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SMART TOURISM ECONOMICS: INTRODUCING A TECHNOLOGY-DRIVEN COMPETITIVE ADVANTAGES FRAMEWORK

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Abstract. Recently, in the Hospitality 5.0 era, the Smart Tourism industry has experienced disruptions due to the widespread integration of cutting-edge technologies (Artificial Intelligence, Internet of Things, Robots, Big Data, and others) enabling the overall tourist experience enhancement. This study aims to identify the main clusters of technologies adopted and to highlight the competitive advantages resulting from their implementation in Smart Tourism. A meta-analysis was conducted on a final WoS sample of 60 papers published between 2015 and 2023. Four synoptic tables showcase the technologies, the processes they facilitate, the competitive advantages, and the smart destinations where they have been implemented. The originality of this research consists of the 70 competitive advantages identified across the industry, leveraged in designing the CECoR map (Customer Experience, Costs, Revenues) and the CAdSTT framework (Competitive Advantage-driven Smart Tourism Technologies). Guidelines for supporting managers in planning and initiating projects aiming at integrating technology to increase organisational value were proposed.

Keywords: smart tourism economics, technology, smart destination, CECoR map, CAdSTT framework, hospitality 5.0.

JEL Classification: M21, Z32, O32, O33.

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1. Introduction

The Smart Tourism (ST) concept generally involves integrating cutting-edge information technology into the tourism sector to attain strategic advantages over competitors (Lasisi et al., 2025; Liang et al., 2022). It also refers to a destination's ability to apply different technologies for the benefit of both visitors and other stakeholders (Balakrishnan et al., 2021). According to Mali (2025), the Global Smart Tourism Market was valued at USD 29154.2 million in 2024 and is projected to reach approximately USD 52614.25 million by 2031. This growth is attributed to enhanced tourist experiences and reflects a Compound Annual Growth Rate (CAGR) of 8.80% over the forecast period from 2024 to 2031. Therefore, the emergence of the digital age has led to a significant shift within the tourism industry, giving rise to the idea of Smart Tourism Technology (STT). Following the COVID-19 pandemic, a profound reconfiguration of

regulatory frameworks and consumer demands serves as a catalyst for the adoption of smart technologies (Buhalis et al., 2022). The latest studies indicate a restart in ST operations and a gradual interest growth in tourism innovation (Pantano & Stylidis, 2021) and in acceptance of information and communication technologies (ICT) services (Su, 2022).

The most recent research topics acknowledged are tourism economics areas in relation to robotics, virtual and augmented reality, trust in and acceptance of technology (Molina-Collado et al., 2022), artificial intelligence (AI) (Anica-Popa et al., 2023), electronic word-of-mouth (eWOM), user-generated content (UGC), self-service technologies (SST), and blockchain (Zhang et al., 2021), oriented towards application rather than theory (Xiang et al., 2021).

Since the ST definitions are closely linked to competitive advantages, we planned to find in the existing literature examples of such advantages generated by disruptive technologies' adoption. To our knowledge, there is no paper presenting an overview of the business processes that integrate emerging technologies, also highlighting the types of competitive advantages created in smart destinations. To fill this gap, we carried out an original research aiming at leveraging the distinctive competitive advantages found to elaborate tools for planning, initiating, and monitoring ICT adoption projects. Our findings could assist managers in guiding their decisions toward reaching some types of organisational benefits.

Combining a pragmatics research paradigm (Je et al., 2020; Kaushik & Walsh, 2019) with the Resource-Based View (RBV) theory (Hariani et al., 2024; Wang et al., 2024), we harnessed the results of our analysis conducted at the smart destination level to propose practice-oriented interpretation, which might be useful for the ST managers working in todays' Hospitality 5.0 environment (Hussain et al., 2023).

The research objective is achieved through a meta-analysis of a final sample of 60 papers from the Web of Science (WoS) database referring to ST technology-induced competitive advantages.

Our findings include the array of emergent technologies that are being used in the current tourism business environment and the engendered competitive advantages, targeting transformed operations, smart destinations adopting these solutions, and documentation sources. The information is structured into four synoptic tables. The research originality is further enriched by distributing the identified competitive advantages along the CECoR (enhancing Customer Experience, reducing Costs, increasing Revenues) axes of competitiveness. Moreover, a proposal for a Competitive Advantages-driven Smart Tourism Technologies (CAdSTT) framework was developed, with practical implications, as it may assists business leaders in designing and initiating emerging technologies integration projects within ST.

This paper is organised as follows: Section 2 includes a primary investigation conducted in the literature, regarding the ST technologies facilitating a competitive advantage for tourism companies. Section 3 outlines the research methodology employed and the research questions, while Section 4 presents the research findings and discussions. The conclusions are discussed in the final Section.

2. Literature review

In recent years, the continuous progress of digitalisation and the widespread application of cutting-edge technologies resulted in an ongoing disruption in the tourism industry (Zhang et al., 2022). The literature records currently the concept of Hospitality 5.0 (Hussain et al., 2023), derived from the construct of Industry 5.0 or the fifth industrial revolution, representing the next stage of the fourth industrial revolution (Industry 4.0). While Industry 4.0 was oriented mainly on the industrial processes automation by using state-of-the-art technologies such as Internet of Things (IoT) and Artificial Intelligence (AI), Industry 5.0 leverages

innovation-driven research to attend the new societal and environmental sustainability needs (Botti & Baldi, 2024). Nowadays, how tourists plan, enjoy, and share their experiences has completely changed (Križaj et al., 2021) as a result of this revolution. From searching for accommodation and booking flights to looking for authentic and personalised experiences, traveling is enhanced with the power of innovation (Elshaer & Marzouk, 2022).

Leisure and travel frameworks have transformed from traditional to Smart Tourism (Liang et al., 2022). Smart Tourism refers to a destination's ability to embrace integrated technology platforms for the advantage of tourists and other stakeholders (Balakrishnan et al., 2021; Nam et al., 2021), unlike traditional tourism, which faced difficulties in promptly accessing tourist-related information (Liang et al., 2022). ST develops from the idea of the smart city and is driven by technology perspectives, new networking strategies, and information exchange methods (Pranita et al., 2023). By adopting advanced technologies, tourism is becoming smart, which aims to give tourists a seamless and individualised travel experience (Buhalis et al., 2022; Zhang et al., 2022). This transition aims to optimise operational processes, actualise electronic and real-time functionalities, streamline convenience, implement systematic precision, and achieve heightened efficiency in the management and service provisioning within these scenic areas (Yu & Wang, 2017), thus creating added value for the business workflows. As expected, many businesses had to reconsider their procedures and methods to gain competitive advantages from the shift in paradigms brought about by technologies (Zhang & Li, 2022).

The competitiveness of tourism destinations is crucial for both national economies and local communities (Gonzalez-Rodríguez et al., 2023). Tourism destination managers must employ competitive strategies to navigate the dynamic and evolving environment of the tourism industry (Lasisi et al., 2025). However, achieving a sustainable advantage in the current highly competitive landscape is considered a challenging task (Napierała et al., 2020). The assessment of tourist destinations' competitiveness and the elements that strengthen their positions in the market have received more attention over the past decade (Gonzalez-Rodríguez et al., 2023). The innovation and competitive advantages of tourism destinations rely on the utilisation of tourism applications based on the development of various technologies (AI, machine learning (ML), blockchain, Internet of Things (IoT) etc.), which enhance tourists' autonomy and self-reliance in engaging with different tourism activities (García-Milon et al., 2020). Given their competitive qualities, tourism managers are recognising the increased value advantages derived from smart technologies (Buhalis et al., 2023).

As for ST technology (STT), it has emerged as a strategic element for creating competitive advantages by tourism organisations and destinations (Sustacha et al., 2023). The enhanced functionality of STT has resulted in increased visitor resources and benefits, leading to long-term advantages like repeat visits, largely influenced by the technology-driven visitor experience (Balakrishnan et al., 2021). Among the integrated STT are AI, ML, robots, IoT, Augmented Reality (AR), Virtual Reality (VR), Big Data, mobile applications, platforms, and blockchain (Pranita et al., 2023; Shafiee et al., 2022; Yu & Wang, 2017). AI was harnessed to gain insights into the interests, habits, and trends of travellers (Tussyadiah, 2020), and to assist tourists in finding more relevant information used in their decision-making process (Buhalis et al., 2022). Tourists might be attracted to AR technology placed at a destination in key spots, which seems to increase travellers' interest (Pranoto et al., 2023). While AR enables users to engage with their existing environments, VR immerses the user in other locations (Shen et al., 2022). As for mobile apps and platforms, they have completely changed how businesses engage with their clientele (Lee & Jan, 2023), serving as central locations for tourism services like accommodation, tour booking, and reaching prospects (Alhanaqtah, 2023). IoT-based applications in ST include entrance guards, safety and protection, self-guided tours, surveillance,

and the development of online travel services (Zhang & Li, 2022). Big Data technology is used to examine visitor behaviours, tourist destination choices, consumption patterns, lodging, travel, shopping, and entertainment (Yu & Wang, 2017). Blockchain adoption within ST improves trust and accountability in booking and payment systems (Nam et al., 2021), or other hospitality-related processes, like supply chain details and managing memberships, ensuring sustainable approaches (Pranita et al., 2023). In the new ST Economics landscape, these technological advancements allow tourists to be more adaptable, businesses to co-create better experiences, and stakeholders to work together (Inversini et al., 2024).

3. Methodology and research questions

The aim of this study is achieved by conducting a meta-analysis, scrutinising papers referring to Smart Tourism Economics and technology-enhanced competitive advantages.

Our paper aligns with McCabe (2024) ideas, exposing the essential new characteristics and features of the ST industry, but being focused on the most recent competitive advantages created through modern technologies. Emerging through our conceptual inquiry, the study was framed by the pragmatics paradigm (Kaushik & Walsh, 2019) and the Resource-Based View (RBV) theory (Hariani et al., 2024; Wang et al., 2024), applied in the Hospitality 5.0 business environment. The pragmatism is considered a practice-minded research approach and problem-solving centred in a context created by a real-world investigation (Je et al., 2020; Kaushik & Walsh, 2019). Through the RBV framework, we explore the technology adoption within the smart destinations, to identify the competitive advantages engendered and propose their CECoR classification, while mapping their effects on the organisational performance (enhanced Customer Experience, reduced Costs, and increased Revenues).

The research objective is defined by the following research questions:

RQ1. Which technologies have been implemented in ST so far in order to generate competitive advantages?

RQ2. What processes and activities have been reshaped through technology adoption?

RQ3. What are the ST competitive advantages to be included in a CECoR Technology-driven Competitive Advantages map?

RQ4. Which smart destinations have already obtained the previously identified competitive advantages?

RQ5. What competitive advantages-driven framework may be offered to business leaders to initiate and manage an emerging technology integration plan?

To answer the research questions, we conducted a literature review on papers selected from the Web of Science (WoS) database, for the period 2015–2023. The search terms *Smart Tourism*, *technology*, and *competitiveness* were employed to capture relevant papers within the ST Economics area. After examining the specialised literature, we found various meta-analysis studies using different search keywords, such as: *technology*, *tourism*, *smart tourism destination* (Gelter et al., 2020), *smart touris** and *technolog** among others (Sustacha et al., 2023), but to our knowledge, no paper used the terms *Smart Tourism*, *technology*, and the lexical family of the term *competitiveness*. To fill this gap, we carried out an original research, aiming at identifying the competitive advantages of ST businesses generated by the implementation of emerging technologies. We further leveraged the results to provide academic and practical settings by elaborating new tools for planning, initiating, and monitoring ICT adoption projects aimed at achieving increased competitive advantages and value creation.

To ensure that the final sample included only relevant papers, we followed the steps listed in Table 1. Furthermore, an Excel file was generated to contain the 155 selected papers.

Subsequently, five non-English papers were excluded. The abstracts were required to contain at least one word of the lexical family of the term competitiveness: competitive, competition, competitor, competing, compete.

Table 1. Breakdown analysis of the inclusion and exclusion criteria (source: own research)

Criteria	Number of papers
1. Initial search	155
2. Non-English papers – excluded	5
English papers	150
3. Abstract analysis DOES NOT contain "competitiveness" or "competition" or "competitive" or "competitor" or "competing" or "compete"	64
4. Paper availability	86
Non-available papers – excluded	26
5. Final sample	60

Out of the 150 papers, 64 did not meet the above specified criterion, and for 26, the full text was not available. The final sample of 60 papers published between 2015 and 2023 was analyzed to answer the research questions, review recent ST technology implementations, and demonstrate the value creation through competitive advantages gained. A Structured Literature Review (SLR) is conducted with the purpose "to identify key scientific contributions in a field and its results are often descriptively presented and discussed" (Becheikh et al., 2006, p. 645). Three stages are to be followed in order to conduct a SLR (Tranfield et al., 2003): planning the review, conducting the review, and reporting and disseminating the findings. This method was chosen for researchers' flexibility on "adding new criteria as they advance with the analysis of the articles" (Caraiani et al., 2018, p. 539). Additionally, the content of the papers is analysed in respect of the main addressed topics.

4. Results and discussion

4.1. Clustering research findings

To organise the implemented technologies by groups, the information gathered from the literature was analysed. The recent study of Cao and Yang (2023) classifies the cutting-edge technologies used in the hospitality and tourism industry in *AI-dominated*, *VR -dominated*, and *robots-dominated clusters*, considering them closely related. Using further the "dominant technology" criterion, we finally identified 37 applications/tools, organised into three core clusters: (1) *AI*, *ML*, *Robotics*, *AR*, *and VR technologies*, with 13 items (35.14%) presented in Table 2; (2) *Big Data*, *platforms*, *and mobile apps*, including the 15 items (40.54%) from the Tables 3 and 4; (3) *IoT and automation*, with 9 items (24.32%) highlighted in Table 5. We listed the designation of the application or tool, the source(s) of information, the transformed process or activity, the performed operations, the competitive advantages gained, and the smart destination integrating ST technologies. The first column presents the names of the identified technological solutions when clearly pointed out in the documentation source and the type of the adopted technology in each case. As for *ST Destination*, we collected the available information regarding the ST places where the new technology was inserted (e.g., ST organisations, cities, regions, countries). For research consistency, we included in the

findings only the items for which all these elements were mentioned. The items that did not meet this inclusion condition were discarded. A total number of 70 competitive advantages were extracted from referenced papers in the tourism industry.

4.2. AI, ML, robotics, AR, and VR in Smart Tourism

Due to their dynamic efficiency, AI, ML, and robotics are anticipated to have significant ST Economics benefits (Tussyadiah, 2020). Immersive technologies such as VR and AR have enabled ST managers to enhance tourists' satisfaction and promote destinations, offering visitors new travel experiences (Shen et al., 2022). Table 2 presents the competitive advantages generated for ST destinations by running operations integrating emerging technologies, in the ST Economics landscape.

Table 2. AI, ML, robotics, AR, and VR technologies insights in Smart Tourism Economics (source: own research)

Application / Tool	Process / Activity	Performed operations	Competitive advantages	ST Destination
Florence Guide by eTips; Metro AR Pro; Flightradar24 Kyiv.Travel / AR and VR (Irtyshcheva et al., 2022)	Tourists' information Destination promotion	– Virtual real-time tourists traveling by using local webcams transmitting over the Internet.	– Reduced tourists' costs, by viewing locations. – Optimising planning time.	Florence/Italy, London/UK, New York/ USA, Kyiv/ Ukraine
VroomService / VR (Irtyshcheva et al., 2022)		– Virtual tours for tourists, in destinations (Chile, China, Rwanda).	– Pre-purchasing 3D virtual tours.	Marriott/ NewYork/ USA, London/UK
Robots (Yang et al., 2021; Buhalis & Leung, 2018)	Front desk service	– Welcoming guests. – Luggage and items delivered to guest rooms.	– Enhanced tourist experience. – Saved energy. – Reduced waste.	Henn-na Hotel/ Japan, Hotel Jen/ Singapore
Robot concierge / Robots & ML (Buhalis & Leung, 2018)	Tourists' information Customer service	– Providing suggestions to guests. – Learning and enriching the hotel's clientele database while interacting with it.	– Enhanced tourist experience. – Increased customer knowledge base.	Hilton Hotels
Ancient Virtual Travel; Encyclopedia Ancient Egypt Virtual Travel; Encyclopedia Virtual Sweden; Second Life; The VR Movement / AI, VR & AR (Zhang et al., 2022; Liu, 2019)	Tourists' information Destination promotion Travel planning	– Illustrating the city planning, architecture, and artistic heritage of ancient Rome and Egypt. – Offering pre-planned scenic tours, an interactive display, scene restoration.	– Enhanced tourist experience. – Optimising customers' planning time/ travel costs.	– Rome/Italy – Egypt – Sweden – Destinations around the world – Liangzhu Museum/China
AR tool (Irtyshcheva et al., 2022)	Tourists' information Destination promotion	– Reconstructing missing components for exhibits.	– Exhibits' better understanding.	Stellenbosch Museum/UK

By implementing the 13 tools found (Table 2), based on AI, ML, Robotics, AR, and VR technologies, *customer service* and *tourist information* processes are transformed. The research findings, which indicate technology-driven competitive advantages and value-added, may be divided into *two categories*: economic indicators directly quantifiable for businesses (increased number of tourists, reduced planning times for activities included in tourist offers, operational costs, waste, energy consumption) and improvements perceived at the customer experience level (enhanced customer satisfaction, deeper understanding of a hotel's customers).

4.3. Big Data, platforms, and mobile apps in Smart Tourism

Big Data implementations, distinguished by the exploitation of increasing volumes of information, complex analytics, and real-time insights, became significant tools in optimising ST performance. By enabling destinations and stakeholders to analyse visitor behaviour, preferences, and trends, it promotes informed decision-making and customised experiences (Zhao et al., 2022). The mobile apps offer access to a wide range of features, from booking platforms and real-time language translation to interactive guides and real-time navigation (Yu & Wang, 2017). Analysing the information collected from the literature, it may be observed, in addition to the presentation of examples at the business level, some initiatives aimed at boosting the competitive advantages of various ST destinations led at local, regional, and national levels. Illustrating this segmentation, the following tables (Table 3 – for the business level and Table 4 – for local, regional, and national approaches) include a selection of the discovered tools using big data technologies, platforms, and mobile applications currently operating in ST.

Table 3. Big Data, platforms, and mobile apps in Smart Tourism – businesses' insights (source: own research)

Application / Tool	Process / Activity	Performed operations	Competitive advantages	ST Destination
TripAdvisor / platform (Buhalis et al., 2023; Paiano et al., 2017)	Tourists' information Destination evaluation	– Enabling destination services rating. – Allowing quick responses to tourists' needs.	– Reaching potential visitors. – Leveraging tourists' feedback. – 24/7 availability.	Slovak destinations
Booking Expedia / platform (O'Connor, 2023)	Tourists' information Feedback collection	– Enabling accommodations/ other services booking. – Collecting tourists' feedback.	– 24/7 availability. – Leveraging tourists' feedback.	Globally used
VeneziaUnica / mobile app (Lee et al., 2020)	Tourists' information Destination promotion Feedback collection	– Enabling direct visitors' communication with service providers, views/pictures exchange with other users.	– Better offers/ real-time responses for customers, by leveraging their experience sharing. – Optimising customers' planning time and travel costs.	Venice/Italy
Salzburger Mittagsplaner / mobile app (Lee et al., 2020)		– Offering details (menus, pricing, locations) about service providers. – Allowing seats/food selection in advance. – Collecting feedback.		Salzburg/ Austria
ReviewPro / mobile app (Buhalis & Leung, 2018)	Feedback review	– Monitoring online hotel reviews (especially negative).	– Tracking social media reviews, analysing contexts, acting.	Marriott Hotels

In Table 3, the competitive advantages identified are an increased number of potential clients, 24/7 availability, reduced travel costs and planning time, increased use of customer feedback analysis in business decisions, and boosted knowledge sharing.

Table 4 lists a selection of 9 items leveraging capabilities of Big Data tools, platforms, and mobile applications at regional and national levels, describing initiatives in countries (Spain, Egypt), regions (Basque, Nantou, Beitou), and cities (Madrid, Seoul, Helsinki, Kyiv).

Table 4. Big Data, platforms and mobile apps in Smart Tourism – local, regional, national public entities insights (source: own research)

Application / Tool	Process / Activity	Performed operations	Competitive advantages	ST Destination
Spain.info platform (Arenas et al., 2019)	Tourists' information Travel planning Marketing	– Using pre-trip/on-trip/post-trip travellers' needs for planning trips. – Tour operators/ service providers present offers, including their own booking website's direct connection.	– Improved capacity to identify/target new visitors. – Attracting inhabitants/ non-residents as potential tourists. – Underpinning marketing approaches by analysing/ segmenting travellers.	Spain
PREDIF platform (Arenas et al., 2019)	Tourists' information	– Promoting offers designed for individuals with disabilities. – Customising tours.	– Enhanced customer service.	Spain
M-Tour / mobile app (Nyaboro et al., 2021)	Tourists' information Destination promotion	– Real-time discovery of locations/services. – Accessing service providers via instant messaging. – Transmitting cultural hints.	– Bridging the communication gap between stakeholders – Increasing tourism companies' value.	Egypt
BaliaTours platform (Arenas et al., 2019)	Tourists' information Destination promotion	– Suggesting/ publishing real-time information by leveraging providers' content. – Promoting the entire tourism value chain.	– Enhanced services to tourism providers/users/ visitors. – Each stakeholder makes their content available in the market (deals/offers/events).	Basque/ Spain
SuperSurv Lodging mobile tour / mobile app (Hung & Lin, 2018)	Tourists' information Accommodation & Booking	– Being used as a travel guide: transportation, dining, attraction points. – Accessing the lodging options nearby using GPS/GIS.	– More accurate tour information. – Optimising planning time/travel costs. – Real-time accommodation	Beitou/ Nantou/ Taiwan
Madrid Precious Time/ platform (Arenas et al., 2019)	Tourists' information Capitalising on collaboration	– Enabling partners from public/private sectors to collaborate and help promote Madrid as a "Premium" travel destination.	– Increased users' interest for accessing real-time information in their native language about attractions/ events/services.	Madrid/ Spain

End of Table 4

Application / Tool	Process / Activity	Performed operations	Competitive advantages	ST Destination
VisitKorea/ mobile app (Lee et al., 2020)	Tourists' information Travel planning Sale conditions	– Providing the most recent travel information, categorised (shopping/lodging/ food) personalised travel plans, discount vouchers.	– Instant access to information for tourists. – Optimising customers' planning time/travel costs.	Seoul/ Korea
BOUT/ mobile app (Lee et al., 2020)	Transportation	– Bringing together people licensed to transport tourists. – Optimising on-demand users 'boat rides ordering.	– Improved access to islands/waterfronts. – Optimising customers' planning time/travel costs.	Helsinki/ Finland

Improving customer experience and generating new interest among potential travellers are identified as key *competitive advantages* when exploring the technology adoption in ST. In line with Arenas et al. (2019), we emphasised *collaborative capabilities*, as they enable platform users from different ST sectors (technology, hospitality, arts and culture, handicrafts, retail, design, insurance) to create and leverage cooperative strategy models for generating new tourism products in urban areas. By establishing connections between the components of the whole value chain (independent hotels, hotel chains, accommodation in rural areas, cruise ships, marinas, conference centres, cultural organisations, natural reserves), competitive edges in the economic environment are gained.

4.4. IoT and automated devices in Smart Tourism

A technology that significantly contributes to the ST strengthening is IoT, by creating and managing connections between various objects and systems (Shafiee et al., 2022). Table 5 presents the competitive advantages generated through 9 identified IoT solutions and other related automated devices (beacons, RFID tags).

Our analysis revealed various transformed processes: accommodation, marketing, food quality management, hotel management, queue management, cruise management, customer service, and tourists' information regarding the amenities offered in ST destinations. Notable competitive benefits – items related to business value creation – include unique, enhanced, and customised services, the attraction of more tourists, reduced check-in time to 20 seconds, diminished energy consumption and food waste, and improved insights into a hotel's clientele.

Besides globally developed organisations, such as Disneyland and various hotel chains (e.g., Marriott, Hilton), the technological solutions identified in the 60 papers analysed in this study are geographically distributed mainly in Europe (58.62%), followed by North America (17.24%), Asia (17.24%), and Africa (6.90%).

The literature also reports other technologies, such as blockchain, implemented in ST, which are still in early stages (Kontogianni et al., 2024). Although the analysed papers mention blockchain (Pranita et al., 2023) and Web 3 (Hawkley, 2023), no concrete instances of their use were found. In ST, blockchain may improve customer experience, guarantee benefits to local communities, minimise privacy concerns, enhance the ability to store and secure tourism data, improve tourist return, and boost the revenues of the destinations, all of these becoming competitive advantages (Kontogianni et al., 2024; Luo & Zhou, 2021).

Table 5. IoT insights in Smart Tourism Economics (source: own research)

Application – IoT Tool	Process / Activity	Performed operations	Competitive advantages	ST Destination
Smart rooms (Mercan et al., 2021)	Tourists' information Accommodation	– Ordering services, managing rooms by interacting with mobile/ voice-enabled virtual assistants. – Facilitating in-room workouts by smart mirrors.	– Enhanced tourist experience. – Optimising customers' ordering time.	Marriott Hotels
Fun Finder (Mercan et al., 2021)	Accommodation Marketing	– Easier navigation through the resort's indoor/outdoor facilities. – Notifying users about preferences-tailored events/ offers by leveraging Wi-Fi/ beacon/GPS	– Enhanced tourist experience. – Customised offers for tourists.	Hilton Hotels
Samsung Gear S3 Smartwatches (Mercan et al., 2021)	Hotel management	– Sending notifications to the relevant employee wearing the watch on, when a service is demanded by guests.	– Enabling managers to monitor work in real-time. – Enhanced staff communication.	Viceroy L'ermitage hotel, Beverly Hills/USA
Automated food temperature monitoring (Mercan et al., 2021)	Food quality assurance	– Automatically controlling the food temperature through wireless sensors.	– Reduced waste. – Safer cooking environment. – Improved quality/ consistency.	Taco John's/ USA
Automated queue management (Mercan et al., 2021)	Queue management	– Wearing RFID tags, tourists receive recommendations from the park management. – Creating smart flows by using real-time data from the sensors.	– Enhanced tourist experience. – Managing large crowds in a constrained area.	Disneyland Parks
MagicBand (Mercan et al., 2021)	Park management	– Equipping visitors with MagicBands at registration. – Incorporating RFID tags and so accelerating hotel arrival/sending luggage/ park entrance/hotel check–in/payments in stores.	– Customised services. – Enriching the park database (visitors' preferences/past purchases/locations)	Disneyland Parks
Ocean Medallion (Mercan et al., 2021)	Cruise management	– Equipping visitors with small devices after booking a trip. – Enabling tourists to enter the cabin/visit the ship/make cruise–related payments. – Transforming the ship into a smart city with more than 7,000 sensors.	– Increased interest among customers for cruises. – Reduced check–in time to 20 seconds. – People may track their kids.	Carnival Cruises/ USA & UK

End of Table 5

Application – IoT Tool	Process / Activity	Performed operations	Competitive advantages	ST Destination
IoT guestroom (Buhalis & Leung, 2018)	Room management	– Enabling guests to manage the room amenities (temperature/luminance), to access external information (weather/road traffic) by using beacons and sensors.	– Enhanced guest experience.	Marriott Hotels
Tourist spots information tool (Irtysh-cheva et al., 2022)	Tourists' information	– Unique details about an exhibited object in the museum using QR–codes/ beacons.	– Increased interest among tourists.	National Slate Museum in Wales/UK

4.5. A proposed technological framework for Competitive Advantage-driven Smart Tourism – CAdSTT

4.5.1. Designing the research

To assess the competitive gains generated by new technologies adoption, Hetu (2020) proposed three axes of analysis: improvements in the Customer Experience, reductions of Costs, and increases in Revenues and business profitability. Hetu's competitiveness reference system was abbreviated *CECoR* (Anica-Popa et al., 2021) and leveraged to develop a conceptual framework focused on retail customer profiling. We capitalised on these main ideas of previous research to create a *competitive advantage-based framework* to support ST decision-makers and specialists in the informed design and initiation of technology adoption projects. To achieve this goal, we designed a triadic research approach:

1. Applying the CECoR competitiveness pillars to map the ST technology-engendered benefits identified in the selected papers as competitive advantages.
2. Building of a general frame of reference that includes the identified technologies, which a ST unit could integrate into business processes to reach a sustainable *competitive advantage* and create value.
3. Elaborating guidelines to help specialists interested in using the proposed framework formulate objectives and effective procedures for planning, initiating, and monitoring ST technologies integration projects.

4.5.2. Smart Tourism Economics Insights: A CECoR Competitive Advantages Map

Inventorying the competitive advantages created by the integration of cutting-edge technologies in the specific ST activities, 70 such benefits were found and shown in Tables 2–5. Out of the total, 34 (49%) are related to customer experience improvement, 18 (26%) to cost reduction, and in the range of revenue-boosting we determined another 18 items (26%). Summarising, keeping only once the items found in several papers and distributing them on the CECoR pillars of competitiveness, we developed an illustrative map for ST Economics (Figure 1).

The map of competitive advantages is not exhaustive, but we consider it may serve as a relevant practice-based tool for decision-makers in developing projects for integrating emerging technologies into ST-specific business processes. Managers could be more interested in revenue growth, customer experience improvement, or operational cost reduction, or they may design various mixtures of competitive objectives based on CECoR categories, that could lead to increased business value.

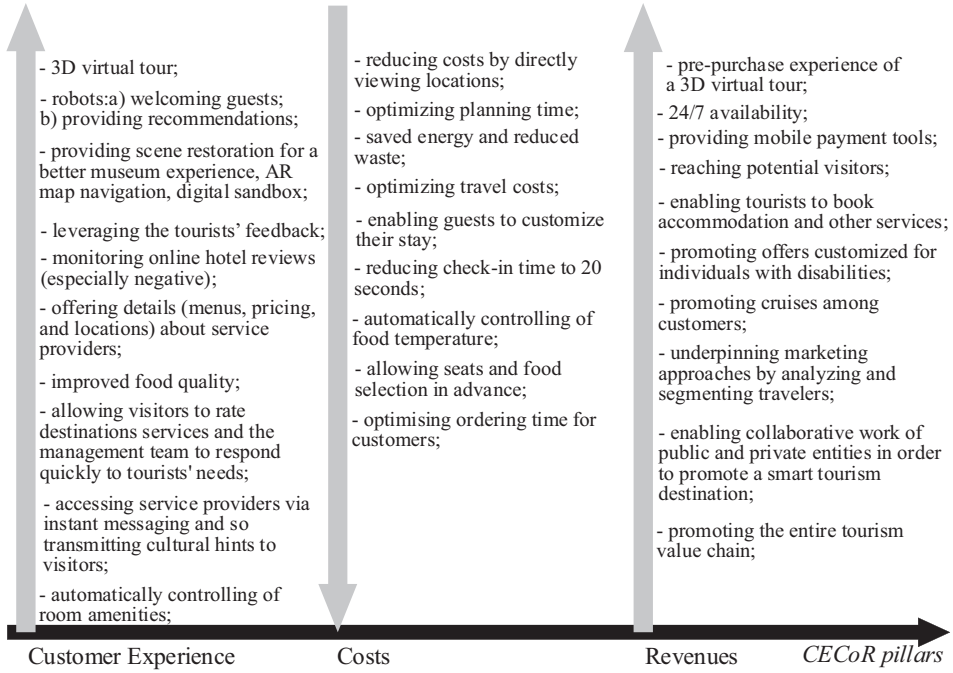

Figure 1. A CECoR Technology-driven Competitive Advantages Map (source: own research)

4.5.3. Shaping the CAdSTT – Competitive Advantage-driven Smart Tourism Technologies Framework

Gretzel et al. (2015) underline the growing dependence of both tourists and destinations on the ever-evolving technology, assigning it a pivotal role in the ST development. Moreover, different practice reports (Barten, 2024; KPMG, 2024) announce solutions such as voice-controlled applications, AI/ML algorithms, robotics, automation, Big Data, contactless features, IoT, AR and VR as top hospitality industry technology trends of 2024.

By leveraging the CECoR Technology-driven Competitive Advantages Map and the items collected in our results tables (Tables 2–5) we started to compose an architectural overview of technologies generating competitive advantages in the ST industry. We intended to provide business leaders with a Competitive Advantage-driven Smart Tourism Technologies framework, CAdSTT (Figure 2), a blueprint for possible pathways to design, scale, and refine their emerging technology integration plan.

Amidst the ST ecosystem, even though companies are cautious about innovative digitalisation and the associated risks, no one could deny the augmenting demand of customers for mobile apps, chatbots, beacons, AR, automated translation, blockchain implementation, 5G, or immersive techniques (Ballina, 2022). Therefore, to attract visitors and increase tourist satisfaction, a business unit will be constrained to become a ST destination, by adopting technological novelties both at the internal and external levels. Consequently, the CAdSTT framework was fragmented into two layers – *internal* and *external*. In each quadrant, technological elements such as AI, ML, Robotics, IoT, AR, VR or Mobile Apps and Platforms were added, depending on the information regarding their implementation available in the data collected

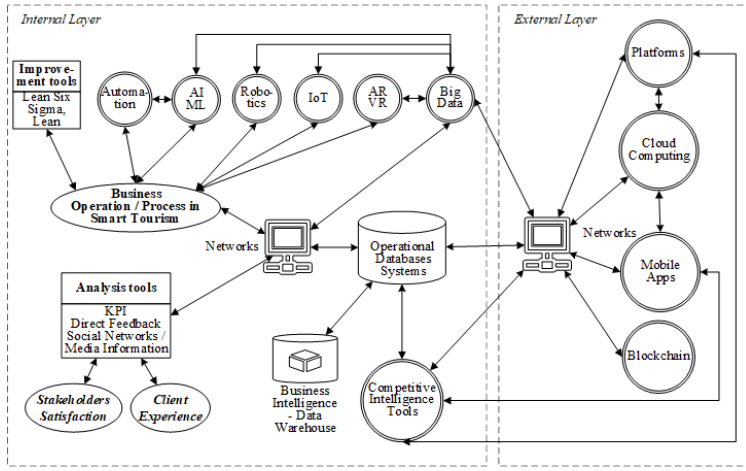

Figure 2. CAdSTT – a Competitive Advantage-driven Smart Tourism Technologies Framework Proposal (source: own research)

from the selected documentation sources. We further proposed possible ST subsystems, with different functions at the level of a ST organization and their connections to adoptable technological solutions, to ensure not only their capitalization, but also the monitoring and evaluation of the competitive advantages thus generated.

Inside the company, the framework starts with business process improvement tools, in the top left corner, required when the operations are prepared for standardisation, future automation and technology insertion. In the lower right corner of the first quadrant, there are Business Intelligence tools, evaluating the performance based on historical data provided by different running information systems and Competitive Intelligence solutions, supporting strategic decision-making processes based on the competition study (Lopez-Pujalte et al., 2022).

The external view includes classes of technologies managed by external entities (local and national organisms, or business partners). Collaborative platforms, booking platforms, and mobile apps enable the collection and exchange of digital data by supporting interconnections, data processing through analysis, visualisation, integration, and intelligent use (Tang et al., 2022).

Creating competitive advantages, alongside risk management, consumer expectations, investor demand, and reporting, are considered key factors for a successful transformation (KPMG, 2024). To be consistent with these business objectives, managers could customize the CAdSTT framework and design technological architectures able to meet stakeholders' expectations or visitors' preferences.

4.5.4. The Competitive Advantages-driven Smart Tourism Technologies framework – usage guidelines and annotations

Both CECoR – Technology-driven Competitive Advantages Map as well as CAdSTT – our Competitive Advantage-driven Smart Tourism Technologies framework are tools that may be generalised not only at the ST level, but also in any other business domains, where processes and operations require technology-powered improvements. Also, the synoptic tables (Tables 2–5) may be enriched with other domain-specific necessary columns and continuously up-

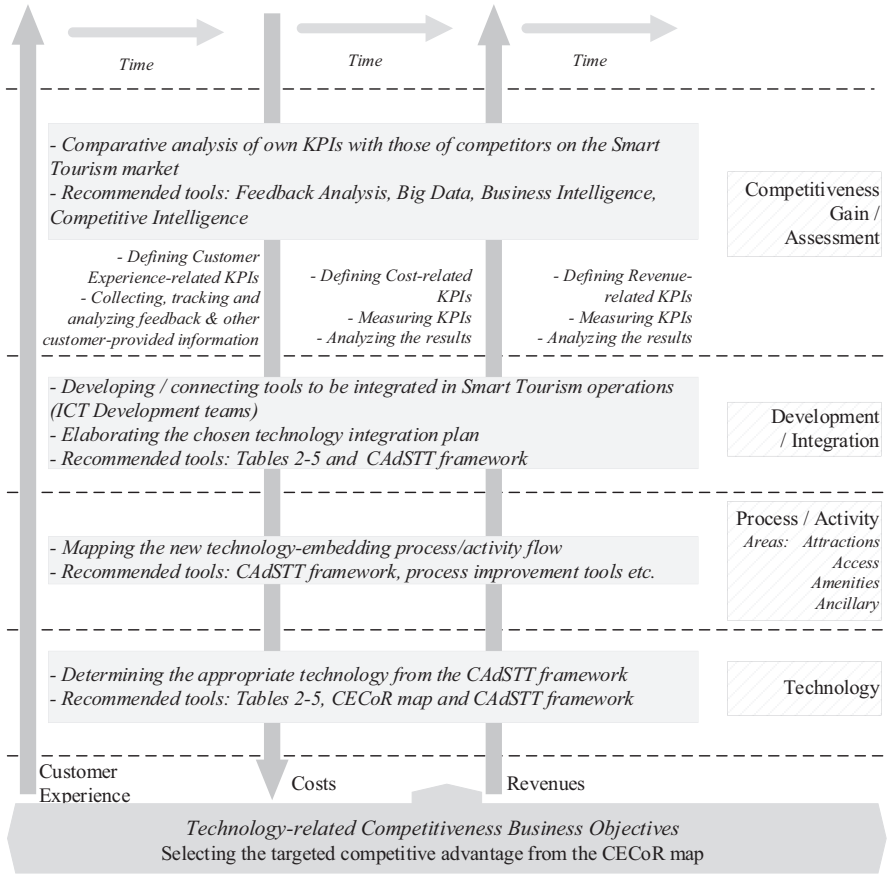

Figure 3. Guidelines regarding the use of the proposed tools (source: own research)

dated with new competitive advantages obtained by implementing emerging technologies.

The proposed CAdSTT framework may serve to smooth the emerging ICT adoption process, the assessment of its outcomes and to overcome the potential predicaments. As in the literature, commonly, a framework ensuing from research is accompanied by the author's vision on how to harness it in practice (Gamal et al., 2023; Yang et al., 2023), we also propose a possible approach to capitalise on the triadic cognitive acquis *CAdSTT framework – CECoR map – Synoptic tables*, outlined in our study (Figure 3).

From a bottom-up perspective, a technology integration project team may start by establishing the goal to be achieved. The team members of such a project could either directly select one of the benefits already presented in our CECoR Technology-driven Competitive Advantages Map, or use the map elements as a source of inspiration in framing new objectives, better adapted to the ST entity needs. At the same time, we would suggest starting to establish the time intervals allocated to each activity defined in the project.

Next comes the analysis and selection of technologies that, once integrated into business flows, may lead to competitive advantages and, consequently, to business value creation. In the context of data-driven nudging, competitive advantages optimisation, and the need for

sustainability in ST, Wang et al. (2020) listed the technologies which determine the smartness of a digital ecosystem: Internet-of-Things (IoT), cloud computing, relational databases, near-field communication (NFC), mobile apps, radio-frequency identification (RFID), smart meters, sensors, beacons. The CAdSTT framework has been completed with AI-based tools, that may provide analysis of data collected around customers' choices. Tracing ratings, feedback, shared photos, geo-tagged locations, and comments in social networking, ST companies could create value-added (Mercan et al., 2021). Processing some metadata, for instance, customer location, the browser and device used, session durations, and referral source, the ST teams could obtain increased revenues by selling pre-purchase experiences of 3D virtual tours, or reduced costs and energy savings by using robots in welcoming guests, transferring their luggage, and delivering items to their rooms (Buhalis & Leung, 2018; Yang et al., 2021). As for customers' immersive experiences, it is delivered through mobile phones, tablets, VR headsets and incorporated VR/AR features reunited into Extended Reality (XR), the Metaverse avatars, digital-specific assets, and the decentralised digital ownership ensured via Web3 – the emerging blockchain-based infrastructure for the Internet (Hawkley, 2023). In our results – the synoptic tables and CAdSTT –, many more technological examples may be spotted by ST specialists.

Further, the technological change of the business process flow could be illustrated by a new comprehensive map, where the activities boosted by the emerging technology adoption, but also the elements that might hinder the process will require increased attention from business analysts. Using process improvement tools and the CAdSTT framework, they may build As-Is and To-Be relevant process/activity diagrams. The points of automation integration, connections with actions before and after insertion points, the people involved, the comments and approvals recorded in the activity stream are noted (IBM, 2021; Microsoft 365 Team, 2022). Additionally, employing Organizational Memory systems (Constantin & Anica-Popa, 2017) enables systematic documentation of challenges and solutions from the technology adoption project, enhancing future initiatives and organizational learning.

In the final stage of the guidelines (at the top of Figure 3), we included activities such as defining specific key performance indicators (KPIs), measuring them, and running comparative analyses of own and competitors' KPIs. From the CAdSTT framework, the project teams may select and use appropriate analysis tools for each CECoR corridor. For example, Big Data and Cloud Computing could serve to analyse the feedback and other information provided by customers. Moreover, Business Intelligence solutions may be leveraged for the own KPIs assessment, and Competitive Intelligence tools could provide information about the up-to-date business position among other ST companies.

Trying to provide a better grasp of how CAdSTT could be used to run technology adoption projects, we considered the case of an ST manager interested in creating and assessing competitive advantages generated by Augmented/Virtual Reality tools integrated into company's daily operations. In Figure 4, we used a dotted line to illustrate the sequence that the manager may compose. Leveraging the CAdSTT, the ST manager could understand the technological infrastructure, hardware and software, necessary not only to generate but also to analyse the competitive position gained by the company following the AR/VR adoption. This sequence might start with the extraction, from the operational database (phase 0), through internal network (1), of those ST processes (2) that might integrate AR/VR tools (3). After their integration, the proposed circuit encompasses Big Data technologies (4), through which large amounts of data that the customers produce when using AR/VR devices are collected and analysed. The results could arrive via the internal network (5) in the operational database

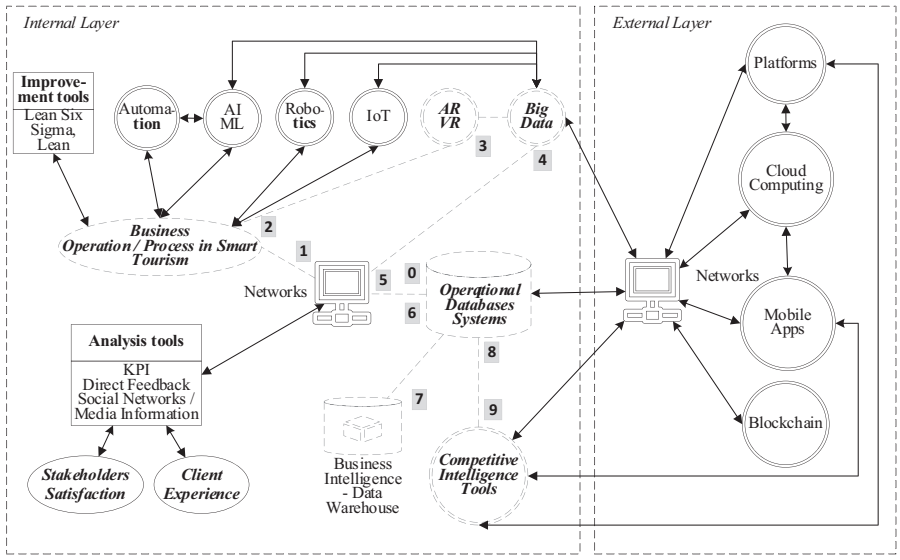

Figure 4. CAdSTT framework usage. An illustrative example (source: own research)

'storage mechanisms (6), from where they could be imported into Business Intelligence tools (7), to determine the internal performance indicators regarding, for example, the revenues thus generated and to perform a multidimensional analysis of them. The aggregated data obtained could be transmitted to the storage tools on the operational database 'servers (8). This information could then feed the Competitive Intelligence applications (9), which might be harnessed to assess how the revenues generated by adopting AR/VR in ST operational processes impact the company's market position and compare it with competitors.

The research results (the synoptic tables, the CECoR Map, the CAdSTT and their usage guidelines) could be also leveraged by ICT specialists responsible for effective technologies implementation and the creation of the necessary mechanisms to connect these tools to the existing ICT architecture.

4.6. Outcomes-based theoretical insights

Considering the Hospitality 5.0 business environment focused on cutting-edge technology adoption and increased sustainability, resilience and a human-centric vision, we tried to improve the comprehensibility of our results' usefulness for ST specialists and managers. Therefore, we set out to substantiate our outcomes by presenting some interpretations framed by both Pragmatics paradigm and Resource-Based View (RBV) Theory.

The Pragmatics paradigm. Being recently considered the most appropriate for the study of tourism digitalisation processes (Ivanova et al., 2022), this research approach encompasses identifying gaps by analysing practical issues and developing solutions in organisational setting (Je et al., 2020). It helped us to emphasise how technology *not only facilitates operations but also affects interactions between ST stakeholders – tourists, ST organisations, and the business environment*. Technologies like AI-driven recommendations, robots, and ML algorithms provide contextually relevant information to tourists. In a CECoR view, this enhances their

experience and satisfaction (*CE* axis), driving revenue increases (*R* axis) (Buhalis & Leung, 2018). For the mobile apps (Lee et al., 2020; Nyaboro et al., 2021), besides bridging the communication gap between stakeholders, they generate competitive advantages on the *Co* axis, such as travel cost reduction and planning time optimisation. The ST platforms (Arenas et al., 2019) or the chatbots for immediate inquiries (Lee et al., 2020) enable real-time interaction between businesses and customers, improving customer experience (*CE* axis), and creating premises for increased revenues (*R* axis). This dynamic communication nurtures a sense of personalisation and responsiveness (O'Connor, 2023; Hung & Lin, 2018; Paiano et al., 2017), leading to higher customer loyalty and spending (*R* axis). Through IoT and sensors technologies, as in Smart Rooms, automated food temperature monitoring (Buhalis & Leung, 2018; Mercan et al., 2021) or tourist spot information tools (Irtyshcheva et al., 2022), ST entities are leveraging knowledge–sharing advantages: vast amounts of data collected might be analysed to outline ST trends and empower ST operations to adapt their offerings, leading to more efficient processes (*CE* and *Co* axes) and targeted revenue generation (*R* items). Last but not least, we noticed that the use of AR tools (Irtyshcheva et al., 2022; Liu, 2019; Zhang et al., 2022) influences social interaction of tourists, their engagement with local culture, and thus the appreciation and spending in local businesses, generating competitive advantages on all *CECoR* axes.

The Resource-Based View (*RBV*) *Theory*. Our RBV interpretation aims at emphasising the strategic importance of adopting emerging technologies as unique resources that contribute to the competitive advantage of organisations in ST sector. In order to be aligned with the market dynamics, in an RBV understanding, *the ST organisations should focus on strategic selection and harnessing of the appropriate resources* (tangible, human, intangible) (Gupta et al., 2024). By adopting more advanced and suitable technologies than their competitors, organisations may differentiate themselves and establish barriers to imitation, thereby consolidating their competitive advantage (Kero & Bogale, 2023).

Our results emphasise the concern of ST organisations to preserve and leverage any technology-driven competitive advantage aiming at attracting and satisfying their customers. For instance, on the *CE* axis, we observed the integration of robots and ML (Buhalis & Leung, 2018), which improves front desk service by providing suggestions to guests, while VR and AR offer pre-planned city tours (Zhang et al., 2022). Moreover, to promote inclusion and support local communities, adapted visits are designed for travellers with disabilities using digital platforms (Arenas et al., 2019). Also, different IoT applications, such as smart watches or automated queue management, are improving the access time and offer customisation (Mercan et al., 2021). Smart destinations from Spain, Slovakia, Italy, and Austria, are leveraging tourists' feedback (*CE* axis) and reaching potential visitors (*R* axis) through the use of platforms like Booking, Expedia (O'Connor, 2023), TripAdvisor (Buhalis et al., 2023), Venezia Unica, and Salzburger Mittagsplaner (Lee et al., 2020). This approach allows them to address existing weaknesses and improve the ST operations. On the *Co* axis, we noticed the waste reduction and energy-saving reported in the case of hotels and restaurants using robots (Yang et al., 2021). Further outcomes reveal that Carnival Cruises (Mercan et al., 2021) obtained an increased interest among customers for cruises (*R* axis), a reduction of the check-in time by 20 seconds (*Co* and *CE* axes), and a tool for people to track their kids (*CE* axis).

Combining the pragmatics and RBV insights, we propose a theoretical background of our CAdSTT framework, CECoR map, selected examples of competitive advantages reported in the literature, and their usage guidelines, which could bolster clarify the courses of action for managers to achieve a targeted competitive advantage. Our findings might also help

strengthen their confidence in the success of their endeavours by analysing the results already achieved, opening up promising competitiveness-related opportunities for ST organisations. All these technology-driven research outcomes – the map of the 70 technology-based competitive advantages revealed in recent literature distributed across the CECoR axes, the CAdSTT framework and guidelines to support managers in planning, initiating and monitoring such projects –, aligned with Hospitality 5.0 principles (Hussain et al., 2023), represent novelty elements through which our work contributes to the body of existing literature.

5. Conclusions

This paper explores the competitive advantages generated in Smart Tourism Economics through the integration of emerging technologies. To address a gap in the specialized literature, it proposes new tools for academics and practitioners to plan, initiate, and monitor ICT adoption projects. These tools, designed to support strategies for creating competitive advantages in ST organizations, represent, to our knowledge, original research outcomes.

Theoretical contribution. The findings answer the research questions (RQ1–RQ5) concerning the emerging technology solutions leveraged in the current ST Economics landscape and the competitive advantages upon their implementation. Moreover, the transformed processes, the smart destinations that implemented these solutions, and the documentation source are specified.

Based on the information structured into four synoptic tables, we delimited some main categories of processes and activities involved in cutting-edge technology adoption: *tourists' information*, *accommodation*, *customer service*, *feedback collection*, *transportation*, *marketing*, and *operations management*, thus obtaining another research result. As discussed in the study, other scholars show technological benefits related to one or more adopted technologies, focused on general details, such as tool designation and an overview description. Our contribution consisted of an in-depth analysis to identify the technology and to use it as a criterion for the results classification. Furthermore, in each table, we added the process or activity involved, the operations and actions executed by the technological tool, the competitive advantages created upon implementation, the tourism destination adopting the emerging solution, and the documentation source. As a geographical insight, we noticed that the smart destinations reporting competitive advantages generated by technology-empowered solutions are concentrated mainly in Europe, especially in the UK, Spain, and Italy. On the American continent, competitive advantages are recorded only in the USA, and in Asia – in China, Korea, Taiwan, and Singapore. In the African area, the country that stands out is Egypt.

Among the research results, 70 competitive advantages upon technology implementation are identified, related to enhanced customer experience, lower costs, and increased revenues. Further, the competitive advantages found in papers were distributed along the CECoR axes of competitiveness, resulting in the proposed CECoR map. Then, CAdSTT – a Competitive Advantage–driven Smart Tourism Technologies Framework – was designed, adding some suggestions, examples, and annotations intended to support ST specialists interested in capitalising on this cognitive acquis to acquire competitive advantages and create value for their business.

Managerial and practical implications. This study expands the field of practice–based knowledge on ST technology-enhanced competitiveness. Even though in the ST Economics research field many examples of technology-related benefits were brought to attention, they were not specifically linked to competitiveness optimisation. In this context, we considered

that ST managers would need a realistic and inspirational overview of technology-generated benefits that engendered competitiveness gains. We also provide them with some tools that may be used in underpinning and consolidating technology adoption projects' roadmaps.

Knowing that emerging technologies fuel customers' appetite for more innovative and interactive experiences, the CECoR competitive advantages map and the CAdSTT framework are consistent with trending technological requirements identified in the literature. The study outcomes (synoptic tables, CECoR map, and CAdSTT framework) could help project managers gain the expertise to create ICT adoption projects' objectives articulated with strategic organisational goals and to ensure a smooth, secure, and reliable, but also competitive technology-enhanced running of daily ST operations.

Research limitations. Despite this research contribution to the field, our paper faces certain general and specific limitations. As a general aspect, it could be mentioned that we included in the synoptic tables only the technological solutions for which all the data structure items (process, activity, performed operations, competitive advantages, destination) were mentioned in the selected papers. A specific limitation refers to some technology cases. For example, although several papers reported competitive advantages gained by leveraging blockchain and Web 3, no clear example of their implementation in ST was found. As a result, blockchain and Web 3 applications were not included in the synoptic tables. We could also mention the lack of data regarding the cost or revenue values generated by the emerging technology adoption in ST organisations, reported in the analysed papers.

Future research directions. The number of innovative technologies that improve the customer experience and facilitate real-time decision-making in various ways is continuously increasing. In this context, how these disruptive technologies will lead to business value creation in ST Economics landscape influence and what tools could enhance an ST organisation's ability to achieve competitive advantage through the use of technology may constitute topics of interest for future research. Moreover, forthcoming studies could be focused on the time and resources required to research, design, implement, test, and maintain the technology that will power the digital transformation and related ways to maximise the organisation's value. Additionally, a similar investigation may be conducted through the lenses of other theories, such as Technology Acceptance Model and Innovation Diffusion Theory.

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Author contributions

Conceptualization: CC, CIL, IMP(P), LEAP; methodology: CC, IMP(P); resources: CC, CIL, IMP(P), LEAP; writing – original draft preparation: CC, CIL, IMP(P), LEAP; writing – review and editing: CC, CIL, IMP(P), LEAP; supervision: CC.

Disclosure statement

The authors declare that they not have any competing financial, professional, or personal interests from other parties.

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