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Tourism in the Era of Internet of Things: Design Principles for Smart Tourism

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Tourism in the Era of Internet of Things: Design Principles for Smart Tourism

Research in Progress

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Abstract. The tourism industry plays a crucial role in many countries and has suffered under the global events of the last years (e.g., COVID-19, economic recession) with a decline in visitors and economic contributions. Through digitalization efforts of cities and states, smart tourism destinations use emerging technologies like the Internet of Things and Smart Services to provide rich on-site experiences for visitors, hoping to increase their competitiveness and attract new tourists. By conducting a design science research project in collaboration with a German municipality, this paper aims to explore how digital assistants should be designed in the context of smart tourism. Based on expert interviews and a multi-case study of 37 tourism apps, we were able to develop twelve key design principles for smart tourism applications, evaluated through a prototypical instantiation, to create design knowledge for the digitalization of tourism.

Keywords: Smart Tourism, Internet of Things, Design Principles, Smart City, Multi-Case Study

1 Introduction

Many cities have undergone extensive structural change for decades due to modernization and digitalization efforts in various industry sectors (Copic et al., 2014; Kunzmann, 1998; Matthess & Kunkel, 2020). For instance, the Ruhr Area in Germany transformed from a former industry and mining region into a service-oriented region, providing services and producing economic information. Nevertheless, or particularly because of this change, these areas are becoming more attractive for touristic activities as much history gets intertwined with modern recreation sites, resulting in various cultural goods for locals and tourists (Copic et al., 2014).

As digitalization also affects more and more sectors, cities and states invest in modernization efforts through targeted digitalization strategies, aiming to develop smart cities in many areas of urban life. Smart cities incorporate information and communication technologies (ICT) with traditional infrastructures to improve life concerning social, environmental, and economic quality (Batty et al., 2012; Lombardi et al., 2012). By

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optimizing resources, monitoring security, and providing valuable services to the citizens in an intelligent and coordinated way, the goal is to create integrated, habitable, and sustainable urban centers (Barrionuevo et al., 2012; Hall et al., 2000).

Following the closing of borders due to the COVID-19 pandemic, many regions and countries were affected negatively due to the absence of visitors and shrinking economic contributions. 66 % of countries worldwide closed their borders entirely or partially to international tourists in 2021 (UN Tourism, 2021). The result was a decrease in travelers, from 1.5 billion people in 2019 before the pandemic to only 400 million in 2020 and 415 million in 2021 (UN Tourism, 2022). The decline also led to lower economic contribution (50.4% decline to 2019) and the demise of 62 million jobs in 2020 (WTTC, 2022). While the numbers have been recovering lately, with almost 97 % of pre-pandemic levels observed in 2024-Q1 (UN Tourism, 2024), destinations seek to attract tourists and deliver an exciting and unforgettable stay. Smart tourism can provide means to attract touristic travelers, enhance their stay, and provide meaningful and entertaining services. Smart tourism destinations use technologies such as Internet of Things (IoT) or Smart Services to enhance touristic experiences by providing rich onsite experiences for visitors (Gretzel et al., 2015; Jeong & Shin, 2020). Especially the popularity of portable digital media devices like smartphones and tablets has led to opportunities for touristic providers to create mobile applications in combination with sensors enhancing tourists' experiences (Brown & Chalmers, 2003), leveraging technological concepts like augmented reality (AR) to provide interactive means (Chung et al., 2015). Because of the ubiquity of smart devices and services, tourists can be supported throughout all stages of their travels (Höpken et al., 2010; Kenteris et al., 2011). Cities such as Amsterdam or Brisbane have developed interactive applications to support tourists during their stay and integrate, for instance, radio-frequency identification (RFID) beacons to provide location-based information (Gretzel et al., 2015). Features such as theme routes, audio and video content, multi-lingual guides, and suggestions for points of interest bring value to the tourists and can serve as smart assistants during their visits.

Although research activities have been focused on the smart tourism phenomenon as well as the development of smart services to enrich the touristic experience (e.g., Smirnov et al., 2014; Souto et al., 2015; Tsaih & Hsu, 2018), the results are primarily trimmed toward single case study solutions and isolated technologies (e.g., Boes et al., 2015; Lobao et al., 2019; Mutch, 1993). Against this backdrop, this paper investigates the smart tourism phenomenon from a design perspective to provide design knowledge supporting researchers and practitioners in leveraging the use of IoT and information systems for touristic destinations. Hence, we explore the following research question:

How to design smart tourism applications?

To answer our question, we conduct a design science research (DSR) project in collaboration with a German municipality to develop design principles. This research-in-progress paper addresses the first iteration of the research process from the elicitation of requirements to the prototyping phase. The remainder of this paper is structured as follows: First, we analyze related literature on the topics of smart tourism and their potential to improve the touristic experience. Second, we elaborate on our research methodology, i.e., how we apply DSR with expert interviews and a multi-case study to

gather our data. Third, we present our preliminary findings in form of design principles and the prototype of the smart tourism assistant. Last, we conclude our work and give an outlook on future steps of the research project.

2 Smart Tourism

The transition from tourism destinations to smart tourism destinations by integrating digital technologies has been a trending research topic in recent years. Cities see the use of ICT as a key factor in creating and enhancing smart tourism destinations. Besides improving tourists' stays with seamless and personalized experiences, e.g., via mobile applications or IoT technologies, destinations also aim to increase their competitiveness (Buhalis & Amaranggana, 2015; Gretzel & Koo, 2021; Jeong & Shin, 2020; Li et al., 2017). ICT and IoT especially can be utilized in various ways to support smart tourism destinations. For example, the use of analytical approaches based on the data provided by various types of IoT devices facilitate real-time insights into tourist behavior, preferences, and needs, allowing for better targeting and personalization of tourist services and products (Kontogianni et al., 2022; Xiang et al., 2017). IoT devices such as smart sensors collect data on tourist traffic and behavior, enabling destination managers to optimize tourist flow as well as create better crowd management strategies (Gretzel et al., 2015; Xiang et al., 2021). Thus, tourist attractions can be relieved, and visitors, as well as residents, benefit from less crowded spaces. Ubiquitous computing throughout the city in the form of RFID beacons, Wi-Fi connectivity, or near-field communication tags further elevate the tourists' experience by providing location-based services (Jeong & Shin, 2020; Meehan et al., 2013; Wise & Heidari, 2019).

Smart Services play a vital role in the offerings to residents and visitors by enabling them to accomplish information seeking by means of interactive and intelligent technology (Maedche et al., 2019). Providing tourists with personalized and relevant information or services, smart services enhance the individual experience (Paukstadt et al., 2019). For instance in Amsterdam or Brisbane, smart services use real-time data from IoT devices to offer context-aware and location-based recommendations to tourists, making it easier for them to discover nearby attractions and activities (Gretzel et al., 2015). Furthermore, they can provide personalized recommendations based on tourists' interests and preferences, creating a tailored and immersive experience (Jiménez-Barreto et al., 2023). The goal is to provide a holistic and unified experience for the user without too much active involvement. Overall, previous research shows that smart tourism destinations created by leveraging IoT technologies and smart services play a crucial role in enhancing tourists' trips. Combining these technologies provides tourists with novel experiences and personalized information to improve the overall satisfaction of tourists (Goo et al., 2022). However, research is lacking in the design of holistic solutions that combine smart tourism with the value-creating benefits of IoT.

3 Research Method

To achieve our overall goal of providing descriptive design knowledge for the design of smart tourism assistants, we conducted a DSR project (Hevner et al., 2004) following the DSR approach of Kuechler and Vaishnavi (2008). This short paper addresses the first DSR cycle up to prototype development (see Figure 1).

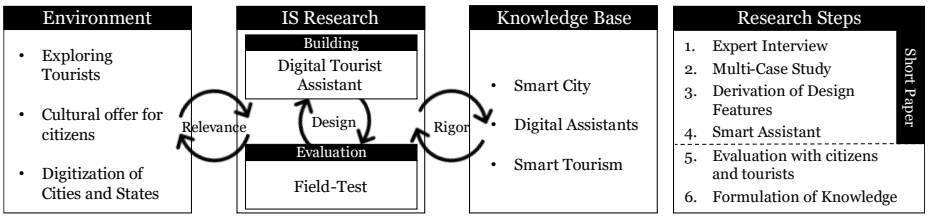

Figure 1. Research Design

Problem awareness. The starting point for our research process was an examination of the smart tourism situation in the municipality. For this purpose, expert interviews[1] were conducted with three project managers from the IT, digitalization, and municipal utility resorts as part of a focus group (Tremblay et al., 2010) (1). To triangulate the findings and enrich them with empirical knowledge, a multi-case study of 37 smart tourism applications[1] (e.g., Munich) was conducted based on publicly available information (Yin, 2018) (2).

Suggestion of a solution. Based on the analysis of the expert interviews in an open coding process (Bandara et al., 2015) and the conceptualization of smart tourism application capabilities from the case study, twelve design principles could be derived (3).

Development. We transferred the extracted design principles into a prototype (4) in the form of a mobile application to make the findings testable in the real world. The prototype was designed as a cross-platform application to include a large user base.

Demonstration and evaluation. As a first proof of concept (Nunamaker et al., 2015), the prototype was tested by resort managers. User-centered artifact development is a central quality criterion in DSR. Therefore, as a subsequent step, additional stakeholders (i.e., citizens and tourists) will be included in the assessment (5) as the project progresses (Rosemann & Vessey, 2008) to ensure the overall usefulness of the results.

4 Preliminary Results

Based on our data analysis, we identified 12 design principles for a smart tourism assistant to enhance user experience and provide personalized recommendations to tourists. Table 1 provides an overview of the first design principles we formulated.

Providing **tailored recommendations** (DP1) is the first design principle we identified, and it pursues adaptive features and information for different types of tourist groups. This principle enables a personalized and inclusive experience for all tourists,

[1] Further information about the expert interviews and case study: http://bit.ly/3Ta8Hbd.

as different groups have distinct expectations of their stay (Arnegger et al., 2010; McKercher, 2016). For instance, the analysis of our case study municipality revealed tourist groups that could be classified into culture and history, nature, and sport. Depending on the personal interests of the tourists, the smart tourism application should present features and information to enhance their stay.

Table 1. Design Principles

#	Design Principle	Description
DP1	Tailored Recommendations	Provide personalized recommendations to enhance the stay of different types of tourist groups.
DP2	Information Augmentation	Provide meaningful information that augments the tourists' stay (e.g., historical background knowledge).
DP3	Location-based Services	Provide context-aware and location-based offerings that are tailored toward the user's location.
DP4	Push Principle	Provide information automatically and context-aware, without the need of active user involvement.
DP5	Accessibility	Provide inclusive access for everyone, regardless their condition (e.g., enhanced auditive or visual options).
DP6	Multilingualism	Provide multiple language options to reach a large and diverse touristic user base.
DP7	Ease of Use	Provide a self-explanatory experience with low technical requirements to promote higher use.
DP8	Mobile Access	Provide mechanisms so that users have independent access (e.g., in offline situations).
DP9	Rich Interaction	Provide rich interactions with the environment and other users (e.g., augmented reality and social functions).
DP10	Gamification	Provide gamified incentives for users to actively continue the use throughout their stay.
DP11	Navigation	Provide navigation functions to the users for better orientation in an unknown city.
DP12	Ticket Provisioning	Provide virtual ticket counters to book tickets beforehand.

Information augmentation (DP2) and **location-based services** (DP3) address the type and delivery of information provided to tourists. To avoid overwhelming tourists with irrelevant data, it is important to provide only meaningful information that adapts to the personal context (Gorgoglione et al., 2019). The **push principle** (DP4) enables the automatic provision of context-aware information, without the need for active user involvement. Hence, tourists can discover nearby attractions and activities and receive valuable information in relation to their location, fostering the engagement and discovery of new experiences and attractions.

Inclusive and accessible design principles enable every tourist to benefit from a smart tourism application (Huang et al., 2017; Tussyadiah & Fesenmaier, 2007). Thus, **accessibility** options (DP5), **multiple languages** (DP6), and a focus on **ease of use** (DP7) are important design principles to be considered. **Mobile access** (DP8), e.g., via offline data, facilitates widespread use among users who may not have access to the

Internet. And lastly, innovative design principles attract users to try out the smart tourism application and profit from functionalities that make the stay more comfortable and enjoyable, e.g., by providing **rich interaction** modes (DP9), **gamification** incentives (DP10), **navigation functions** (DP11), or **ticket provisioning** possibilities for attractions in the area (DP12).

Figure 2. Prototypical Implementation of the Smart Tourism Assistant

By instantiating our design principles into a prototypical application, we developed a smart tourism assistant for a German municipality (Figure 2) to provide a tangible evaluation basis and baseline for the formulation of design knowledge for the artifact class. We believe that the assistant can help improve the overall tourism experience and provide a personalized, inclusive, and engaging experience for all tourists.

5 Conclusion and Outlook

This paper has investigated the design of smart tourism applications by presenting the first results of a DSR project. Through eliciting and developing a prototypical smart tourism assistant for a German municipality, we have gathered preliminary design knowledge regarding design principles for smart tourism applications. Our work has shown the importance of personalization, context-awareness, and interactivity for assistants in the field of tourism. The proposed smart assistant can provide tailored recommendations, location-based information, and multimedia content to enrich the tourist's experience. In our next steps, we will derive further design knowledge for the artefact class based on succeeding evaluations of the smart assistant in the real-world. The design principles we have identified in this paper will be refined through a field experiment with citizens und visitors to prove their effectiveness in enhancing tourists' experiences. Future research will also explore the potential of emerging technologies, such as virtual and augmented reality, to further enhance the smart assistant's capabilities.

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