

A Review of Space Tourism Research

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Since 2001, when the first tourist flew to the International Space Station and then six others after him, space tourism can be considered a reality. Although space tourism remains in its pioneering stage, it has been attracting research studies since the beginning of the 1990s. As a relatively new tourism industry, it is opening up new aspects of research in the fields of technology, economics, sociology, law, medicine, safety, insurance, and others. The purpose of this paper is a comprehensive review of the research areas of space tourism. The available scientific articles, books, contributions to scientific conferences, symposia and workshops dealing with space tourism have been reviewed. Following careful analysis, we have identified the most important space tourism research trends, as well as the scientists who have contributed the largest number of publications. We have also recognized the under-represented areas that would be suitable for further studies.

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Introduction

Space tourism has become a reality, although it remains in its pioneering stage. Currently, only people who can afford to spend between 20 and 30 million dollars can fly to the International Space Station, orbiting the Earth. However, as predicted by Ciccarelli and DeMicco (2008, p. 15), the 21st century might see the greatest development of space tourism in the context of the tourism industry, which is constantly looking for new products and destinations. Studies have shown a desire to travel into space. Since the 1980s, many organizations have attempted to introduce space tourism, but high costs have prevented commercial forms of spaceflight (Klemm & Markkanen, 2011). Until 2001, when the first tourist flew into space, only a very minor part of the scientific literature was dedicated to the study of space tourism. Since 2001, tourism studies have begun to explore commercial spaceflight in many areas, although to

date only a handful of tourists have flown in Earth's orbit, and we still await the first suborbital passenger. The number of scientific publications, conferences and symposia dedicated to space tourism has also increased. In this review, we will examine the current publications of the scientific literature in the field of space tourism and attempt to identify the most important investigation guidelines of this new tourist industry.

The Purpose of the Literature Review

The purpose of this literature review is to identify the most important areas of this new tourist industry in the making, studied by the authors around the world. The review aims to discover the main trends of research of space tourism as well as the areas that receive less attention. We want to identify the most relevant authors, the most useful literature, and the scientific contributions in the field of space tourism.

The Current State of Space Tourism

The term “space tourist” is not currently widely accepted, but it is the most commonly used. To Klemm and Markkanen (2011, p. 95), the more appropriate term seems “public journey into space” or “private space flight”. The European Space Agency (ESA) (2008, p. 19) use the term space tourism “[...] to mean suborbital flights by privately funded and/or privately operated vehicles and the associated technology development driven by the space tourism market.”

Goehlich (2007, p. 215) suggests two definitions of space tourists. The first defines space tourists as passengers who pay for a flight into space, above Earth’s atmosphere. The second defines the space tourists in a broader sense, as visitors to the attractions that simulating the “experience” of space (space theme parks, camps to prepare for space flights, virtual reality centres, interactive multimedia games, etc.) or tourists who take part in a variety of flights in the atmosphere, which, however, do not reach outer space (stratospheric and parabolic air flights). In this study, we will focus mainly to the two forms that can currently reach space: orbital and suborbital tourist flights.

Orbital Flights

Orbital flight occurs when a spacecraft reaches Earth orbit (an orbit is a gravitationally curved path of an object around a point in space) high above the atmosphere. The height of the so-called low-Earth orbit is somewhere between 160 and 2,000 kilometres. Orbital spacecraft are capable of extended periods in space, from two weeks (e.g. a Space Shuttle) to months and years for orbiting platforms, such as the International Space Station (Anderson, 2005, p. 58).

The first manned space flights to Earth orbit was on 12 April 1961, when Yuri Gagarin flew the Vostok 1 spaceship to orbit, and remained there for 108 minutes. Forty years later, in April 2001, the first space tourist Dennis Tito flew into space. He spent a week at the International Space Station (ISS) and paid the Russian Space Agency \$20 million for this flight. He became a symbol of the development of space tourism (Livingston, 2001). Since Tito, there have been six space tourists in orbit: Mark Shuttleworth (South Africa) in 2002, Gregory Olsen (USA) in 2005, Anousheh Ansari (USA/Iran), Charles Simonyi (USA) in 2007 and in 2009, Richard Garriott

(USA) in 2008 and Guy Laliberté (Canada) in 2009. These are the seven participants that can currently be characterized as space tourists¹. The Space Adventure travel agency from Virginia, which organizes tourist flights into orbit in cooperation with the Russian Space Agency, announced a new tourist space flight for 2015. The flight is scheduled for the singer Sarah Brightman (Giacalone, 2013: 643).

Suborbital Flights

A suborbital flight is each flight of a special craft reaching a height of 100 kilometres² and returning to Earth. It takes anywhere from 2.5 to 3 hours, with passengers experiencing weightlessness for about five minutes. The leading company for the suborbital flights is currently Virgin Galactic, which won the Ansari X-Prize and received \$10 million for successfully launching the SpaceShipOne above 100 km twice within two weeks in 2004. (Burić & Bojkić, 2007). Their new craft, SpaceShipTwo, can carry six passengers to a height of 110 km. Virgin Galactic has already received over 700 passenger payments (\$200,000 each) for participation in suborbital flights. Other companies actively testing craft for suborbital flights include Armadillo Aerospace, Bigelow Aerospace, Blue Origin, Planet Space, Space Dev, SpaceX.

Methodology of the Literature Review

We have reviewed the scholarly books in the field of space tourism available at some of the largest online bookstores (Amazon, Barnes & Noble, Books at Half, Google Books), published mainly in English, and have identified 23 publications that focus directly on space tourism. We also searched for scholarly books and articles with the help of the online scientific information databased Science Direct and Space Future. The latter offers over 220 papers focusing on space tourism. Further titles were discovered by reviewing the references in the published literature. The literature was then further analysed and divided

- 1 Some authors consider the first tourist to be Japanese journalist Toyohira Akiyama, who flew to the Russian space station Mir in 1990. The flight was paid by the Japanese television company TBS (Akiyama, 1993).
- 2 The boundary at 100 km is called the Karman line and roughly represents the administrative border between Earth’s atmosphere and space. It was defined by the International Aeronautical Association.

into eight space tourism study areas addressed by the authors. Given the fact that we can consider the year 2001 to be the start of orbital space tourism and that the suborbital commercial spaceflight began three years later (although, due to the technical and administrative reasons, no tourist has yet to make such a flight), priority was given to the selection of literature published after 2001.

The Most Important Authors and Fields of Space Tourism Investigation

Examination of the selected literature identified eight in-depth researched areas or aspects of space tourism:

Research area	Author
Space tourism market research	Abitzsch, S. (1996) Barrett, O. (1999) Burić, T., & Bojkić, L. (2007) Collins, P., et al. (1995) Crouch, G. I., & Laing, J. H. (2004) Devinney, T., et al. (2006) O'Neil, D. et al. (1998a, 1998b) Reddy, M.V. et al. (2012). Webber, D. et al. (2002) Webber, D., & Reifert, J. (2006)
Economic aspects of space tourism	Bensoussan, D. (2010) Collins, P. (2006a) Collins, P., & Autino, A. (2008) Eilingsfeld, F., & Schaetzler, D. (2002) Goehlich, A. R. (2007) Livingston, D. M. (2000a, 2001a)
Legal aspects of space tourism	Collins, P., & Yonemoto, K. (1998) Dunk, F. G. (2013) Eilingsfeld, F., & Schaetzler, D. (2002) Livingston, D. M. (2001b, 2002) Masson-Zwaan, T., & Freeland, S. (2010) Seedhouse, E. (2008) Yehia, J. A., & Schrogl, K. U. (2010)
Medical aspects of space tourism	Apel, U. (1999) Kluge, G., et al. (2013) Marsh, M. S. (2006) Mitarai, G. (1993) Seedhouse, E. (2008)
Spaceflights directly connecting places on Earth (point-to-point)	Peeters, W. (2010) Webber, D. (2010, 2013a)
Technological aspect of space tourism	Anderson, C. E. (2005) Zakaria, N. R., et al. (2011) Goehlich, A. R., et al. (2013) Collins, P., et al. (1994b) Livingston, D. M. (2000d) Giacalone, J. A. (2013) Rogers, L. (2008) Torikai, T., et al. (1999) Webber, D. (2005)

Research area	Author
The analogy of space tourism with some other areas of tourism	Fawkes, S., & Collins, P. (1999) Robson, S. (2003) Spennemann, H. R. D. (2007a) Stine, G. H. (1996) Webber, D. (2003)
Development trends in space tourism	Collins, P. (2002, 2003a, 2003b, 2006c) Favatà, P. (2001) Genta, G., & Rycroft, M. (2006) Goehlich, A. R., & Schumann, D. (2004) Hilton, B. (1967) Kramer, R.W. (2011) Martinez, V. (2009) Nair, G. M., et al. (2008) Spennemann, H. R. D. (2007a, b) Srivastava, M., & Srivastava, S. (2010) Webber, D. (2012)

Based on the number of articles in various scientific journals and papers at various scientific conferences, symposia and workshops, the following authors were identified as the most important in the field of space tourism: P. Collins, D. Webber, D. M. Livingston, G.I. Crouch, D. Ashford, R. A. Goehlich.

Space Tourism Market Research

Since the early 1990s, approximately ten in-depth market studies of space tourism have been conducted. Particularly in industrialized countries, the studies were carried out by independent researchers, governments, various organizations or private companies that wanted to support their intention to invest in space tourism with concrete numbers (Crouch, 2001). Most studies have been conducted by Collins and others who have studied public interest in tourist space flights in Japan (Collins et al., 1994; Collins, Stockmans, & Maita, 1995) as well as in Canada and the United States (Collins, Stockmans, & Maita, 1995). The results of studies conducted in the U.S. on a sample of 1,500 American families were reported by O’Neil and others (1998a, b); this study was jointly conducted by the National Aeronautics and Space Administration (NASA), the Space Transportation Association (STA) and Georgetown University. Abitzsch (1996) studied the German market in 1996, and Barrett (1999) repeated his studies three years later, this time in the UK. How interested Australians were in space travel and how much they would willing to pay for it was studied by Crouch and Laing (2004). One of the most extensive and in-depth market stud-

ies of space tourism was conducted by Futron/Zogby in 2002. The study was expanded and complemented in 2006 (Futron, 2006). It is considered a reference for orbital and suborbital flights (Webber et al., 2002; Webber, 2003; Ziliotto, 2010).

Economic Aspects of Space Tourism

The authors agree that space tourism as a future new tourist industry can be economically and socially highly beneficial. Primarily, it can create new jobs in the field of transport, astronautics, tourism and related fields (Livingston, 2001a; Collins, 2006, Collins & Autino, 2008). While authors in the 1990s were still doubtful whether there was a potential market for tourist space flights (Collins, 1997), in the 21st century their focus is on the process of development of space tourism (Beery, 2012), the financial model for the maintenance of space tourism (Livingston, 2000a; Eilingsfeld & Schaetzler, 2002) and the development of products and services related to space tourism (Goehlich, 2007). Space tourism also raises new demands and risks, as well as new opportunities in the insurance sector. As Bensoussan writes (2010, p. 1633), the design of an adequate and affordable insurance regime for future space tourists is an important step towards the development of space tourism market.

Legal Aspects of Space Tourism

Collins (1998) was one of the first authors to propose the preparation and regulation of both national and international legislation concerning future space

flights. In his opinion, the most suitable model that could be emulated is that of the civil aviation industry. Wollersheim (1999) agrees but points to a number of complications that may arise in adapting existing laws to the new space tourism industry. He finds the preparation of entirely new legislation in this area to be a more sensible approach. Dunk (2011) notes that this issue is crucial and remains unresolved. In addition to the aviation law, he refers to legislation in the field of adventure tourism as a useful model for space tourism. The only author writing about the importance of ethical standards in space is Livingston (1999, 2000b, 2001b, 2002). He proposes the creation of an ethics code for commercial spaceflight that would, among other things, establish relationships between employees in the aerospace industry, respect for environmental values, and relations between prospective settlers and visitors to the Moon.

Medical Aspects of Space Tourism

Various factors (take-off and landing forces, weightlessness, vibrations, noise, radiation, etc.) affecting the human body during space flight have been explored on cosmonauts and astronauts for decades, ever since the first space launch; preparations and exercises are also adapted to these factors. Therefore, the medical aspect of commercial spaceflight is the most comprehensively covered of all the aspects of this literature review. However, as noted by Apel (1999), professional astronauts are chosen very carefully, mostly from among the best air pilots. For future space tourists, the trainings and stress tolerance during space flight will have to be adapted to different ages, genders, cultural backgrounds and levels of physical fitness. In order to avoid health problems, it will be necessary to take into account certain medical standards of both crew and passengers on commercial spacecraft (Seedhouse, 2008). For Marsh (2006), an important ethical aspect of spaceflight is ensuring that passengers and their personal physicians are well informed about potential health hazards of such tourism.

Spaceflights Directly Connecting Places on Earth (point-to-point)

One of the promising future forms of spaceflight that will be useful for tourist are the commercial spacecraft flights that directly connect places on Earth.

In this case, the spacecraft is launched into lower or higher orbit at one point the Earth's surface and then lands on another. In this manner, the flight time can be shortened; a flight from New York to Tokyo by plane usually takes 13 hours, while in this case would only last an hour and a half (Peeters, 2010). A relatively high ticket price will be offset by time savings, and we expect these flights to be of interest to business executives (Ibid.). Webber (2013) does not entirely agree with this and presents an analogy of point-to-point flights to the Concord, where more than 20 per cent of passengers were wealthy individuals, film stars, athletes, etc. Webber (2010) also points out the lack of research on the potential market for space flight directly connecting places on Earth, about which is so little is known.

Technological Aspect of Space Tourism

Space tourism is highly dependent on the development of space technology. Currently, orbital tourists can only stay on the International Space Station and fly on spacecraft intended and designed for professional astronauts or cosmonauts. Crafts for tourist suborbital flights have already been built but remain in the testing phase. Therefore, authors writing about the technological aspects of space tourism consider safe, reusable spacecraft, adjusted for tourist flights (Torikai, 1999; Livingston, 2000d; Anderson, 2005; Seedhouse, 2008). Collins, Akiyama, Shiraishi and Nagase (1994b) go a step further and point out the necessity for a suitable interior design of spacecraft and services that the passengers will enjoy during the flight. Alongside the construction of these technologies, it will be necessary to devise suitable launch facilities or "spaceports", where the prospective tourists will board the spacecraft (Webber, 2005; Zakaria et al., 2011).

The Analogy of Space Tourism with Some Other Areas of Tourism

Space tourism is a new tourist industry still in the phase of developing its own standards, requirements and needs. To improve the presentation and perception of space tourism, some authors, therefore, look for analogies with other, long-established forms of tourism. Most often, they make comparisons with the development of flights (Webber, 2003, 2013b) and adventure or extreme tourism (Spenneman, 2007).

Even before the beginning of the space tourism, an interesting analogy was made by Fawkes and Collins (1999). Future hotels in orbit were compared to passenger cruise ships that sail on the high seas, are self-sufficient, and the passengers cannot leave them whenever they want. The authors also speculate that, based on experience with cruises, some shipping companies could become major investors the future orbital hotels (Ibid.).

Development Trends in Space Tourism

Although space tourism is at an early stage, many authors have discussed more far-reaching goals of development of this industry in the future. Technologies for certain forms of space tourism already exist (suborbital and orbital flights, flight to the Moon and back), while the rest remains to be developed (Srivastava, 2010, p. 47). Most authors considering the future of space tourism refer to the development of space habitats (hotels) in orbit (Favata, 2001; Goehlich & Schumann, 2004; Martinez, 2007, 2009). The idea of a hotel in the Earth's orbit is not new, as it was introduced by Baron Hilton well over a decade ago (1997) at a conference of the American Astronaut Association. More futuristic forecasts of space tourism in the articles deal with commercial flights to the Moon and back (Collins, 2006c; Spennemann, 2007a, b) and permanent settlements on the Moon and Mars (Nair et al., 2008). Tourists' interest for these destinations can encourage potential investors (Spennemann, 2007). Broader discussions on commercial tourist flights to the other reachable Solar System bodies (mostly asteroids and moons of major planets) were not found in the literature. Due to the technological and human factors, manned space flights to these bodies are currently impossible and are not expected in the next few decades.

Conclusion

The literature on space tourism reflects the fact that this is a new kind of tourism in the making. There are simply not enough tourists going into space in order to draw in-depth conclusions; even the few tourists that have gone have only experienced the orbital flight. However, based on the number of articles published in scientific journals, contributions to numerous scientific conferences and published scientific books, we can conclude that the interest among

scientists for following the exploration of space tourism is considerable. Most of the contributions published in the 1990s predict that space tourism as an industry that will flourish in the near or distant future. We also found incorrect assumptions in the literature: for example, the anticipation of suborbital tourist flights before orbital flights (Fawkes & Collins, 1999). However, since 2001, when the first space tourist, Dennis Tito, flew into space followed by a few others, authors are discussing space tourism as a real fact of our time. More in-depth studies can be expected with the commencement of suborbital tourist flights. In the literature, we most often noted the interest in the study of space tourism from the perspective of economics, law, medicine, and historical analogies, such as development of the aviation industry, adventure tourism, etc. Some authors seek to address more futuristic predictions about the hotels in orbit, direct transport between places on Earth through space or tourist flights to the Moon and Mars. In addition to these areas, space tourism brings new avenues of research that the literature currently only scarcely covers. Apart from the contribution about space tourism in the book *Cosmic Society: Towards a Sociology of the Universe* (Dickens & Ormrod, 2007), we did not find a broader study of the sociological and psychological aspects of commercial space travel. With the exception of Livingston, there is also no research to be found on the ethics of space tourism or its ecological impact. Studies of motivation of potential space tourists are also insufficient. Some market surveys do ask questions about the motives for space travel, but the answers raise suspicions that the respondents were not informed about the specific features, requirements, preparations and dangers they can expect during space flight.

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