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Robots in tourism and Sustainable Development Goals: Tourism Agenda 2030 Perspective article

This is the author's manuscript

Original Citation:

Availability:

This version is available http://hdl.handle.net/2318/1898192 since 2024-12-09T15:48:07Z

Published version:

DOI:10.1108/TR-08-2022-0404

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(Article begins on next page)

12 November 2026

emerald PUBLISHING

Tourism F

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Journal:	*Tourism Review*
Manuscript ID	TR-08-2022-0404.R2
Manuscript Type:	Viewpoint
Keywords:	robots, tourism, sustainability, Sustainable Development Goals

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Robots in tourism and Sustainable Development Goals: Tourism Agenda 2030 Perspective article

Abstract:

Purpose

The purpose of this perspective article is to investigate the role of robots in tourism's contribution to the achievement of the Sustainable Development Goals (SDGs).

Design/methodology/approach

With a deep analysis of the 17 SDGs and their 169 targets, the authors provide an interpretation on both the positive and negative impacts of robots in tourism towards the achievement of the SDG.

Findings

For several SDGs, the positive impact of robots in tourism is evident, while for others it can be debated since the adoption of robots can lead to both positive and negative impacts, mostly dependent on how robots will be used. In particular, robots can provide a decent work environment for tourism and hospitality employees (SDG 8) who perform dangerous tasks, while decreasing the consumption of resources (SDGs 2, 6, 7, 12, 13) due to their contribution to a company's effectiveness and efficiency. In the meantime, robots have some impacts on the environment, both in terms of use of resources (their manufacturing relies on rare Earth materials and robots are energy demanding), and output, especially for the management of toxic waste (e.g. batteries).

Originality

This perspective paper is one of the first studies to investigate the role that robots can play in achieving the SDGs by tourism and hospitality companies.

Research limitations/implications

The main limitation of this perspective paper is the lack of empirical measurement of the effects of robots in tourism on the achievement of the SDGs. However, it is a necessary exploration as a foundation for future research.

Practical implications

This perspective paper may be useful for robot manufacturers in identifying the positive and negative aspects of robots when designing sustainable robots (in terms of energy efficiency, management of the end of life of components, etc.) to conform to the expectations of the SDGs. It can be useful to tourism and hospitality companies when their managers evaluate whether to adopt robots in service operations or not.

Tourism Review

Social implications

This contribution discusses the social implications in adopting robots in tourism and hospitality, specifically in terms of new opportunities of employment, and in the substitution of humans in dirty, dull and dangerous tasks. It helps policy makers adopt the best policies for fostering the use of robots in tourism and hospitality with an eye to the environmental and the social ramifications of robots.

Keywords: robots, tourism, hospitality, sustainability, Sustainable Development Goals

1. Introduction

Adopted in September 2015, the 2030 Agenda for Sustainable Development formulates 17 Sustainable Developed Goals (SDGs) that encompass a wide range of environmental and social issues as peace, poverty, justice, prosperity and environmental protection (Griggs *et al.*, 2013; Guenat *et al.*, 2022), operationalised into 169 targets. The introduction and discussion of SDGs had an impact on all economic areas, influencing the debate in the tourism sector too (Dwyer, 2022; Nunkoo *et al.*, 2021).

It is commonly recognised that tourism can act as an important driver for the development of local communities, since it is one of the main economic sectors for many countries. For this reason tourism has been considered as a "pivot" in achieving the SDGs (Pasanchay and Schott, 2021). Moreover, tourism is explicitly cited in the "inclusive and sustainable economic growth" (Goal 8), "sustainable consumption and production" (Goal 12) and "sustainable use of oceans and marine resources" (Goal 14). However, it can help achieving all other goals, starting from poverty alleviation (Kc *et al.*, 2021), and gender equality, by encouraging women in directly be involved in working in the tourism and hospitality (TH) sector and, in doing so, in generating income for families and communities. The Agenda for Sustainable Development highlights the role of business innovation to solve sustainable developing challenges (Gössling and Hall, 2019).

The International Organization for Standardization (2021) defines a robot as a "programmed actuated mechanism with a degree of autonomy to perform locomotion, manipulation or positioning". Robots are devices, i.e. they have physical embodiment in contrast to other automation technologies such as chatbots that exist only in the virtual space. Service robots in tourism can have various designs – functional, zoomorphic, caricatured or anthropomorphic depending on their intended tasks. Robots can be critical drivers in making it possible for TH companies to play a key role in the achievement of the SDGs. Even if the relationships between SDGs and robotics are under discussion (Guenat *et al.*, 2022), to the authors' knowledge, there are no studies focused specifically on the tourism sector. Previous studies on robots in tourism have discussed a wide scope of topics such as customer attitudes and adoption of robots (Abou-Shouk *et al.*, 2021; Chen et al., 2022; Goel et al., 2022; Yu, 2020; Zhong *et al.*, 2022), employee perceptions (Pavez *et al.,* 2022), the economic aspects of robots (Ivanov and Webster, 2020), aoption of robots by tourism and hospitality companies (Jabeen et al., 2022; Pizam *et al.*, 2022; Vatan and Dogan, 2021), the service delivery system design (Seyitoğlu and Ivanov, 2020), and a number of other issues, but the role of robots in tourism's contribution to the achievement of the SDGs has been neglected – a gap to be partially filled in by this perspective article.

2. The role of technology in achieving the SDGs

Technology is disrupting the tourism industry (Buhalis, 2020). It has been already recognised that technology can be a fundamental tool to achieve the SDGs (Walsh *et al.*, 2020), including in a tourism context (Ali *et al.*,

2020; Xiong *et al.*, 2022). A branch of the literature has specifically paid attention to the role of technology policy for accomplishing the SDGs adopting "*the broader concept of science, technology and innovation (STI) policy"* (Managi *et al.*, 2021, p. 1). In doing so, STI has been considered in relation with the different levels of governance, from a national perspective (Li *et al.*, 2020) to the regional context (Kastrinos and Weber, 2020), underlining the need to address some challenges at the different levels in order to make STI fully effective in achieving the SDGs (Managi *et al.*, 2021).

Another avenue of research has focused the attention on peculiar policy areas of intervention, such as the energy sector, assessing the capability of specific technological solutions in meeting one or more SDGs (Lohani *et al.*, 2021) or in investigating the potential role that can be played by the newest technological innovative solutions. In their paper, Kitonsa and Kruglikov (2018) explore the potential in the use of drones in several economic sectors, from agriculture to the possibility of transporting supplies in remote areas, to promoting the tourism sector by sharing aerial photos or videos. Weber and Knaus (2017), furthermore, underline the use of drones as a promising monitoring tool for managing mountain protected areas with respect to winter sport tourism. Tourism can indeed take advantage of the technological innovation, in the meantime contributing to achieve the SDGs thanks to the introduction of new technological solutions as robots and artificial intelligence. The potential of contributing to this goal, however, still needs to be fully assessed and discussed.

3. The role of service robots in tourism in achieving the SDGs

Table 1 summarises some of the ways the implementation of robots in tourism and hospitality companies contributes to the achievement of the SDGs. As the table illustrates, robots can have both positive and negative impacts on the SDGs. Most prominently, by automating dirty, dull, dangerous and repetitive tasks robots help improve the quality of the work environment for tourism and hospitality employees (SDG 8) (Tuomi *et al.*, 2020) and ensure the health and well-being of people (SDG 3) (Mai *et al.*, 2022), increasing the quality of life of workers. Additionally, by improving the effectiveness and efficiency of TH companies' operations, robots decrease the consumption of some resources and contribute to their sustainable use (SDGs 2, 6, 7, 12, 13) (Ivanov, 2019), with positive implications for both the present and next generation. Underwater robots (Antonelli, 2018) and drones (Stankov and Vujičić, 2022) can also help tourists explore sensitive marine (SDG 14) and terrestrial habitats (SDG 15) without the physical presence of tourists on spot (avatar tourism), thus avoiding the pressure of the environment, or can help managing tourism activities in sensitive environments (Weber and Knaus, 2017). From an economic perspective, through their enhancement effect robots improve the productivity of TH employees which leads to more highly paid robot-related jobs (SDG 1). Moreover, the implementation of cleaning and disinfection robots, robotic housekeeper carts, or robotic waiters enhances job positions with traditionally more female workers (e.g. housekeepers, waitresses, etc.). In that sense, robots contribute indirectly to the empowerment of women and gender equality (SDG 5). New business models that involve the implementation of service robots (e.g. robot deliveries for F&B outlets) could promote innovation and stimulate sustainable industrialization (SDG 9) by also performing more efficient business, waste and resource management operations (UNWTO and UNDP, 2017). In terms of education (SDG 4), robot-related courses might be included in the curricula of TH university programmes (see, for example, Murphy *et al.*, 2017). On destination level, autonomous vehicles in theme parks, at airports, and automomous taxis can make cities less polluted and improve the environment local residents, TH employees and tourists live in, work and stay (SDG 11), stimulate accessible tourism (Cohen and Hopkins, 2019) and decrease inequalities among countries (SDG 10). In the long run, all the afore-mentioned challenges should lead to a general improvement of the quality of life of citizens in a more sustainable way.

Tourism Review

On the negative side, there are various ways in which robots hinder the achievement of the SDGs. Most importantly, the substitution effect of robots (Ivanov and Webster, 2020) decreases the number of jobs available to human employees and may have an overall depressing effect on their salaries (DeCanio, 2016) and stimulate automation fears (Ivanov *et al.*, 2020) (SDGs 1). In order to overcome this potential negative implication, policies oriented to define a "coexistence period" between humans and robots may help the acceptance and adaptation of employees and society to robots. In the long term, the massive introduction of robots may decrease the income tax base of countries that would lead to a substantial drop in their income tax revenue (SDG 17). It may also have a negative impact on people's health due to their decreased physical mobility when robots do most of the physical tasks (SDG 3). Additionally, through robotisation the number and scope of entry-level jobs in tourism and hospitality might be decreased which will have a negative impact on people's well-being (SDG 1) and gender equality (SDG 5) because the job opportunities in tourism and hospitality, especially for women and for people with less education, might decrease. Some jobs might be deskilled due to the robotisation of some tasks that constituted them (SDG 8). Moreover, robots can aggravate the digital gaps and inequalities between high-skilled and high-paid TH employees who work with service robots and other employees, and among destinations with and without service robots (SDG 10). These considerations open questions regarding the willingness of tourism-dependent local communities to engage with robots. In the meantime, from a tourist's viewpoint, in sustainable tourism destinations a "digital-free environment" can be part of the added value in experiencing the destination during digital detox vacations.

Furthermore, while robots save resources, the manufacturing, operation, recycling and disposal of robots and their batteries consume a lot of electricity, water, metals, oil and other resources and can cause pollution (SDGs 6, 7, 12, 13, 14, 15) (Luan *et al.*, 2022). The reliance of strategic resources as some metals (lithium and other rare Earth materials), can play a fundamental role in the development and implementation of robots in the coming future. Indeed, these resources are often produced in countries with internal political instability and are subjected to geopolitical instability.

Eventually, some concerns can raise in terms of security. Robots are not completely free from the risk to be hacked for different purposes such as blackmail, sabotage, or terrorist attacks in crowded tourism destinations.

4. Conclusion

As evident, robots can make both positive and negative contribution to the achievement of the Sustainable Development Goals when utilized by tourism and hospitality establishments. While for some SDGs robots have a more positive effect, for others the negative consequences are more evident (see Table 1). Overall, it seems that robots might have a positive effect on the achievement of the SDGs (Guenat *et al.*, 2022) but considering the very small number of robots used by tourism and hospitality companies worldwide (there are no official statistical data but we expect that TH companies use altogether probably a few thousand robots for cleaning, room service delivery, cooking, robotic waiters, hosts and concierges, etc.) the actual magnitude of the impact is small although likely positive. In the future, the greater implementation of service robots by TH companies might have a stronger effect on some SDGs compared to others, change the balance between the positive and negative impacts on some SDGs, or cause new impacts. Technological progress, especially in the field of batteries, may significantly improve the environmental sustainability of robots.

To better evaluate the role of robots in tourism's contribution to the SDGs we urgently need empirical studies to measure the actual effects of robots on jobs, skills and salaries in tourism, on gender equality and inclusion. In addition, empirical studies need to be directed towards the use of robots for avatar tourism that involves a person's connection to a robot at the destination without physical travel to it.

Tourism Review

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Tourism Review

Table 1. The role of service robots in tourism in achieving the SDGs

SDG Goal	SDG Topic	Positive impacts of robots in tourism towards the achievement of the SDG	Negative impacts of robots in tourism towards the achievement of the SDG
1	End poverty in all its forms everywhere	• Create high-paid jobs • Enhance tourism employees • Boost economic development	• Replace tourism employees • Decrease entry-level job opportunities
2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	• Increase the efficiency of the food production in F&B outlets and accommodation establishments and minimise food waste	• Decrease entry-level job opportunities
3	Ensure healthy lives and promote well-being for all at all ages	• Perform dirty, dull, dangerous and repetitive tasks instead of human employees; thus robots create a safe work environment • Provide a physically distant service to avoid viral infections	• Decreased physical mobility of people due to automation of tasks
4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	• Incorporation of robotics and technology-related courses in the curricula of tourism and hospitality programmes • Staff training to use robots effectively and efficiently	• Create digital skills gaps between the graduates of universities with and without robotics and technology-related courses
5	Achieve gender equality and empower all women and girls	• Enhance job positions with traditionally prevailing female workers (e.g. housekeeping)	• Substitution of workers with low skills • Decrease entry-level job opportunities
6	Ensure availability and sustainable management of water and sanitation for all	• Robots for cleaning the floors, swimming pools, disinfection	• The manufacturing, recycling and disposing of robots and their parts, especially the batteries, consumes and may contaminate the water resources
7	Ensure access to affordable, reliable, sustainable and modern energy for all	• Use of sustainable sources of energy in tourism companies to charge robots • Use of sustainable sources of energy in robotics companies to manufacture robots • Energy efficient batteries	• Energy consumption for manufacturing, operation, recycling and disposing of robots and their parts. • Use of non-renewable sources of energy to manufacture robots • Use of non-renewable sources of energy for charging batteries
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all	• Robots perform dirty, dull, dangerous and repetitive tasks and allow humans to focus on more creative and revenue-generating activities • Upskilling of employees that collaborate with service robots	• Deskilling of some job positions due to the robotisation of some of their tasks • Substitution of workers with low skills • Decrease entry-level job opportunities
9	Build resilient infrastructure, promote inclusive and sustainable	• New business models of tourism and hospitality companies that involve the implementation of service robots	• Potential vendor lock-in effect

Tourism Review

	industrialization and foster innovation		
10	Reduce inequality within and among countries	• Stimulate accessible tourism • Robotisation is a choice, not a must. Some destinations may position themselves as robot-free destinations for digital detox vacations	• Greater digital gaps and inequalities between high-skilled and high-paid employees who work with service robots and other employees • Greater digital divide among countries whose tourism industries use and do not use robots
11	Make cities and human settlements inclusive, safe, resilient and sustainable	• Use of autonomous taxis for urban mobility • Use of autonomous vehicles at airports, theme parks, for transfers, etc. • Robots for disinfection and air-purification	• Excessive robotisation leads to stress when robots fail
12	Ensure sustainable consumption and production patterns	• Decrease in food waste • Research in the sustainability of robot operations • Develop tourism experiences that balance robotisation and nature • Streamlining operations of tourism and hospitality companies leading to effective and efficient use of resources	• Batteries cause pollution • Pollutions from toxic materials used to manufacture some robots' components
13	Take urgent action to combat climate change and its impacts	• Sustainable use of resources for manufacturing, operation, recycling and disposal of robots and their parts	• Use electricity from non-renewable resources
14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development	• Avatar tourism - use underwater robots to explore sensitive marine areas instead of diving	• The manufacturing of robots and their batteries cause pollution
15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	• Avatar tourism - use drones to explore sensitive terrestrial areas	• The use of robots requires batteries whose production leads to increased mining and deforestation of some areas
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels	• Decrease work-related deaths • Decrease in work-place discrimination	• Robots can be hacked and their information stolen and used to commit crimes • Robots are expensive and signing contracts with robot suppliers may be accompanied with unethical business practices (e.g. corruption)
17	Strengthen the means of implementation and revitalize the	• Produce robots or robot parts in developing countries	• Decrease in the income tax base due to robots' substitution effect

Tourism Review

	Global Partnership for Sustainable Development		

Tourism Review


+Create high-paid jobs, and enhancement of tourism employees
- Replace tourism employees
+ Efficiency in food production
- Less job opportunities
+ Perform dirty, dull, dangerous and repetitive tasks
- Decreased physical mobility of people
+ Robotics and technological course in hospitality and tourism curricula
- Digital gaps between graduates with and without this topic in the curricula
+ Enhance job positions for female workers
- Less job opportunities
+ Cleaning the floors, swimming pools, disinfection
- Potential water contaminati0on while performing the activities
+ Use of sustainable sources for energy production and consumption
- Energy consumption for manufacturing if without renewable sources
+ More creative and revenue-generating activities for humans
- Deskilling of some job positions
+ New business models of tourism and hospitality companies
- Potential vendor lock-in effect
+ Stimulate accessible tourism
- Greater digital divide among countries whose tourism industries use and do
+ Use of autonomous vehicles at airports and for urban mobility
- Stress when robots fail
+ More effective and efficient use of resources
- Toxic materials and batteries management
+ Sustainable use of resources for manufacturing, operation, recycling and disposal of robots and their parts
- Electricity (not from renewable sources)
+ Underwater robots to explore sensitive marine areas
- Pollution
+ Drones to explore sensitive terrestrial areas
- Pollution
+ Decrease in work-place discrimination and death
- Unethical business practices
+ Producing parts in developing countries
- Decrease in the income tax for the robots' substitution effect

Tourism Review

TR-08-2022-0404.R1

Title: Robots in tourism and Sustainable Development Goals: Tourism Agenda 2030 Perspective article

Author Report

We have addressed the issues raised by the authors and reacted to the comments. In the table below, we highlight the relevant comments and our reactions to them.

Reviewer Comments	**Response**
Editorial comments	
SUBMIT SIMILARITY REPORT: If you have access to similarity software such as Turnitin or iThenticate please check your paper for similarities with previous studies and upload the similarity report to the system for our records.	Thank you for the comment. Turnitin report attached.
TITLE CHANGE TO Robots in tourism and Sustainable Development Goals: Tourism Agenda 2030 Perspective article Do not forget to change on the translations too	Title changed, including in the translations
Add definition of robots	Definition added
Please engage with the following papers too Goel, P, Kaushik, N, Sivathanu, B, Pillai, R, & Vikas, J (2022). Consumers' adoption of artificial intelligence and robotics in hospitality and tourism sector: literature review and future research agenda. Tourism Review, emerald.com, <https://doi.org/10.1108/TR-03-2021-0138> Chen, Y, Xue, T, Tuomi, A, & Wang, Z (2022). Hotel robots: an exploratory study of Generation Z customers in China. Tourism Review, emerald.com, <https://doi.org/10.1108/TR-02-2022-0095> Jabeen, F, Zaidi, S Al, & Dhaheri, MH Al (2021). Automation and artificial intelligence in hospitality and tourism. Tourism Review, emerald.com, <https://doi.org/10.1108/TR-09-2019-0360>	Papers cited – see text marked in green

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please explain that Robots do not need to be anthropomorphic and can be only software you may like to engage with Buhalis, D, & Moldavska, I (2021). Voice assistants in hospitality: using artificial intelligence for customer service. Journal of Hospitality and Tourism …, emerald.com, <https://doi.org/10.1108/JHTT-03-2021-0104> Buhalis, D, & Cheng, ESY (2020). Exploring the use of chatbots in hotels: technology providers' perspective. … and communication technologies in tourism 2020, Springer, <https://doi.org/10.1007/978-3-030-36737-4_19>	Thank you for the comment. Robots are devices. Software robots are bots. We focused the paper on robots only. Future studies can concentrate on the role of intelligent automation (bots) in the achievement of SDGs.

We hope that this revised version of the manuscript now fulfils the high requirements of the journal.

The Authors

Tourism Review