Safety and Security in Space Tourism

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The purpose of the study is to shed further light on the understanding of safety as one of the most important aspects of space tourism. From the safety perspective, the development of spaceflight tourism is hoped to contribute to a deeper and more comprehensive understanding of safety factors in commercial space travel, and thus, to the more sustainable development of this new tourism industry. Therefore, it is important to discuss, even at this embryonic stage of space tourism, that planning and implementation of future tourist flights into space must consider all possible safety factors and minimize risks. We see limitations in the fact that space tourism is a new phenomenon and a new research field, which is now fostering the theoretical and methodological foundations of its development. As a result, research into space tourism and the safety of commercial space flight is limited. A typology of space tourists is practically non-existent; therefore, any comparison of space tourism safety with other types of tourism is inadequate. This study focuses on the analysis of new safety strategies for space tourism; the experiences and knowledge obtained from previous forms of adventure and extreme tourism have been considered.

Keywords: space tourism, security, safety, space flight, risk

Introduction

The tourism industry is now one of the largest and fastest growing economic activities in the world. It is essential for economic growth and development: employing people, improving the standard of the world's population and playing an important role in alleviating poverty in developing countries. More and more people can afford the opportunity to travel and are also exploiting the possibilities to do so. Until recently, it has been difficult for existing transport to access out of the way destinations in less than one day (Kurež, 2011). In 2015, the number of tourist arrivals increased by 4.6%, reaching a record number of 1.186 billion. Despite the global financial crisis, international travel results were above expectations, with an additional 52 million international passengers in 2015. Forecasts prepared by the United Nations World Tourism Organization (2014) in January 2016 point to a continuation of growth in international tourist arrivals at a rate of between 3.5% and 4.5% in 2016. The largest growth in tourism for 2015 was recorded in Asia and the Pacific (+6%) and Europe (+5%). By subregion, the best results were recorded by South East Asia (+8%), Oceania, the Caribbean, Central America and Northern Europe (all +7%), followed by North America and South America (both +6%). According to the World Travel & Tourism Council (2016) data, the direct economic impact of tourism in 2015 contributed to global

GDP to the value of 2.2 billion dollars (3%). However, when we calculate the direct, indirect, and induced impact of tourism, it comes to 7.1 trillion or 9.8% of global GDP. With regards to employment, the importance of tourism is even more pronounced. In 2015 the tourism industry employed 107 million people, which is five times more than in the automotive industry. Taking into account the indirect and induced employment in the tourism sector, we find that 283 million jobs were provided in 2015, accounting for 1 in 11 jobs in the world (World Travel & Tourism Council, 2016).

The basic condition for the development of tourism is safety and protection. However, it is only in the last two or three decades that the issue of safety has gained greater importance. During times of terrorist acts, local wars, natural disasters, epidemics and pandemics, levels of safety significantly fell. The importance of security in tourism began to increase in the 1950s (Table 1), with the development of mass tourism. During this period, tourism was no longer the privilege of a narrow social order or class, but tourist flows gradually incorporated the middle and lower classes. Tourism started to develop in more and more countries and regions of the world. Faster development of transport in the automotive and aerospace industries contributed to greater passenger mobility (Kovari & Zimany, 2011). The globalization of tourism began in the 1990s, causing vulnerability and susceptibility to security threats (Kurež, 2011). Such security issues as we encounter today, have all arisen since the emergence of modern tourism, but their impact is markedly greater since the end of the Cold War, and especially since the terrorist attacks in the US on 11 September 2001 (Mansfeld & Pizam, 2006).

Decisions about a tourists' journey strongly depend on their feelings of well-being, the sense of insecurity and the presence of risk (Ambrož & Mavrič, 2004). The security component in tourism must, therefore, be addressed in order to ensure safety at all levels of the tourism service (Ivanuša, Lesjak, Roša, & Podbregar, 2012). Respondents to Ambrož's (2003) study on motivations for tourist travel under the influence of a culture of fear, expressed the opinion that the tourist is also obliged to care for their safety and to comply with safety rules. However, security issues in tourism are complex, and thus also need to be addressed. There is particular sensitivity to the relationship between security and human rights and security and freedom, pleasure, discretion, and integrity. Stricter safety measures may also lead to the limitation and weakening of human rights. In tourism, this is reflected in degraded or limited tourist activities (Mekinc, 2010). Suitable information for users of tourist services is also among the important factors in tourism safety. The process for informing tourists includes obtaining, analysing, and communicating relevant information to them.

Defining the Concept of Space Tourism

The wish to visit space was recognized thousands of years ago, and cannot be spatially or temporally defined. It was first realized by Russian cosmonaut, Yuri Gagarin, on 12 April 1961, when the Vostok 1 space flight stayed in orbit for 108 minutes. Since then, spaceflights have been exclusively reserved for scientists and professional astronauts or cosmonauts. Over the past 35 years, many organizations have attempted to realize and establish space tourism, but high costs and political concerns have prevented commercial forms of spaceflight (Klemm & Markkanen, 2011). It was not until April 2001, forty years after Yuri Gagarin's space flight, that Dennis Tito became the first space tourist. Today, space tourism is becoming a reality, although it remains in the pioneering stage. As predicted by Ciccarelli and DeMicco (2008), in the 21st century, space tourism will possibly become the greatest development in the tourism industry. This industry, which is constantly looking for new products and destinations, may become the biggest promoter of space tourism. Certainly, there is the prospect of space tourism becoming what air flights are today (Goehlich, 2007).

Space tourism is a new, incomplete and untested market niche. Thus, tourism operators, as well as tourists, are becoming familiar with it. Something that was, until recently, a utopian, futuristic, science fiction concept is becoming a more realistic possibility. Undoubtedly, this will become a tourism industry, as with previous others, essentially relying on the traveller and their requirements and need for safety. Therefore, it is important to discuss, even at this embryonic stage of

Table 1 The Changing Concept of Safety and Security in the Tourism (1950–2010)

Period	Main characteristic	Features, attributes
Mass tourism (1), 1950–1970	Safety and security in tourism as one of the problems in tourism. Simplified approach to the perception of safety and security issues in tourism.	• Tourism security is a one- or two-dimensional notion. • Only a few elements of security issues are in focus (public safety, health safety, road safety, etc.). • Within the elements of safety and security, only a small number of factors were given importance (e.g. health and hygiene problems: 1. drinkable water, 2. necessity of vaccination, 3. cleanliness of toilets). • Security problems are localized in time and space. • Security problems may affect the image of a city or country but not the image of a whole region. • Travel-related risks and problems are not raised on the international level of tourism industry (excluding international transport regulations). • Solving problems of security depends mainly on the regulations of the national authorities.
Mass tourism (2), 1970–1990	Period of enlargement of security concept of tourism.	• Additional risk factors appear in travel and tourism (airplane hijacking, terrorist actions as a tool of social struggle). • Threats to security reach regional level in some parts of the world (Middle East, Basque country, etc.). • Beginning of a wider international cooperation related to security issues. • Technical improvements in safety, e.g. air transport). • WTO draws attention to safety, security of tourists (World Tourism Organization, 1989). • Compact but specific (that is to say not general) solutions are created (e.g. the case of Israel's El Al airlines).
Transition to Global Tourism 1990–	Period of complex perception of security and safety in tourism.	• Numerous new elements appear within the tourism security issues due to the omnipotent factors of globalization meaning that national/regional economies, societies, and cultures become integrated through a worldwide network of communication (internet!), mobility (tourism!), trade of goods and services (personal data security, environmental security, natural disasters, pandemics, etc.). • Security of travel has become a global problem that we cannot disregard. • Number of destinations, situation, and tourists affected by the lack of security is increasing. • Lack of security causes regional stagnation or decrease in tourist flows and even on global level (9/11). • Basic changes in security concept in travel and tourism, understanding the necessity of common actions.

Notes Adapted from Kovari & Zimanyi (2011).

space tourism, that planning and implementation of future tourist flights into space must consider all possible safety factors and minimize risks. Rather than focusing only on passenger safety in tourist space flights, this should include safety personnel on the ground, also during the testing of vessels, as well as during all phases of flight, public safety during vessel take-off and landing, managing space traffic, as well as the prevention of pollution in orbit. One important aspect of safety is the availability of appropriate and relevant information for the public and future space tourists. The link between safety and tourism has been present since the emergence of modern tourism and the travel industry, as safety is an indispensable component of modern tourist attractions, their quality, and development. Given its nature, complexity, cost

Table 2 The Changing Concept of Safety and Security in the Tourism (1950–2010)

Stage	Description	0g duration	Flight duration	Price	Realized
1	Natural attractions and others	none	none	\$0–\$2000	yes
2	Terrestrial tour	none	none	\$20–\$8500	yes
3	Parabolic flight	0,5 min.	few hours	\$4000	yes
4	High-altitude flight (jet airplane)	none	few hours	\$32,000	yes
5	High-altitude flight (balloon)	none	few hours	\$75.000–110,000	no
6	Point to point flight	few min.	1–2 hours	not known yet	no
7	Suborbital flight	5 min.	2,5–3 hours	\$250,000*	no
8	Orbital flight	1 day	1 day	\$300,000*	no
9	Orbital flight plus stay (ISS*)	10 days	10 days	\$20 M	yes
10	Moon flight	weeks	weeks	\$100 M*	no
11	Mars flight	months	months	billions*	no
12	Titan flight and beyond	years	years	billions*	no

Notes * International Space Station. Adapted from Goehlich (2007, p. 217), Peeters (2010, p. 1630), D'Orazio (2013), and Emanuelli (2013).

and risk, space flight is related in many ways to more extreme forms of adventure tourism. The preparations are time-consuming and stressful, the conditions during take-off, while in space and during landing are still relatively dangerous. Therefore, in the first place, especially in preparing new safety strategies for space tourism, the experiences and knowledge obtained from previous forms of adventure and extreme tourism must be considered.

Scientific studies emphasize space tourism as commercial flights for tourists into space, either as shorter suborbital or longer orbital spaceflight. Klemm and Markkanen (2011) point out that due to the small number of passengers and the exclusivity of spaceflight, this still cannot be called tourism. Instead of space tourism, the terms 'public space travel' or 'private flight in space' could be used. European Space Agency (2008) defines 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.' Table 2 presents the field of space tourism considering the duration of weightlessness, flight time, cost, and possible realization.

In terms of space tourism safety, attention is mostly given to suborbital and orbital flight tourism, which have already been executed or will be executed in the near future, and which, therefore, are most relevant. Although technology is already partially available for several other forms of space tourism (staying in an orbital hotel, flights to the moon, moon landing); for most other forms (flights to Mars, Mars landing, flights to Titan), it has yet to be developed (Srivastava & Srivastava, 2010). The start of commercial flights to these celestial bodies is predicted within a few decades.

The aerospace industry is currently dominated by several national space agencies, such as the American National Aeronautics and Space Administration (NASA), European Space Agency (ESA) and Russian Federal Space Agency (RKA). Even the Chinese Space Agency (CNSA) is becoming an increasingly important participant for space launches (Morley, 2006). Increasingly, private companies are also starting to develop commercial spaceflight, either in cooperation with national space agencies or by developing separate independent projects. A breakthrough private spaceflight took place in October 2012, with the privately held company SpaceX, which has a contract with NASA, successfully launching the Falcon 9/Dragon cargo spacecraft to the International Space Station. A similar agreement by NASA was concluded with Planet Space and SpaceDev. It can be assumed that space tourism services will draw on services from these pioneering organizations (Giacalone, 2013).

Orbital flight is when a spacecraft flies high above the atmosphere and enters the Earth's orbit (orbiting or circling). The altitude of Earth's orbit is somewhere between 160 and 2,000 kilometres. At this altitude, spacecraft can orbit the Earth for an extended period, from two weeks (e.g., the former Space Shuttle), up to several months or years (e.g., the International Space Station) (Anderson, 2005).

In the spring of 2001, Dennis Tito became the first space tourist, spending over a week on the International Space Station, paying $20 million to the Russian Space Agency for that flight. Since Tito's orbital flight, there have been six more space tourists: In 2002, Mark Shuttleworth (South Africa) in 2005, Gregory Olsen (USA), 2006 Anousheh Ansari (USA/Iran) in 2007 and 2009, Charles Simonyi (USA), 2008 Richard Garriott (USA) and Guy Laliberté (Canada) in 2009. These seven participants are currently the only ones who can be characterized as genuine space tourists. Thus far, only the Virginia-based travel agency Space Adventure, in cooperation with the Russian Space Agency, is offering the possibility for tourist trips into orbit (Giacalone, 2013).

Orbital space tourism as a commercial activity remains at an embryonic stage, but in the coming decades, it will not consist of only one or two trips per year, costing $20 million. Revenue from ticket sales alone may reach up to 10 billion dollars annually. High revenues can also create additional services, such as providing food for space tourists, entertainment, and sports in space, designing and selling space garments, etc. (Goehlich, 2007). One important contribution of space tourism will be the construction of future commercial, residential space stations (space hotels) in orbit (Martinez, 2007; 2009). The most advanced company in space hotel planning is currently Bigelow Aerospace. The founder, Robert Bigelow, is also the owner of the Budget Suites of America hotel chain. Bigelow Aerospace has two experimental orbiting habitats, the small-scale Genesis I and Genesis II (Pizam, 2008). In April 2016, the Bigelow Expandable Activity Module (BEAM) arrived at the ISS: the temporary, experimental module developed by Bigelow Aerospace, under contract with NASA. It was expanded and pressurized and will be tested as the future home of astronauts or space tourists (Navarro, 2016).

For suborbital trips, each flight requires a specific vessel, reaching an altitude of 100 kilometres before returning to Earth. It takes from 2.5 to 3 hours and at the highest point, passengers experience weightlessness for about five minutes. In that time, they can enjoy views of the Earth, planets and stars, without the filter of the atmosphere. Private companies such as Armadillo Aerospace, Blue Origin, and XCOR Aerospace are actively testing vessels for suborbital flights; the leading company for executing suborbital flight is currently Virgin Galactic. In 2004, the company successfully launched the Virgin Galactic SpaceShipOne craft to an altitude of over 100 km. Their SpaceShipTwo craft can carry six passengers to an altitude of 110 km (Burić & Bojkić, 2007). To date, Virgin Galactic has already received more than 700 passenger pre-orders. The price for a suborbital flight per person ranges from $200,000 to $250,000 (US) (Virgin Galactic, 2014). Their future services also offer over 140 accredited 'space tourist' agencies from all continents. While test flights were carried out from an airstrip in Mojave, California, future suborbital flights will launch from Spaceport America, established in New Mexico. Spaceport America is the first airport dedicated to commercial spaceflight. According to the Futron research company, it is predicted that there will be 15,000 suborbital flight passengers per year by 2021, representing annual revenues of more than $700 million (Beard & Starzyk, 2002).

Tickets for space flights will initially be purchased by wealthy individuals, but in the future, price reductions will also be accessible to others. As the fares for suborbital flights drop to $10,000, there could be up to one million passengers per year. As with orbital flights, suborbital flights can also generate revenue in addition to ticket sales. One firm, Orbital Outfitters, has developed specialized aerospace garments both for spacecraft passengers and the crew of suborbital flights (Giacalone, 2013).

To date, only 24 people have ever left Earth orbit and journeyed close to the Moon. The last people to walk on the Moon were Gene Cernan and Harrison Schmitt, who left it on December 14, 1972. Since then, no one has been closer to the Moon than low Earth orbit. The company Space Adventures want to change that. Using flight-proven Russian space vehicles, they intend to fly two private citizens and one professional cosmonaut on a free return trajectory around the far side of the Moon. Space Adventures expect to launch their first mission before the end of the decade.

To date, no manned mission has ever been undertaken to any of the other planets of the solar system. The main problem, decreasing the travel time, has not yet been resolved. It is highly unlikely that space tourists will fly to Mars in the coming decades, but not impossible. NASA (2015) is developing the capabilities needed to send humans to an asteroid by 2025 and Mars in the 2030s; these goals *are outlined in the bipartisan NASA Authorization Act of 2010 and the US* National Space Policy, also issued in 2010. Recently, a number of private initiatives advocating the private exploration of Mars were proposed. The simplest missions, proposed by the non-profit organization Inspiration Mars Foundation, is a space cruise for two people on a 501-day Mars flyby travel. The main goals are to generate excitement about space travel and test technologies necessary for landing on Mars in the future. Furthermore, SpaceX plans to establish a Mars colony in a more distant (but not too distant) future. The long-term goal is establishing a settlement of up to 80,000 people. This huge enterprise would be made possible by the reusable rocket SpaceX is building. The explicitly declared goal is that of contributing to the birth of a multiplanet, spacefaring civilization (Genta, 2014, p. 484).

Safety in Space Tourism

As with other types of tourism, space tourism must also take into account all the different aspects of safety. The history of spaceflight teaches us that it is a hazardous human activity, which hides many potential dangers. Proof comes from several high-profile spacecraft accidents, such as the Space Shuttle Challenger and Columbia tragedies, not to mention accidents related to the rocket launch preparations, psychophysical issues for astronauts and cosmonauts, damage to vessels while in orbit, etc. When considering the safety of space tourism, scientific studies focus on the areas of science or technology specific to the psychophysical (medical) requirements that must be met by future space tourists to avoid potential problems during flight. In the 1990s, the Japanese Rocket Society's (JRS) development of spacecraft for tourism purposes took into account the safety standards required for a tourist trip into space (Torikai et al., 1999). Manufacturers of spacecraft technologies pursue a standard of safety and reliability, which are comparable to the modern aircraft intended for commercial flight (Sawaya, 2004). The technological aspects of safety are also emphasized by Zakarija et al. (2011), identifying the advantages and disadvantages of vertical take offs and landings by commercial spacecraft. Just as safety in air traffic is regulated, internationally comparable standards for tourist flights into space will also be required. Various organisations dealing with space flight have a range of approaches and standards, which is another reason for creating a single umbrella global space agency to regulate and unify the legal standards in this area. Currently, the *International Space Safety Standards* (Sgobba, 2008), *Introduction to the Australian Space Safety Regime* (The Space Licensing and Safety Office, 2009) and *Space Safety Standard: Commercial Human-Rated System* (International Association for the Improvement of Space Safety, 2010) exist. There will be significant issues concerning spacecraft licensing arrangements and their use in both suborbital as well as orbital flight (Pelton, 2007; Crowther, 2011). The development of space tourism represents a challenge to the insurance industry. New risks in tourist flights bring new requirements to this economic area, which will have to deal with new security management and pre-spaceflight preparations with significantly greater dynamism (Bensoussan, 2010).

Various theorists (Apel, 1999; Marsh, 2006; Kluge, Trammer, Stern, & Gerzer, 2013) prioritize medical guidelines due to the extreme nature of space tourism trips. It is anticipated that the biomedical perspective for commercial spaceflight will very quickly influence the minimum legal requirements for safe travel. Above all, it will be necessary to consider the medical dilemmas of how to deal with cases of accidents and emergencies related to space tourism.

As a result of new tourism services, while there is still no specific typology of space tourists, analysts seek meaningful correlations between space tourism and other forms of tourism. Previous references to safety and risk are related to adventure and extreme tourism (Fluker, 2005; Buckley, 2006; Spennemann, 2007; Ziliotto 2010; Reddy, Nica, & Wilkes, 2012). One can look for common characteristics between space, adventure and extreme tourism in the areas of preparation, risk, hazards, and pricing (Kemp, 2007). Research studies indicate that adventure tourists would travel to space for, among other reasons, the adrenaline rush and risk, just as mountain climbers, divers and parachutists do (Crouch, 2001). Dunk (2013) also describes adventure tourism in the context of space tourism safety, warning that this element will also need to be considered in legislation, or where it does not exist, it will need to be created.

Many authors (Malik, 2008; Pelton & Gini, 2012; Pultarova, 2013; Rakobowchuk, 2013; Courage, 2014; Fuller, 2008; Powers, 2014) deal with the existing safety issues, especially in suborbital tourism, noting the safety issues faced by so-called space companies (Virgin Galactic, Armadillo Aerospace, Blue Origin, XCOR Aerospace) in preparing commercial tourists for space flights in the near future.

Improvements in overall safety and the development of new safety standards in scientific research flights into space are still largely the responsibility of state space agencies, especially those who conduct flights, for example, the American NASA, the European ESA, the Russian Roskosmos and the Chinese CNSA space agency. Private companies with plans for tourist flights into space receive ample descriptions and practically verified information regarding travel into space from these agencies.

Participating commercial and state-backed spacecare institutions cooperate via the Commercial Spaceflight Federation (CSF), which was founded in 2007 in the US and today comprises over forty companies and organizations. The association's mission is to promote commercial manned flight into space, to develop a higher level of safety and to exchange experiences and best practices in the aerospace industry. In the US and Europe particularly, there are also a few specialized organizations that deal with various aspects of cognition, development, and safety improvements during space flight.

The International Association for the Improvement of Space Safety (IAASS) was founded in 2005 in the Netherlands. It is a non-profit organization aimed at promoting international cooperation and scientific developments in the field of space systems safety. The agency's sponsors are the ESA, NASA, Roskosmos, the Japanese Space Agency (JAXA), the Canadian Space Agency (CSA), the French National Centre for Space Studies (CNES), German Space Agency (DLR), and the Italian Space Agency (ASI). Approximately every two years the association holds a major international conference on security in space (Pelton, 2007).

Like the IAASS, the International Foundation for Space Security (ISSF) is a non-profit organization. Its research and projects are focused on the safety of space flight, spacecraft safety, ground staff, passengers, crew, and cargo.

They aim for responsible attitudes towards space, especially in the orbital environment. The Federal Civil Aviation Authority (FAA) is the United States' largest national and civil aviation administrative institution. It was founded in 1958. The Office of Security and Hazardous Materials Safety (OSHMS) works within the administration, protecting the facilities and staff of the FAA from criminal and terrorist acts; it is responsible for airports, air transport, air safety and commercial transportation into space. In the latter case, its task is primarily to ensure safe take-off and landing by vessels while in the Earth's atmosphere.

A similar body exists in Europe, the European Aviation Safety Agency (EASA). The European Union was founded in 2003 with its headquarters in Cologne. EASA regulates and maintains control of civil aviation safety in Europe. The scope of spaceflight legislation in Europe is monitored by the European Centre for Space Law (ECSL), which was founded in 1989 at the initiative of the European Space Agency. It comprises professionals in the fields of aerospace, mainly lawyers, academics, and law students. ECSL encourages discussion and reflection and promotes exchanges of opinions in the field of space legislation.

Given the fact that spaceflight is still in the developmental stage, it is inherently risky for trained astronauts, as well as for tourists. According to Bensoussan (2010) 'Private human spaceflight is like climbing Mount Everest with a lot farther to fall.' Below we summarize some of the security aspects of spaceflight to be taken into consideration for future space tourists. Given the different levels of spaceflight, the terms of safety and risk should consider the stages of preparing the craft for flight, take-off, and landing and spacecraft, or in space stations, in a lower or higher orbit.

From a security point of view, hijacking a spacecraft or placing an explosive device should be almost impossible these days. The volume and weight of luggage carried by space tourists will be limited and strictly inspected to avoid any risk of fire, explosion or contamination. To take a weapon or bomb into orbit is virtually impossible (Pelt, 2005).

Tourists flying into space would be required to carry out certain physical and mental preparation, as all astronauts, scientists and researchers do. For longer flights, passengers must also acquire some technological skills and be able to react in case of complications, danger or accidents. These preparations vary depending on the form, length, and complexity of the flight. Preparations for passengers on suborbital flights are less demanding and much shorter, but compulsory for every passenger to attend. They would comprise a two-day basic program, a two-day follow-up program with in-depth preparation and an additional day for participants learn about the various experiments, space garments, and life support systems, etc. The program includes classroom studies, exercises, and simulations, including a centrifuge-based simulation of acceleration during take-off. Virgin Galactic believes that pre-flight preparation could be shortened to only three days. Each passenger would have to undergo a medical examination, although not to the same complexity as for astronauts. However, passengers with increased health risks would not be able to participate in a suborbital flight (Virgin Galactic, 2014). The company has not published more detailed criteria for space flight.

In contrast to suborbital visits, flights to other Earth orbits require strenuous, months-long preparations, something that all seven previously mentioned space tourists had to complete. Consequently, for space flight, as well as extended stays in space, and the return to Earth pose a significant stress on the human body and mental health, thus requiring a high degree of mental and physical skills (Anderson, 2005). The fact is that professional astronauts are already selectively chosen from among the very best aircraft pilots (Apel, 1999), and are therefore subject to the strict health requirements that would be required for orbital space tourists.

There is a necessity for intensive physical and other training to acquire tolerance to stress, adapted to age, gender, cultural environment and general fitness. Preparations begin with strict medical examinations, during which experts check the respiratory system, heart function, blood pressure, cholesterol, white blood cell count, levels of enzymes for organ function, balance, and mental stability (Seedhouse, 2008). Several weeks before the flight, the prospective space tourists would be subjected to daily active physical preparations, which include sports training, aerobic exercise, jogging, walking, etc, all with the aim of raising the aerospace passenger's condition, physical fitness, improving cardiovascular system function, increasing the sense of balance, etc. (Seedhouse, 2008). Another crucial part of preparation is a specialized diet to prepare the body for the efforts of the flight and life in space. Preparations also include learning to skydive, scuba diving, adapting to high and low-pressure conditions, and training in a specialized centrifuge to simulate the strong forces on the human body during take-off. The simulator is also used to practice reactions to different situations, different manuals are read, models of the spacecraft and space station are studied, even learning the Russian language, if travelling to the International Space Station with a Russian crew (Burić & Bojkić, 2007).

Risk Factors in Space Tourism

Travel in space is still in its development phase; consequently, the risks are higher when compared with atmospheric flights. Spacecraft take-off and landing are among the greatest potential risks. The risk of a serious event is also emphasized by Alexander Saltman, Executive Director of the Commercial Spaceflight Federation: 'There are going to be dangers that we don't know about when we start flying. There will be incidents and at some point somebody will lose their life in this industry' (Rakobowchuk, 2013).

For suborbital flights to an altitude of just over 100 km, different companies are developing different systems of take-off and landing. Engineered with vertical take-off rockets, as well as horizontal ones, the spacecraft is attached to a large plane and released at a specific altitude for flights at the edge of space. Each of these modes poses different risks. The main problem is the high-speed that the vessel needs to achieve, requiring large quantities of high quality (but also dangerous) fuel. The forces acting on the spacecraft during take-off are also significantly higher than in civil aircraft.

This is also mirrored for the passenger, who must, therefore, be appropriately prepared mentally and physically. Such factors greatly affect a flight into orbit and thus increase the likelihood of accidents. Commercial space companies aim for safety standards that over time will become similar to those currently applicable in aviation. Therefore, numerous test spacecraft and other technologies are on a quest to minimize the risks of spacecraft during take-off, flight, and landing (Webber, 2010).

An important aspect of understanding spacecraft safety during take-off and landing is the possibility that such vessels may stray from the flight path and threaten populated areas (Seibold et. al., 2008). This was illustrated in the tragic breakup of the space shuttle Columbia in 2003, when falling wreckage threatened not only nearby residents but also airborne civilian aircraft. It is, therefore, important to establish safe space flight corridors, at least while still in the atmosphere.

One proposal, presented in a study by Zakaria et al. (2011), is that spacecraft take-offs and landings be moved to distant locations in seas or oceans and away from populated areas. Take-off could take place vertically, from a specialized ramp, with sea landings by parachute, as frequently happens today. For future space tourists, it is also important that, in the event of an accident, and at any stage of the flight, passengers could escape the spacecraft (Pelt, 2005). Ejection seats are not suitable in this instance due to the high altitudes; therefore, it will be necessary to develop new ideas. Development in this area is directed towards the design of closed rescue capsules.

During suborbital flights, tourists will reach an altitude of about 100 kilometres with a five to seven-minute descent to Earth. Therefore, at this level, they are minimally exposed to normal risks, in comparison with orbital passengers who survive in space for several days, weeks or months. For orbital tourist flights, current spacecraft are adapted for scientific space exploration and operated by professional astronauts or cosmonauts. In orbit, passengers are exposed to hazards ranging from physiological changes to orbital debris threatening the spacecraft itself (International Space University, 2000). Among the factors for increased safety and reducing the danger during the orbital flight that need to be taken into account, are the requirements for a suitable living environment within the vessel, radiation, weightlessness, orbital debris, and meteors.

Spacecraft must provide suitable living conditions. Since all spacecraft are sealed, controlled air pressure is continuously required in the vessel to provide a safe, breathable atmosphere. Major changes in air pressure can cause pain or serious injury. Passengers must be equipped with specialized garments in case of decompression (Grabianowski, 2008). Particularly important is appropriate air pressure within the spacesuit for when a passenger leaves the vessel. It is also necessary to continuously monitor air quality because there is a risk of contamination with toxic substances. Equally important is a water supply for drinking and hygiene, as there may only be a limited supply of this liquid on board. Another particular risk and serious threat to a vessel and its passengers is a fire within the spaceship or space station.

In space, there are constant levels of intense radiation emitted by solar plasma eruptions, solar wind, and cosmic radiation, etc. The Earth's magnetic field protects the planet from such radiation; however, this protection does not exist in space. For passengers undertaking shorter suborbital flights, radiation will not have a significant effect. For longer orbital flights, radiation can pose a problem. Astronauts staying in low-Earth orbit (from 200 to 2000 km) receive the same amount of radiation in one week as a person on Earth receives in one year (Pelt, 2005). Thicker spacecraft walls provide protection against radiation, along with frequent monitoring for powerful bursts of solar radiation. In particular, considerable attention would need to be given to the effects of strong radiation on space-suited passengers when leaving the spacecraft.

The sensation of weightlessness, which is one of the most valuable experiences in space and one of the main motivators for tourist space flights, could also cause difficulties and inconvenience to the travellers. Symptoms such as dizziness, drowsiness or Space Adaptation Syndrome (SAS) or 'space sickness' is caused by excess blood in the head, which would otherwise flow towards the feet by gravity. Weightlessness causes muscle numbness and weakens the bones. Astronauts have also reported poorer sleep in weightlessness with resulting depression and confusion. Particular attention should, therefore, be given to passengers spending longer periods in space. After living in weightlessness, people returning to Earth have difficulties with independent walking for some time.

Since spaceflight began, there has been a growing problem of pollution due to orbital debris in space, which, according to some estimates, number over 100,000 pieces (International Space University, 2000). These are satellite remnants, space station waste, lost parts, etc. Since flying at high speed is a constant threat to spacecraft, damage can be caused. Thick spacecraft walls and smaller windows (which space tourists will definitely want, at any size) can offer greater protection. It is necessary to consider the flight direction of such spacecraft, thus planning for panoramic windows on board future orbital tourist spacecraft or hotels is an important safety consideration (International Space University, 2000).

A large number of smaller or larger meteors exist in space, which can seriously damage or even destroy a spacecraft. Individual meteors in the Earth's orbit are rare, but occasionally meteor showers do occur, which can endanger a vessel or station. There are cases in which such meteors have destroyed satellites (Pelt, 2005). Thankfully, the majority of the meteor showers orbiting the Sun are known, and it is possible to predict their direction. Similar to space debris, meteors also present a significant hazard for space hotels and development of some form of mechanical protection against them will be required.

Conclusion

The scientific literature on safety in space tourism is limited as this is a new form of tourism, still in the development stage. At this time, there are too few tourists who have travelled to space for in-depth empirical studies and conclusions on space tourism safety, and even those who have been were limited to orbital flight. In reviewing the literature, we did not find reports that study the safety of space tourism in the broader context of global security.

Experience with scientific research-based space flights can significantly contribute to the safer design and execution of tourist flights into space. The major concern regarding these experiences is that they are based on the professional, highly trained and well-prepared men and women who have travelled into space. Typical space tourists will clearly not achieve such a level of preparedness, such that tourist flights into space (training, spacecraft, food, sleep, leisure, etc.) make it necessary for proposals on a different basis, adjusted for abilities, ages, also the interests, wishes, and requirements of future space tourists. It will also be necessary to consider the potential dangers, as space remains a highly dangerous environment where the smallest problem can quickly develop into a disaster of unpredictable dimensions.

In addition, it is important to consider that space tourism is only in its infancy and that any major incident (at least for some time) will discourage or halt the interest of potential space passengers, thus also increasing the economic obstacles in this new emerging industry. Furthermore, by anticipating potential problems, eliminating them, along with negative public opinion, space tourism could learn a lot from extreme and adventure tourism.

Ewert and Hollenhorst (1997) have investigated the impact of risks and hazards as elements in decision-making by adventurous tourists who venture into the unknown and unexplored wilderness. They especially point out that awareness of danger sharpens concentration on a trip, but in many ways, it also affects the decisions, processes, and relationships between participants, etc. Given the risks of adventure travel, there are some contradictions. All providers of such trips first emphasize the element of safety, but the hidden risks also encourage tourists to join up. How this paradox has, nevertheless, allowed adventure tourism to operate successfully has been researched by Fletcher (2010). He found that providers often emphasize only one element (or security risk), while others are concealed.

An essential element of safety in space tourism will, in addition to technological processes and human factors, also include preparation and adoption of relevant safety standards. Uniform safety standards must consider all the companies and organizations developing commercial spacecraft and space tourism service. Today's standards require guidance from conventional space travel; adjustment and optimization for tourist flights will be required. The foundations of safety standards in space tourism can be drawn from standards that currently apply to civil aviation. It will be necessary, of course, to improve and establish appropriate safety in the space tourism industry, requiring continual research, both in terms of new space technologies, medicine, psychology, sociology, sustainable development as well as in the many forms of safety and security.

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