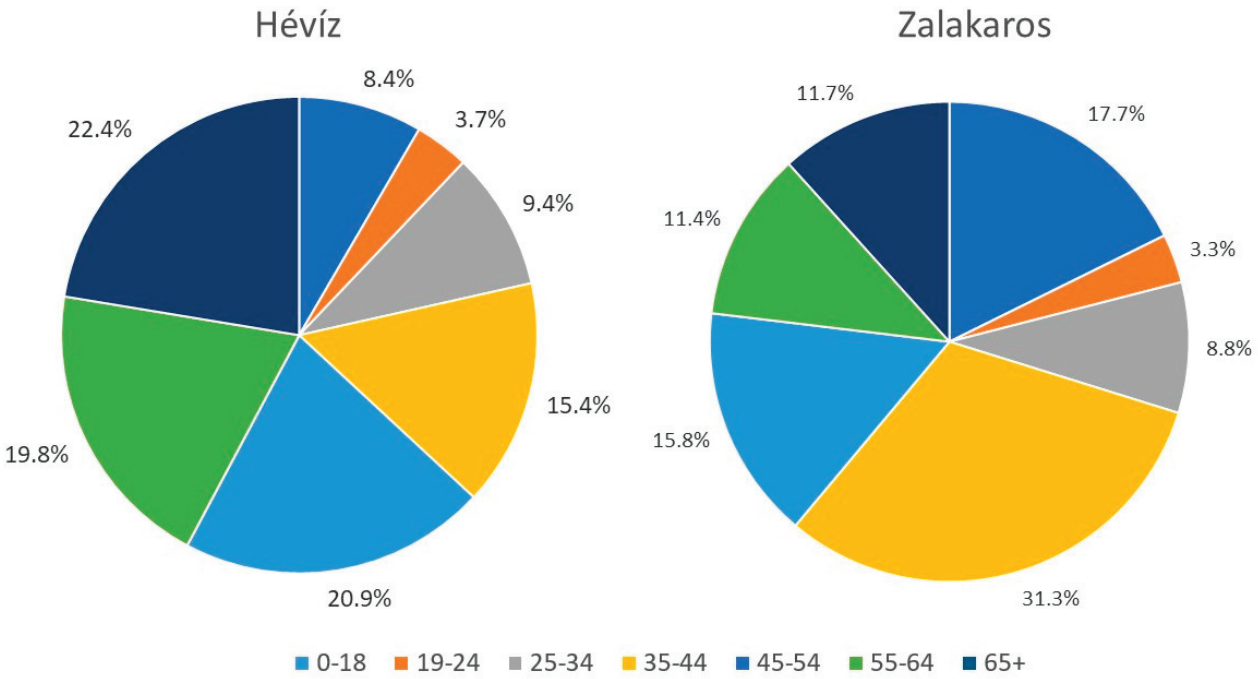

Figure 3. Guest turnover by age groups in Hévíz and Zalakaros, 2021. Source: Own editing based on the NTAK database.

It is important to emphasize that the specific expenditure of foreign guests is significantly higher than that of domestic guests. In the case of Hévíz, the expenditure per guest was 87.3% higher in the case of Zalakaros and 41.2% higher among foreign guests in 2021. The greatest contrast is in the comparison of foreign and domestic seniors. Foreign guests over the age of 65 spend 2.5 times as much on average in Hévíz and 2.2 times in Zalakaros as Hungarian guests. The difference is much smaller among the younger age groups. Data from recent years, on the other hand, show that this long-standing finding that foreign visitors are highly profitable for caterers appears to be declining on the basis of data from recent years. Partly as a result of the epidemic situation and state measures to encourage domestic tourism, a large number of solvent Hungarian guests have appeared, and their returning guests may be of strategic importance to the spa settlements.

Table 2. Top 5 sending market in Hévíz and in Zalakaros, 2021.

Municipality	Country of Origin	Number of Guests	Number of Overnight Stays	Average Length of Stay	Spending Per Guest (Thousand HUF)
Hévíz	Germany	12,687	77,423	6.1	118.4
	Russia	5589	36,677	6.6	169.8
	Czech Republic	8711	30,501	3.5	72.2
	Austria	7959	25,791	3.2	80.1
	Slovakia	4576	13,332	2.9	65.8
	Abroad total	51,822	232,559	4.5	
Zalakaros	Czech Republic	8535	31,476	3.6	76.7
	Germany	3745	26,007	7.3	101.3
	Austria	1888	6558	2.9	74.1
	Slovakia	1581	4596	2.7	55.1
	Poland	733	2339	2.8	32.8
	Abroad total	18,584	77,146	4.2	

Source: Own editing.

Domestic demand is becoming more and more important in the tourist traffic of the West-Balaton destination, which is significantly more diverse in terms of demographics than foreign visitors. Among the domestic tourists of Hévíz, in addition to the traditionally large number of seniors, the 35–44, 45–54, and 55–64 age groups also come to the spa settlement in similar numbers. The over-55 age group stays almost exclusively in hotels, while the share of private accommodation and other types of accommodation is high (30–40%) for the younger age groups. Regarding the spending per guest, a significant difference can be identified between the groups of guests under 35 (HUF 43,329) and those over 35 (HUF 54,758). There is no significant difference in the comparison of the 10-year age groups of those over 35 years of age. In the case of Zalakaros, the largest proportion of domestic guests are between the ages of 35 and 44 (30%), while the second largest age group is under the age of 18. It is clear from the data that Zalakaros is a typical destination for domestic family holidays, mainly during the summer months of the season. Families do not only stay in hotels, almost 20% of them choose private accommodation. In the age group between 35 and 44, another solvent target group arriving without children can be identified, which is characterized by high specific spending (HUF 73,289) compared to the other age groups, which is catching up to the spending intensity of foreign guests. The number of visitors to this target group increased almost one and a half times in Zalakaros in 2021 and 2020, while the number of visitors with families did not change significantly based on the number of registered guests under the age of 18. In the summer of 2021, the capacity utilization showed values above 80%, domestic demand in 4- and 5-star hotels was able to make up for the lost foreign guest traffic in the summer. This is the young and middle-aged group, who presumably travel abroad, are characterized by high spending, are less price sensitive, but chose domestic destination in the summer of 2021 due to the uncertainty caused by Covid. On the other hand, domestic demand showed moderate interest in lower-category hotels. Pre- and post-season traffic lagged behind, thus strengthening the seasonality that used to be generally less common in spa towns.

The spatial pattern of tourism demand in Hungary is less a Covid-related phenomenon than a phenomenon determined by the urbanization processes and changes in the spatial pattern of development of the past decades, which in Hungary has two main dimensions: The metropolitan–rural (center–periphery) contrast and the west–east regional inequalities,

it means the division of the country is quite sharp [20]. Due to the strongly unipolar spatial structure of Hungary [21], the metropolitan area of Budapest, like in the case of many other socio-economic phenomena, plays a prominent role in terms of the territorial distribution of tourism demand. The distribution of domestic demand in Zalakaros and Hévíz by destination area is represented by dot density maps (see Figures 4 and 5), where one point represents 10 guests. As shown by spatial data, the majority of domestic guests—24% in the case of Hévíz and 17% in the case of Zalakaros—come from Budapest. The capital city and its growing agglomeration are increasingly dominant in terms of economic, technological, cultural, and human resources [22], and as a result, the purchasing power and potential target groups for spa towns are also predominantly concentrated in the metropolitan region. Satellite towns around Budapest with a high standard of living are among the most important sending areas of the West Balaton region: Not only because of the better geographical location, but the higher status population could offer to reach these settlements for holidays.

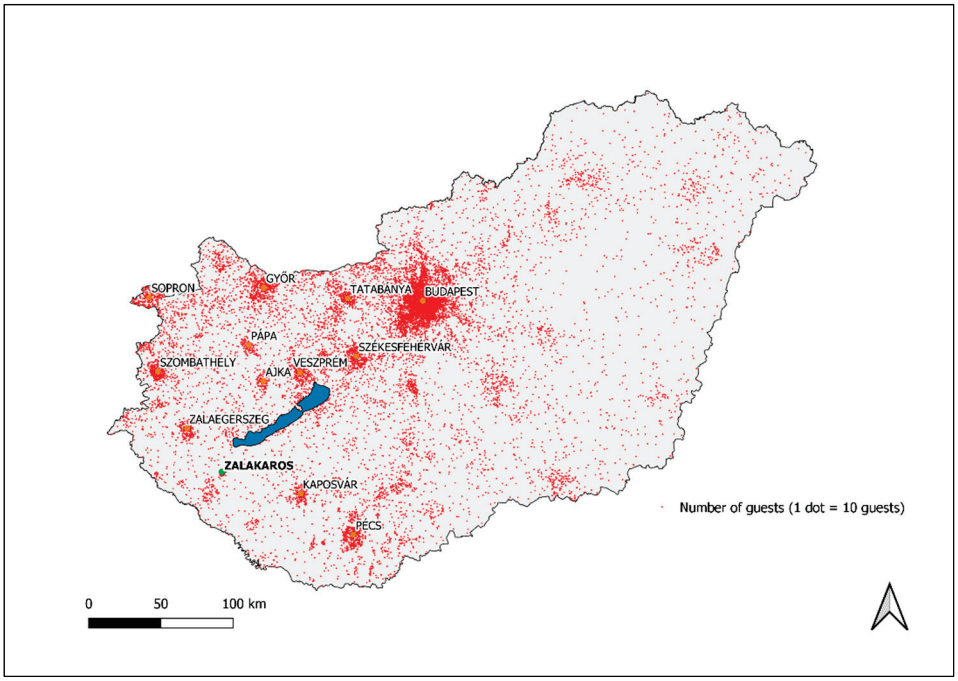

Figure 4. Spatial distribution of domestic guests registered in Zalakaros, 2021 (1 dot = 10 guests).

Comparing the domestic traffic of the two cities (Figures 4 and 5), it can be stated that Zalakaros is much more of a destination with regional significance, with an area extending to the west of the Danube (Transdanubia), while Hévíz is a nationally known and visited destination. Apart from the Budapest area and the city of Pécs, the main Hungarian sending cities of Zalakaros are exclusively Transdanubian cities (Székesfehérvár, Győr, Szombathely, Veszprém, Sopron and Tatabánya). Important sending towns—such as Veszprém, Zalaegerszeg, Ajka, Pápa, and Kaposvár—are situated within 100 km of the destination. In the case of Hévíz, Pécs, Győr, Székesfehérvár, Sopron, and Szombathely are dominant markets as well, but Hévíz is also visited in large numbers from the cities of Northern Hungary (Miskolc), the Northern Great Plain (Debrecen, Nyíregyháza), and the Southern Great Plain (Kecskemét). We can conclude that the attractiveness of Hévíz extends to a wider area, geographic proximity seems to be less important for the visitor flows of Hévíz. Looking at the sending areas of the region in the light of the spatial structure of Hungary, it can be seen that the two settlements tend to target more developed urban agglomerations with a higher standard of living, which is also reflected in the increasing trend of the expenditure structure.

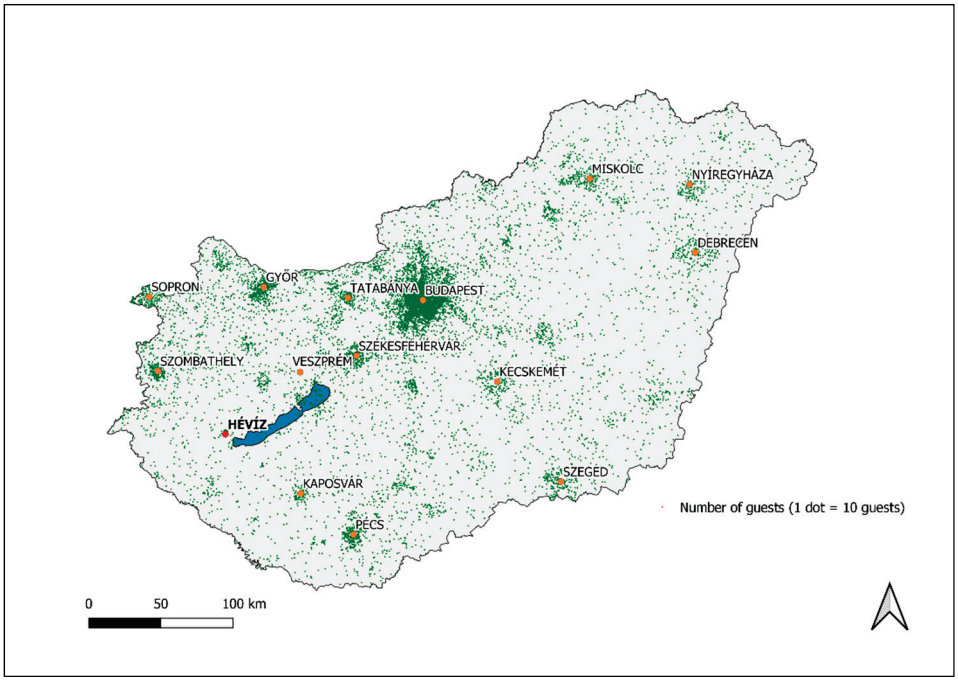

Figure 5. Spatial distribution of domestic guests registered in Hévíz, 2021 (1 dot = 10 guests).

In the case of Hévíz, the analysis of the new type of database made the reorganization of the target groups even more visible, which resulted primarily in 2020 from the fact that the guests of the classic spa treatments of the pre-pandemic period (German seniors and Russian spa guests) became unavailable due to the restrictions, and a proportionally larger share of the thus reduced traffic reached the traffic of domestic and neighboring countries. The data analysis clearly highlights the need for a drastic transformation of the target groups, as well as the creation of a new image of Hévíz. The city's new marketing strategy responded to this change, on the basis of which, sports and slow tourism, as well as the Post Covid Care program, are currently in focus, still addressing target groups with a higher ability to pay [23]. However, it is important to mention that the transformational effect of the processes of the past years on the long-term target group cannot yet be established based on the data from 2021.

In the case of Zalakaros, in the years prior to the pandemic, the spa town already placed family-friendly experience bathing and wellness bathing in the focus of its product development and marketing strategy instead of being an exclusive health resort mainly aimed at young, family customers from domestic and neighboring countries [24]. The travel restrictions affected these target groups less, so they were able to further strengthen the already started communication and act effectively in the changed tourism market. In the case of Zalakaros, the change in the target group can already be clearly seen from the statistical data from 2021, which is also helped by the fact that the investments affecting the young age group were realized in connection with the urban development (walking route around the artificial thermal Lake and Ecopark, thus increasing the settlement as a family-friendly tourist destination appearance.

7. Conclusions

The last two years have caused a significant change in the life of the two settlements, which clearly made it necessary to rethink the target groups. From the data of returning guests, it is clear that people's desire to travel is unbroken. Despite the restrictive measures, they are looking for travel opportunities. As a result, the role of stable domestic demand is becoming more important for individual destinations.

Hévíz is the number one tourist settlement in Hungary after the capital, however, it was most severely affected by the pandemic, with a 62% shortage of visitors. One of the

main reasons for the large decline is the slower return of senior (over 65) foreign visitors to the destination. This is intensifying this year, as the Ukrainian–Russian conflict is clearly making its mark on the lack of the current main sending market—in the case of Hévíz—which must be filled with a new strategy by renewing the supply market and brand of the settlement. Here we can clearly relate to the issue of sustainability: Is the settlement able to renew itself, address the domestic market sufficiently, adjust its offer to the Hungarian—primarily high-status clientele, establish a network connection in the region—one of the elements of which is sustainability in connection with domestic travel? In the city of Hévíz, the service providers have started their activities in this direction, i.e., a completely new target group: In addition to the seniors, the family has become the most important potential target group, targeting those interested in hobby and professional sports tourism. In addition, it has launched a new health tourism product package called "Post Covid Care" that offers standardized treatment packages using existing medical experience and medical infrastructure as part of private health care in a quality hotel environment. For Hévíz, due to its distinctive medical tourism image, adult-friendly, age-restricted tourism products can also be a competitive advantage, which can also be unique, attractive products for the target groups of the domestic and surrounding countries.

In the city of Zalakaros, the service providers were in a less vulnerable position to the markedly present foreign sending market, so the transformation, addressing the guests, offering the service providers, rethinking the brand of the city created an easier situation: Addressing the domestic target group, being active on social media, using new urban attractions and programs for the young age group clearly have the effect of changing the city's clientele. Sustainable product development opportunities should be to develop for the new domestic clientele. In Zalakaros, ecotourism (through the protected areas of the Kis-Balaton National Park) and active tourism have been further strengthened, but there are untapped opportunities to address the young adult clientele with high wellness, such as manager disease management, burn out programs, immunity boosting, and post-Covid cures.

From the development of demand and the comparison of the two settlements, it can be seen that the domestic guests are mainly couples aged between 35 and 45, looking for a wellness experience, not a treatment based on balneotherapy. This attitude could only be changed by shaping a long-term national approach.

Based on the new type of database (the National Tourism Data Center) examination, we can highlight the fact that the two settlements, Hévíz and Zalakaros, have two similar attractions, but their guest structure, destination areas, and future perspectives have changed radically in the last two years. The differences are also very clear in terms of the domestic market of the two spa towns: While in the case of Hévíz, the medicinal character generated many guests from the eastern part of Hungary, also from the big cities (which means that the people living in the big cities have higher status), in the case of Zalakaros, the sending area of the guests affects the more developed western region. This can also be attributed to the fact that in the eastern part of the country, the people living there can visit many family-friendly settlements with medicinal water, meaning that it is not worth it for them to travel to a more distant settlement, while in the case of Hévíz, the unique medicinal character generates greater and higher-status purchasing power.

The examples show that in the short term (1–2 years), destinations (without external help) cannot introduce a new product and reach a large number of new target groups, even though product development is taking place. Introduction and promotion of the market require regional or state-level resources. A suggestion for both settlements is that much more attention should be paid to the National Tourism Development Strategy 2.0. the goals of creating sustainable destinations, the development and communication in this direction at the local level, the implementation of a conscious attitude formation, as a result of which a much more conscious, high-quality clientele seeking recreation, healing, and sustainability can flow into the region.

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Opinion

Travelling the Metaverse: Potential Benefits and Main Challenges for Tourism Sectors and Research Applications

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Abstract: The paper focuses on analysing the potential benefits and challenges of the Metaverse, particularly in the field of research in the tourism and food and wine sectors. The Metaverse is part of the new generation of the internet known as web 3.0, which also includes AI, blockchain and other digital innovations. The food marketing and tourism sectors are the main fields where companies are experimenting with solutions to offer people a fully functioning immersive Metaverse experience. This paper aims to highlight the potential impact of the Metaverse on tourism sectors as well as on research activities. Open challenges concern the social acceptance, affordability, and environmental sustainability of these technologies. Research is needed on the Metaverse's ability to reduce bias and accurately simulate real experiences, as well as on tourists' perceptions, attitudes, and willingness to pay for mediated experiences. Another important issue is the management of sensitive data that will travel through the Metaverse. Looking forward, the Metaverse has the potential to become a valuable tool for advancing tourism research through virtual collaboration and interdisciplinary research projects.

Keywords: digital innovation; food; Metaverse; phygital tourism; research; tourism; web 3.0; wine

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1. Introduction

Various fields of scientific research are increasingly turning their attention toward the Metaverse, both as an object of study and as a possible new space within which to practice research.

Currently, no unambiguous or shared definition of the Metaverse can be found in the literature, but from the major published studies to date, recurring elements allow it to be described as a shared online reality accessible via the internet, in which users are represented in three dimensions and can move around, share data and information, interact and socialise through shared experiences simulated in realistic, unrealistic, and mixed environments [1–3]. Thus, the Metaverse is a new way of interacting with reality, whether real, augmented, virtual, or mixed. It is part of the so-called web 3.0, a new generation of the internet that also includes artificial intelligence, blockchain, and new frontiers of digital and phygital innovation. Users access the Metaverse via 3D viewers and have virtual experiences connected to realistic avatars, other users, objects, concerts, events, travel, and more [4–6].

Although the publicity is only recent, the first attempt to design a three-dimensional environment in which people could create their own twin identity, communicate with each other, participate in events, and use a virtual currency was Second Life, launched in 2003. Since then, increasingly advanced technological infrastructure and investors' and users' interest in more user-friendly online environments for more immersive experiences have been central elements in the further development of virtual settings. Furthermore, the many restrictions on in-person activities and physical travel due to the COVID-19 pandemic have been an impressive stimulus for the growth of the Metaverse [7,8], creating a need for novel and unconventional mobilities.

Despite the embryonic nature of the Metaverse, several organisations, both public and private, have already begun to consider how they can reorganise their existing management models. For example, several recent studies [9–11] have analysed the potential impact of the Metaverse on the health sector. They argue that the use of innovative elements, such as immersion and interactive virtual reality (VR) technologies and applications would benefit both patients and healthcare providers, especially in the public sector. They describe the Metaverse as a space in which 'virtual hospitals' can be built, where consultations, remote care, physiotherapy, disease monitoring and even surgical operations can take place. Nevertheless, some experts have expressed critical issues about the health sector that arise with the development and implementation of Metaverse technology [12,13]. For example, with the rise of telemedicine and remote consultations, it is still unverified whether the quality of care provided in the Metaverse meets the same standards as in-person medical care. Furthermore, health data are subject to strict regulation, and it is crucial to determine how these regulations apply in virtual environments.

The potential of the Metaverse has also been evaluated in relation to the education field. The transposition of education into the Metaverse could be considered an evolution of the already well-known phenomenon of distance education, which has become common practice in schools and universities since the first lockdowns. The creation of virtual classrooms along with the use of digital twins by teachers and students may contribute to the creation of a new, more engaging, technology-driven style of learning [14–16]. Additionally, in the education sector, critical issues about the Metaverse have been raised with regard to both students and teachers [17,18]. For instance, are teachers equipped with the necessary skills and knowledge to effectively deliver education in virtual environments? How user-friendly and accessible are virtual educational environments for all students and teachers? Are virtual education environments designed to effectively engage and motivate all students?

Clearly, however, the increased levels of interaction and immersion offered by the Metaverse provide unprecedented opportunities and challenges for research. Some organisations and brands seeking to better position their products and services have already taken the first steps to harness the potential the Metaverse in their research. More specifically, as highlighted in a recent review of studies dealing with the Metaverse [19], the food marketing and tourism sectors currently represent the main fields in which companies are experimenting with solutions aimed at offering people the opportunity to enter a fully functioning, immersive Metaverse somewhere between the virtual environment and the real world.

Building on these considerations, this paper aims to analyse the potential benefits and main challenges of the Metaverse, with particular reference to the field of research in the tourism and food and wine sectors.

This topic calls for sociological, economic, and environmental reflections, since the Metaverse is an emerging and evolving entity that has not yet been sufficiently investigated [20–22], despite its complexity and impacts on people and society as well as on research activities. In fact, the Metaverse is contributing to the formation of new concepts and values that do not always overlap with those found in the real world [23].

The reminder of this paper is organised as follows: Section 2 deals with issues linked to tourism activities in the Metaverse, while Section 3 focuses on travelling the Metaverse, especially through gastronomy and wine tourism experiences. Section 4 discusses implications for research applications, and in Section 5, conclusions are drawn.

2. Tourism and the Metaverse

The tourism sector comprises the goods, services, and experiences of travel, hospitality, and entertainment and the enjoyment of cultural, social, and environmental resources. As highlighted within the most recent literature on the subject [24–27], tourism experiences provide not only moments of leisure and entertainment but also situations in which subjects

can form their own identity through confrontation with cultural elements other than their own.

Consequently, the Metaverse may represent an additional element capable of enriching tourism offerings beyond physical spaces. Even before the pandemic, certain digital solutions had been widely used in tourism and hospitality [28,29]. The forced immobility associated with lockdowns not only led many people to seek alternative and unconventional forms of mobility, but also incentivised many players in the tourism industry to offer mediated experiences. These give potential travellers the opportunity to experience the world and practice tourism without physically moving, in line with emerging needs related to the search for safety and sustainability [30].

In this regard, distinguishing between 'moving tourism' and 'stationary tourism' may be useful [31]. The first term denotes tourism in its conventional sense. Its main features include physical mobility, the use of transportation, and face-to-face interactions between visitors and the local population. 'Moving tourism' assumes that people travel to visit tourist destinations in person.

By contrast, 'stationary tourism' refers to tourist experiences that people can enjoy through technology, without physically moving. The word 'stationary' is commonly used in the fitness world, recalling the concept of 'stationary bicycles'. This stationary fitness equipment may be used in homes, gyms, and other indoor or outdoor locations to replicate the use of a regular bicycle for physical training, enabling people to move despite actually remaining in the same physical location. Thus, a stationary tourist can travel without changing locations in the same way that a stationary bicycle stays in place while allowing users to ride at various speeds and intensities and providing the same experience as a conventional bike.

A third way is represented by the new frontier of phygital tourism. This term refers to an innovative way to connect with the environment in which physical and virtual locations are combined to complement and reinforce one another. In phygital tourism, the intersection of digital data with physical objects and landscapes forms the foundation of the visitor experience. The process can also work in reverse: a physical action might prompt a search by interacting with sensors or machine-readable milestones that provide users with pertinent information through digital interfaces [32].

From this perspective, the Metaverse can further expand the range of possibilities for practicing 'stationary tourism', providing a good opportunity for destination marketers and scholars who intend to advance knowledge in the tourism industry by exploiting the potential of simulated environments [33]. Through virtual reality, augmented reality (AR), mixed reality (MR), telepresence, and immersive storytelling, tourism experiences in the Metaverse could indeed affect consumers' decisions in the real tourism environment. In particular, several pioneering immersive experiences have highlighted how the Metaverse is already contributing to the creation of shared value in the tourism field, especially in situations in which potential tourists are asked to express their expectations and preferences as part of research on territorial branding and the launch of new tourism services [34,35].

In the same vein, some hospitality players have already begun to create immersive and interactive hospitality spaces within the Metaverse to allow their customers to simulate the experience of their stay, with the goal of receiving feedback that can be used to improve offline offerings. In 2022 the hotel company CitizenM became the first to enter the Metaverse, creating a hotel in the Sandbox platform. In this virtual hotel, people can interact with each other and purchase goods and services, such as an exclusive collection of non-fungible tokens (NFTs), thus influencing the construction of real hotels based on their feedback. CitizenM monitors avatar behaviour to increase brand awareness and positioning and to co-design, test, and then launch real hotels in the physical world, in line with the brand's democratic approach. Similarly, the hotel chain Italian Hotel Group also entered the Metaverse to offer users the chance to experience and learn about its property before they stay there. Once they connect with the hotel in the Metaverse, users can meet staff avatars who can converse with them in real time. The staff members lead users on a

tour of the rooms and hotel facilities, showing them the customisation options available in the real facility, the spa, and other services offered. Such interactions help the hotel to understand potential travellers' new and different needs and to intervene in any critical issues reported by avatar visitors.

A further field of research is also beginning to study tourists' behaviours in the Metaverse using an ethnographic perspective [36–38].

These activities represent an opportunity for tourism players to develop tourism spaces, offers, and services to be marketed in a more targeted and informed way. Similarly, these activities enable people moving through the Metaverse to become more prepared and aware consumers, encountering in advance through their simulated enjoyment the goods, products, and services that may be of interest to them during their travels [39–42].

Because of its inherent potential, the use of the Metaverse for marketing can target not only individual customers but also travel professionals, such as travel agencies, influencers, and other intermediaries.

3. Potential Metaverse Applications in Food and Wine Tourism Experiences

Gastronomy in the Metaverse may sound paradoxical, as food is strongly linked to sensory and tangible experiences. Currently, if a restaurant or a winery opts to open a store through NFTs on the Metaverse, the goal may seem purely promotional, since it would not be possible to exploit the most important senses involved in tasting, smelling, and enjoying food and/or wine. However, food and wine are much more than simply the act of eating and drinking: they involve connecting with communities, cultures, and different territories.

The recent COVID-19 pandemic represented an unprecedented crisis for the hospitality industry. Due to health and social distancing measures, many hotels, restaurants, wineries, and bars have had to close. In addition, following the financial crisis resulting from the containment measures, several hospitality companies worldwide permanently ceased their activities. Thus, innovation must be given top priority in looking for potential solutions for hotel and oeno-gastronomy businesses. In more practical terms, innovation in the food sector is not just about physical food; it is also a matter of the phygital food experience. Oeno-gastronomy in the Metaverse must extend beyond the sense of taste to enhance the enjoyment of dining through immersive experiences, even incorporating gamification technologies into the custom of eating at a table. During the pandemic, evidence of such innovation appeared in the key role played by (virtual) technologies [43,44], from instant text messaging for food orders [45–47] to the ghost, cloud, and dark kitchens initiatives, virtual wine tasting experiences [48], and virtual tours of cellars and vineyards.

Particularly in oeno-gastronomic tourism, sharing experiences with friends, family, followers, and peers became one of the most important aspects of travelling across territories. To expand such experiences, food and wine in the Metaverse may open up novel and unconventional possibilities, such as the opportunity to visit production sites, breweries or farms in different states or nations and to interact with influencers and chefs.

Since 2022, companies have begun to experiment with phygital food experiences by opening virtual outlets in which customers may place their orders by logging in using VR goggles and have food delivered to their homes. Another example is represented by the Flyfish Club, which only allows access to its physical location in New York through NFTs supported by blockchain technology.

The wine sector might also add interesting phygital features to customise wine lovers' experiences by, for instance, using VR devices to explain the wine-making process during a wine-tasting session [49]. Concerning wine tourism, some companies have proposed immersive virtual tours of the world's finest wineries, assuring that the experiences are so real that by the end of the tour, virtual tourists can smell the wine.

Currently, it is difficult to predict whether oeno-gastronomic phygital experiences will gain any interest over physical ones. Certainly, however, VR, AR, MR, and the Metaverse offer significant potential for destination promotion. Firstly, they may make it possible to erase physical barriers for those who do not have the opportunity to travel around the

world, even though, at least at first, such experiences will be accessible only to a certain niche of customers. Secondly, on the one hand, tourism experiences in the Metaverse could be criticised as amplifying a stationary lifestyle, which could worsen the trend in place since the 21st century; on the other hand, immersive virtual tourism experiences may lessen the perceived risk associated with intangible services, enabling visitors to make more knowledgeable choices and have more realistic expectations for their real visit [50,51]. According to several scholars [52–54], in the post COVID-19 era, people consider their health and safety as top priorities, even if it means organizing their travel experiences differently than in past, by, for instance, leveraging virtual potentials.

Finally, adding artificial intelligence (AI) features would make it possible to customise individual travellers' experiences to new levels.

4. Discussion

The rapid spread of the Metaverse has stimulated numerous discussions about its potential to transform society. Supporters of the Metaverse describe it as an innovation that will have major impacts on people's lives in the long run, as the internet has had already [55,56]. Likewise, with the Metaverse still in its early stages, some have shared concerns about governance, ethics, privacy protection, and data reliability and accuracy.

In terms of research applications, the pioneering experiences reviewed in this article indicate that the Metaverse holds a number of possibilities for research. In the context of food marketing and tourism research, one advantage that has already emerged is the possibility of creating objects or arranging activities that are unrealistic or that are not yet available in the marketplace, thus allowing users to experience goods and services that cannot be experienced in reality. This feature expands the possibility of allowing potential customers to evaluate multiple prototypes of the same product or service at a lower cost than creating them in reality for use and evaluation [57].

However, testing vineries, hotels, and restaurants on the Metaverse might be different from the real experience, generating a sense of dissatisfaction induced by the mediated simulation. Moreover, the anticipation could affect the originality and freshness of tourists' experiences and relationships with territories [53]. In this regard, the attractiveness of real destinations could be undermined when users develop an unhealthy level of attachment to the Metaverse, due to the possible feeling of addiction, as virtual reproduction could become increasingly addictive and captivating.

The new possible forms of interaction between players and users foreshadow a scenario in which, for data and information collection, traditional channels are giving way to interactive, anthropomorphic AI agents that engage in personalised interactions with customers, such as virtual 3D AI agents in VR or holograms in AR [58]. Moreover, as a space that can be used freely, the Metaverse makes participation in research more accessible and inclusive in several respects. First, all subjects can ideally take part in such research, overcoming the physical limitations that exclude certain people, such as those with mobility impairments. In the Metaverse everyone can create their own avatar and explore simulated environments freely. Similarly, distant or hard-to-reach places can be reproduced in the Metaverse. As a result, research can benefit from the participation of those who otherwise would have opted out due to distance or travel costs. This circumstance also makes research more sustainable. The Metaverse can help reduce carbon emissions by making travel by plane, train, and personal transportation unnecessary for activities that were previously only feasible in person [59]. Additionally, access to the Metaverse provides a strategy to decongest certain areas, freeing them from seasonal over-tourism [60]. Finally, the trend of people purchasing fewer physical items in favour of digital ones hints at a more sustainable dematerialised future [61–63].

However, some scholars [64–66] urge caution regarding the benefits for environmental sustainability, since the Metaverse, along with the growth of its user base, could result in the need for significant computing power and high bandwidth speeds, consequently increasing energy consumption, mainly through non-renewable sources. In addition, further critical

considerations appear to be necessary, as certain limitations in the field of research could be identified.

The technologies still need to be perfected, the governance and rules for recruiting study participants have yet to be defined, no shared navigation standards exist, and the multiple Metaverses that current exist differ from each other in some respects.

Another concern involves regulation. Organisations and nations are not yet prepared to address privacy and security issues related to the Metaverse. More specifically, data privacy and cybersecurity regulations lag behind innovations in the Metaverse [67–69]. For example, because the Metaverse is borderless, in Europe it is still unclear how the clauses of the European Union's General Data Protection Regulation (GDPR) regarding the transfer and processing of data outside the EU can be applied.

A final issue concerns possible disparities in access to the Metaverse and its associated infrastructure and technologies. Indeed, certain populations (or parts thereof) are currently unable to access the infrastructure needed to obtain entry into the Metaverse [70]. Moreover, since access to the Metaverse is stratigraphically linked to ICT skills, using the Metaverse requires a range of technical knowledge not currently possessed by everyone. Without actions to mitigate this gap, those who cannot adapt to this change or who lack sufficient resources will be excluded from the new levels of connection and collaboration fostered by the Metaverse, and consequently, from new forms of communication, interaction, and research [71,72].

As a result, further insights into how to handle the challenges and opportunities of the Metaverse for research are needed, but these must be balanced by further research into potential new forms of social exclusion, the reliability of data, and the many ethical, behavioural, and negative impacts on vulnerable users.

5. Conclusions and Future Research Perspectives

In the transition from the pandemic to the post-pandemic era, a memorable long-term change in the way that people interact through technological applications is taking place and it will affect all domains of (virtual) life.

Starting from recent developments, reflections, applications of digital innovations, and the new frontier of the Metaverse, this paper has outlined the main tendencies in the domains of tourism and food and the consequences for research applications.

In the short term, it will likely be possible to experience unconventional and unexpected possibilities in tourism, such as walking in the ancient Roman forum as part of the initiative known as Time Machine Europe, which uses AR/VR applications to simulate hypothetical spatiotemporal 4D reconstructions with the aim of 'mapping the European social, cultural and geographical evolution across times' (Time Machine Europe website, https://www.timemachine.eu/about-us/, accessed on 12 January 2023).

From a more critical standpoint, many open questions linked to the social acceptance, economic accessibility, and environmental sustainability of such technologies remain unanswered. Tourism experiences reflect intricate socio-psychological processes, including a multisensory performance. The quality, authenticity, and sustainability of the travel destination are just as important as the social, demographic, economic, and cultural characteristics of the traveller in determining value, significance, and level of satisfaction. In this framework, digital innovation and immersive virtual practices can provide further opportunities to explore and to advance research on customers' and travellers' desires, needs, expectations, and satisfaction.

Nevertheless, while the (re)construction of immersive environments, goods, and services is becoming increasingly sophisticated, the Metaverse still proposes unrealistic objects, which may mislead users or challenge the validity of results through their lesser sense of reality [73]. For example, while sound and visual aspects tend to be relatively realistic, limitations exist in relation to atmosphere, smell, and perceived tactile sensations. Based on these considerations, research on the ability of the Metaverse to reduce or mitigate hypothetical bias in choice experiments is needed. For instance, scholars should pay attention

to the reliability and validity of the evaluations of virtual experiences using psychometric scales able to capture the psychological complexity and the hidden dimensions of consumers' willingness to welcome tourism experiences in the Metaverse. Indeed, the individual perception could be biased, since it is mediated by a virtual tool and may not correspond to the possible evaluation of the real experiences. Similarly, a discussion on how to appropriately design digital environments so that they can more accurately simulate real face-to-face experiences must be advanced [74,75]. Other research directions, currently unexplored, could focus on how the Metaverse could affect the decision-making behaviour and consumption habits of tourists, and/or explore whether such technologies are applicable in other tourism niches.

In addition, further research must focus on people's perceptions, attitudes, acceptance, and willingness to pay for AR/VR/MR experiences, while also considering cross-country and multi-cultural aspects, as noted by several scholars [44,76,77].

Another critical issue is related to the management of the large quantities of sensitive data that will travel through the Metaverse until clear and shared procedures and policies are defined within the scientific community.

To conclude, the Metaverse can become an important tool for promoting and advancing tourism research through the implementation of some initiatives, such as facilitating virtual collaboration among researchers, allowing them to work together on projects and share data in real time. In encouraging cross-disciplinary collaboration, the Metaverse can bring together researchers from different fields to work together on tourism research projects.

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