VIEWPOINTS

Tourism 4.0 technologies and tourist experiences: a human-centered design perspective

Uglješa Stankov[1] · Ulrike Gretzel[2]

Abstract

Building on the momentum of Industry 4.0 developments in production and manufacturing, the tourism-specific concept of Tourism 4.0 currently fuels visions of similar technology-based transformations towards highly interconnected and phygital systems in the tourism industry. There is an implicit assumption that the technological innovations of Tourism 4.0 work better for the benefits of tourists. However, even marvels of tourism information technology often come with a serious lack of human-centered design. The unprecedented speed of development and implementation of Tourism 4.0 technology further adds to this neglect. In addition, traditional approaches to designing the user experience of interactive systems are now seriously challenged by the disruption of traditional views on the goals of system use, more complex user roles, and the dynamic and hybrid context of the use. The powerful capabilities of Tourism 4.0 technologies allow for the enhancement of interaction with a system and enrichment of the tourist experience itself, providing new ways of assisting in behavior change and even in the long-lasting transformation of the users. However, this also means greater potential for harm. This viewpoint conceptualizes three different effects of interactive system use on technology-mediated tourist experiences—besides goal achievement that impacts satisfaction, effects can be goal-limiting (ranging from distracting to damaging) or goal-surpassing (ranging from enhancing to transforming). This conceptualization is then used to frame the importance of human-centered design for emerging Tourism 4.0 technologies.

Keywords Human-centered design · User experience · Tourism 4.0 · Smart tourism · Technology-mediated tourist experience

✉ Uglješa Stankov
ugljesa.stankov@dgt.uns.ac.rs

Ulrike Gretzel
gretzel@usc.edu

1   Department of Geography, Tourism and Hotel Management, Faculty of Sciences, University of Novi Sad, Prirodno-matematički fakultet, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia

2   USC Center for Public Relations, Annenberg School of Communication and Journalism, University of Southern California, 3502 Watt Way, Los Angeles, CA 90089, USA

1 Introduction

Tourist experiences are set in a traditionally highly technology-dependent industry context and for a long time have been greatly affected by information technology design, both in relation to the use of specialized interactive systems (e.g. destination management systems, in-room entertainment, self-check-in kiosks) (Lehaney et al. 1999) or based on general purpose systems for the delivery or enhancement of services (e.g. provider websites, mobile phone applications) (Slivar et al. 2019; Wani et al. 2017). It is therefore not surprising that tourism has been quick to jump onto the emerging Industry 4.0 trend, embracing increased technological development within is own framework of Tourism 4.0. Tourism 4.0 may be referred to as a new tourism value eco-system built upon a highly technology-based service production paradigm and supported by the common principles of Industry 4.0, namely interoperability, virtualization, decentralization, real-time data gathering and analysis capability, service orientation, and modularity (Pencarelli, 2019).

With the emergence of Industry 4.0 technologies, such as the Internet of Things (IoT), Big Data Analytics, Artificial Intelligence (AI), Blockchain, Location-based Services or Virtual and Augmented Reality Systems, and their implementation in tourism (Starc Peceny et al. 2019), a lot of the production and delivery of tourism goods and services is now in the process of being fully automated (Ivanov 2020). Even though Tourism 4.0 technologies have a great potential to elevate tourist experiences (Neuhofer et al. 2014; Wang et al. 2012), they also blur the boundaries between technology use and touristic experience (Buhalis et al. 2019; Tussyadiah 2017), and have a high potential to disrupt the essence of tourist experiences (Gretzel 2010) or even cause bodily harm. For example, the extensive implementation of immersive technologies envisioned by Tourism 4.0 is creating a new space where physical and virtual objects are overlapping (Flavián et al. 2019), including examples of phygital experiences, or live streaming tourist experiences (Deng et al. 2019). Touristic gazes are framed in significant ways by such technologies. Furthermore, the perception of tourism settings is not the only reality to be affected since it could be expected that soon mutually competing online services run by AI algorithms and coupled with portable and embodied devices that mentally, and maybe even physically enhance human minds and bodies, could even further disrupt understandings of what humans are and what lies in their best interests when they travel.

Although many of the contemporary tourist experiences are closely interlinked with the use of interactive systems (Neuhofer et al. 2014), the very essence of tourism offerings is still centered around human experience (Tussyadiah 2017). Human centeredness marvels at the ability and ingenuity of human beings and advocates that people must be put before machines, however attractive the machine might be (Cooley 2007). In terms of their design, human-centered interactive systems represent "an approach to interactive systems development that aims to make systems usable and useful by focusing on the users, their needs and requirements, and by applying human factors/ergonomics, and usability

knowledge and techniques" (ISO 2010, p. vi). In general, interactive systems designed using human-centered design (HCD) methods improve the quality of the interaction. This involves increasing user productivity (e.g. systems are designed to be easier to understand and use; i.e., they are accessible), improving the user experience, or reducing discomfort and stress in users (ISO 2010). For organizations using the technology, the results of HCD pertain to greater operational efficiency (e.g. lower training and support costs), improved competitive advantage, and contributions towards sustainability objectives. HCD is gaining in importance in the tourism domain (Gonçalves et al. 2019) and HCD's role here is to ease the interaction and build trust between tourists and technology by further supporting the agenda of people-literate technology, not computer-literate people (Case 2015).

Various examples of new technologies to support Tourism 4.0 already exist, such as autonomous agents and things (e.g., smart voice assistants or self-driving cars) (Cohen and Hopkins 2019) or anthropomorphic service robots (Murphy et al. 2019; Tussyadiah and Park 2018). Still, most of Industry 4.0 solutions have not been created with a primary aim to serve tourists. Sometimes their design does not even match their purpose, likely affecting tourist experiences in negative ways. Often, their use itself counteracts the benefits tourists seek from vacations (Dickinson et al. 2016; Gretzel 2014; Pearce and Gretzel 2012). Tourists can be enchanted by new technologies, but some are becoming more aware of their downturns during long-term use (Hannah 2019; Li 2017). Indeed, with an increased presence of and dependence on Tourism 4.0 technology in tourist experiences, several human-system interaction issues have emerged, resulting in various use-related difficulties or misuse (Weaver and Moyle 2019). The possible consequences are technostress, information overload, dehumanization and depersonalization of tourist experiences, human rights violations, perceived riskiness of technology use, and ultimately tourist experience value destruction (Dinçer et al. 2020; Kim and Qu 2014; Lee et al. 2014). Pencarelli (2019) pinpoints that Tourism 4.0, in practice, often lacks a people-orientation and a sustainability component, and focuses mostly on the efficiency of new technological solutions. In these contexts, HCD becomes critically important for ensuring that technology use does not harm humans or undermine the many benefits that can be derived from tourism.

Furthermore, there is a constant question and debate if tourists (humans on the move in unfamiliar leisure-focused environments) can mentally, physically and culturally follow the speed of technological development in a way that works for their true benefit. The current COVID-19 pandemic adds to the speed of development and often unquestioned acceptance of technology (Gretzel et al. 2020). For instance, some tourism marketers have rapidly switched to new virtual solutions to satisfy people's desire for travel, such as virtual museum tours and even a virtual reality concert in Helsinki that attracted over one million spectators (Chandler 2020). However, the long-term effects of recent advances in visual and immersive technologies (Wagler and Hanus 2018) remain unknown. Thus, the plethora of Tourism 4.0 technologies, their rapid development, and deployment, and their cumulative effects coupled with tourism providers' ceaseless quest for competitive advantage and operational efficiency potentially create a latent risk of neglecting wider aspects of HCD

and its positive effects on the users' overall well-being. Globally, 47% of people believe that technological innovations are happening too quickly causing changes that are not perceived as good for them (Edelman 2019). The term *techlash* emerged to reflect the growing animus toward big technology companies and generalized opposition to technological innovation (Atkinson et al. 2019). In response, there are more calls to oppose Industry 4.0 development and its profit-focused rather than human-centric progress, to advocate for more responsible approaches of technology providers, and to search for an alternative design of more humane and positive technology (Calvo and Peters 2019; Riva et al. 2012; Stankov and Filimonau 2019).

In response to the promising but also potentially problematic use of Tourism 4.0 technologies, with this piece, we provide several viewpoints on the effect of Tourism 4.0-related technologies on tourist experiences. In doing so, we highlight the need for HCD approaches that specifically address tourist experience contexts and foster positive effects.

2 A system design perspective on effects of tourism 4.0 technologies

We start from the pragmatic perspective of the user experience of an interactive system (Fig. 1). The user experience is referred to as a person's perceptions and responses resulting from the use and/or anticipated use of an interactive system. It is a consequence of *object-oriented factors*, such as functionality, system performance, and assistive capabilities of the interactive system, and *subject-oriented factors*, for example, users' internal and physical states resulting from prior experiences, attitudes, skills, and personality, user behaviors and preferences, and the context of the use (ISO 2010). For Tourism 4.0, it is important to recognize the embeddedness of object-oriented factors in digital ecosystems and smart development efforts (Gretzel et al. 2015) to determine functionalities and performance goals in relaton to interconnected, phygital tourist experiences. Although general Industry 4.0 transformation emphasizes human-automation symbiosis, in tourism settings this symbiosis can be problematic as Industry 4.0 principles of efficiency and effectiveness (Zarte et al. 2020) have less relevance. Indeed, in tourism, a hedonic component of interactive system use has to be added to the pragmatic use (Hassenzahl et al. 2010; Wani et al. 2017), and can even outvie functional uses (Rusu et al. 2020). In particular, if tourism is the main context of the use, the subjectivity of experiences should be more heavily weighted in the design (Tussyadiah 2014) and in the evaluation of user experiences than object-oriented factors due to the importance of hedonic motivations and hedonic use contexts.

In general, interactive systems should support goal achievement and result in user satisfaction. In the context of Tourism 4.0, the centrality of technology-mediated tourist experiences opens up the potential for different shades of goal surpassing effects but also for goal-limiting outcomes. The focus of HCD for Tourism 4.0 technologies then transcends the simple achievement of user satisfaction and concentrates on the avoidance of goal-limiting effects while enabling goal-surpassing experiential outcomes. These aspects are explored in detail in the following paragraphs.
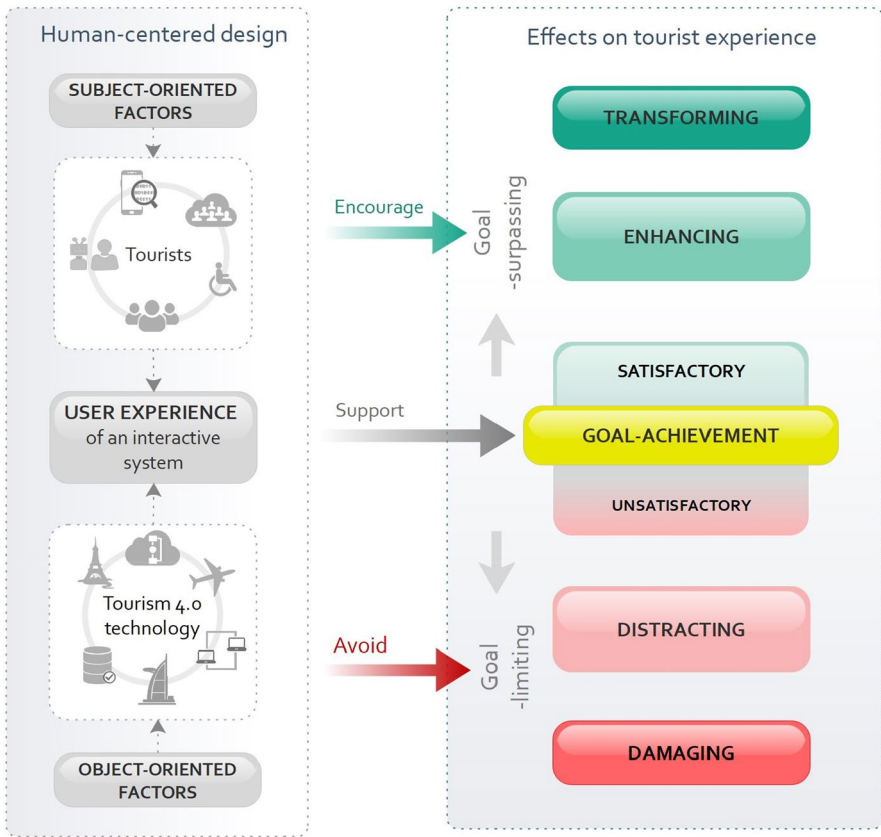
Fig. 1 The role of HCD in shaping effects of Tourism 4.0 technologies on tourist experiences

2.1 Goal-achievement and user satisfaction

Goal achievement lies at the center of traditional user experience design efforts. Achieving system use goals leads to satisfaction, without leading to delight or other positive effects on the experience. Malfunctioning creates unsatisfactory use experiences; however, they rarely spill over to the overall tourist experience.

A perfect example of this is the use of smartphones within tourist experiences, which has become a common occurrence. Despite the potentially problematic use of smartphones (Ayeh 2018), their usefulness in navigation, information search, payments, providing a sense of security and connection, etc., has been proven to be beneficial for most tourists. Consequently, the industry is increasingly trying to capitalize on smartphone use. For instance, a mobile boarding pass serves its purpose of increasing convenience quite well. If a user encounters a slight glitch at check-in, the problem can lead to dissatisfaction, or it can go smoothly and create a satisfactory effect. In either case, the main goal of accessing the airport terminal

area or boarding an airplane will likely be achieved without much thought given to it. The effects of such interactive system uses are mundane and narrow.

2.2 Goal-limiting effects

Interactive systems can take away from touristic experiences and therefore *limit* the pursuit of experience goals. When this happens to a lesser extent, we refer to the effects as *distracting*. At more extreme levels, system use can have *damaging* effects on users.

If the use of an interactive system consumes too much of a tourist's attention by needing them to focus on the system (e.g., too many tasks, complex equipment, unfamiliar or unresponsive user interfaces) or the digital content rather than the enjoyment of a tourist experience, we call it *a distracting effect.* For example, a voice interface at a busy airport or the need to download and use various tourism providers' mobile phone applications (Ayeh 2018) could frustrate users and move attention away from the touristic experience. Similarly, while the use of drones in tourism settings is becoming more frequent (Dinhopl and Gretzel 2016; Stankov et al. 2019b), the visual and auditory pollution they produce may distract tourists from the ambiance (Hay 2016). For some tourists, just the need to use more digital technology during vacations could be potentially distracting (Fan et al. 2019).

Solutions to distracting effects are both in the hands of technology and tourism providers. Implementation of principles of calm ICT design (Case 2015) is being suggested as a conceptual solution for e-tourism settings (Stankov et al. 2019a), while the tourism industry tries to alleviate technology overload in general by offering less exposure to ICT or digital-free experiences during vacations (Cai et al. 2019; Gretzel 2014; Li et al. 2019).

When the use of an interactive system is perceived to harm a user's health and overall wellbeing, we refer to it as *a damaging effect.* For example, the employment of VR goggles in the provision of tourist experiences can be perceived as damaging due to concerns that blue light could harm tourists' eyes (Ma et al. 2018). Worries about visually induced motion sickness (VR sickness) (Somrak et al. 2019) or lack of social self-consciousness (Lessiter et al. 2018) are additional damaging effects that emerge from VR use. Similarly, one of the major concerns regarding the use of wearable gadgets is the exposure to radio frequencies (RF) and resulting biological damage, especially in the context of the coming 5G network (Sun et al. 2017). Besides, concerns about the IT sector's energy footprint can be added (e.g. concerns about the carbon footprint of streaming service data centers) (Srivatsa and Prasad 2019). Here, the usefulness of an interactive system becomes irrelevant since tourist experience goals and the desire for well-being are seriously compromised.

Solutions to these problematic effects mostly lie within the responsibilities of technology designers and might require the interference of regulatory bodies. In this context, the EU considers a temporary ban for facial recognition based on AI for public and private actors, due to potential material risks (loss of life, safety, health, etc.) or risks inherent in a huge digital footprint (loss of privacy, human dignity, etc.) (Masseno and Santos 2018; Stolton 2020). However, tourism providers can also be

instrumental in designing Tourism 4.0 experiences that consciously reduce potential harms by selectively implementing technologies with human users rather than profits in mind.

2.3 Goal-surpassing effects

Goal-surpassing effects emerge from the use of interactive systems that are designed to create benefits beyond their immediate functional use context. When these positive effects elevate the specific tourist experience, we refer to them as *enhancing* effects. When they have profound or long-term positive effects beyond a single tourist experience, we classify them as *transformative* effects.

Interactive system use *enhances* tourist experiences when it goes beyond simple task achievement, often requiring a user's sensory, physical or emotional engagement, or other forms of active participation in co-creating the experience. For example, the employment of AR/VR technologies is very often seen in museums and galleries offering virtual experiences of their exhibitions. Here, the goal of using AR/VR tools is to enhance the interpretation of artifacts. Furthermore, human attention is especially perceptive to novelty (Lessiter et al. 2018) and play (Xu et al. 2017). This gives Tourism 4.0 technology an advantage when mediating experiences compared to old-fashioned interpretation techniques.

In this context, the employment of Tourism 4.0 technologies is planned and staged to create superior experiences (Bec et al. 2019), implying the inclusion of users' interests, skills, and willingness to engage by default. For example, the opportunity to use smartphones to engage with *Pokémon Go*-like AR games during vacations could be a perfect fit for passionate players, making them more physically active, happier and aware of the destination (Williams and Slak-Valek 2019), while for others it could go unnoticed or could even be considered as a distraction from real-life experiences (Neuhofer et al. 2014).

Transformative effects of interactive system use emerge from human-centric opportunities provided by Tourism 4.0 efforts in combination with users' willingness to engage in long-lasting transformations of their bodies and minds. In essence, systems that encourage transformative effects are anchored in human-centeredness by default and they provide stimuli that prompt desired well-being outcomes beyond system use or tourist experience goals. A good example would be an activity-tracking device integrated into a touristic experience, where the transformative effect starts when there is a willingness of users to use them to change their behavior, is critically supported by the tourist experience, and is sustained beyond the immediate experience, e.g. through post-trip communication.

Similarly, a long-lasting transformation of tourists, as an ultimate target, is the primary purpose of the use of various meditation applications and devices that are becoming more popular for delivering technology-mediated mindful tourist experiences (Stankov et al. 2020a). Moreover, this kind of *transcendental effect* could be considered as the next evolutionary step in technology use and design (Alli 2019; Stankov et al. 2020b).

3 Implications for research

The rapid development of new and innovative tourism solutions to support the transformation of the tourism industry to Tourism 4.0 requires careful reflection. Our research employs the premise that HCD is a way for grounding high-speed and high-impact Tourism 4.0 development. Based on the arguments provided we pinpoint two main research streams that could further support an HCD-driven agenda in this context, both for academic and practical deployment.

Firstly, the tourism community should insist more on embedding HCD into research on and evaluation of technology-mediated tourist experiences. In Tourism 4.0 settings, the role of tourism to provide hedonic, altruistic, and meaningful experiences (Kay Smith and Diekmann 2017) that can support transformations toward greater well-being and sustainability is becoming of paramount importance. Consequently, tourism providers must resist the urge to hastily implement various sets of Tourism 4.0 technologies (Stankov and Filimonau 2019), despite the potential economic benefits their use may bring (Ivanov and Webster 2019). They will only do so if provided with hard evidence regarding the value of HCD. HCD approaches that leave enough space to comprehensively assess how technologies may affect tourists should become commonplace. In particular, more longitudinal research should be encouraged for Tourism 4.0, otherwise transformational or damaging effects underlined by our framework cannot be truly captured.

Secondly, various ways for streamlining knowledge transfer from other disciplines to the tourism domain should be facilitated. For example, in retail contexts, there are reports that some consumers have been refusing to use self-checkout kiosks to save cashier jobs (Harris 2018; Jackson et al. 2014). In these instances, systems do not account for the wider social environment, which must be considered as an important variable of HCD. Furthermore, the omnipresence of Tourism 4.0 technologies requires the inclusion of a multitude of tourism stakeholders (tourism-centered focus), not just tourists (tourist-centered focus) (Starc Peceny et al. 2019). The place of HCD within Tourism 4.0 is not limited to system use during specific service or product delivery instances but pertains to the enhancement of complex technology-mediated tourist experiences taking place within a wider tourism ecosystem (Gretzel et al. 2015). Hence, collaborative models for research and knowledge transfer are needed. In particular, more research is needed in studying innovation and design processes, as well as the impact of the use viewed from cross-domain and multiple-stakeholder viewpoints rather than just evaluating user experiences of Tourism 4.0 technologies as just as end-products in a particular tourism setting.

While the notion of Industry 4.0 was invented elsewhere, there is a real opportunity for Tourism 4.0 to set its own course. However, this will require research and technology development that recognizes the central role humans and their well-being play in tourism.

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