Article B

Toivonen A. (2021). Space tourism – Science fiction becoming a reality. In Ian Yeoman, Una MacMahon-Beattie and Marianna Sigala (Eds.) *Science fiction, disruption and tourism* (pp. 56-72). Bristol: Channel View Publications.

Space Tourism – Science Fiction Becoming a Reality

Annette Toivonen

Chapter Highlights

- The chapter explores the development of future space tourism
- The current industry trend is to create space tourism accessible to the masses
- Space tourism is at variance with current sustainable travel trends in tourism more generally
- The space tourism industry needs to act regarding environmental protection

The Era of Space Tourism

For many generations, space exploration simply represented a wishful dream, which finally became reality in the 1950s *Space Race* between the United States (US) and the former Soviet Union. Inspired by this development, Hollywood producers started to create space-related science fiction movies that enhanced audiences' imagination and desire to visit space. 2001: A *Space Odyssey* (1968), for example, constituted one of the first space travel films, introducing human-like intelligent computers.

It was commonly imagined that, within just a few decades, such a form of travel would be made available to the public. Some airlines, such as Pan American, even opened reservation lists for trips to the moon. However, it was three decades before even government-funded space flights occurred, when the first segment of the international space station (ISS) was launched into orbit in 1999 (Anderson, 2005). Nevertheless, in early 2018, a real-world, science fiction-like attempt at conquering space occurred, in the form of shooting a Tesla car with a human-like passenger on a rocket into space (SpaceX, 2018).

Typologically, space tourism consists of terrestrial space tourism, atmospheric space tourism, suborbital space tourism and beyond earth orbit astrotourism. The Kennedy Space Center in Florida, US and Baikonur Cosmodrome in Kazakhstan comprise some of the current global spaceports on earth, from which space vehicles can be launched into orbit (Carter *et al*., 2015).

Only a handful of people have thus far visited space as paying tourists in orbital spaceflight, compared to about 550 professionals, mostly US astronauts. In order to do so, one must reach the altitude of space according to the Federation Aeronautique Internationale definition of the boundary of space being over 100 km (FAI, 2018). Dennis Tito was the first paying space tourist customer, travelling on a Russian Soyuz rocket in 2001. His $20 million trip involved a five-day stay at the ISS and included six months of astronaut training and hours of physical exercise (Wall, 2011).

There are currently many ongoing projects, including high altitude ballooning, aimed at starting to offer regular space tourism experiences to paying passengers. In December 2018, a Virgin Galactic-crewed vehicle, built for commercial passenger service, reached suborbital space with a team member in a passenger seat (Virgin Galactic, 2018). In July 2021, Virgin Galactic and Blue Origin officially entranced into the market of private spaceflight; both

demonstrating successful suborbital flights, alongside their billionaire owners as well as the oldest and youngest passenger ever have flown in space (Blue Origin, 2021).

Rapid developments in technology during the 21st century have accelerated predictions for the future space tourism industry. According to Ashford (2002), space tourism is likely to generate significant public enthusiasm for space exploration as soon as it becomes safe and affordable. Suborbital space travel, whereby passengers are transported above the earth to experience weightlessness and star sighting, is a new adventure tourism experience offered by private space tourism companies. The wildest imaginations include visions of the moon becoming akin to a gas station, in which its dark spots (widely considered to be ice) are converted into fuel, so that travellers can continue to Mars (Tett, 2018).

The ultimate goal of such ventures is to develop a space tourism that is accessible to the masses; however, the high cost of a journey has limited the pioneering stage to wealthy, healthy travellers. Future space tourists' missions are likely to include vacation packages for a range of lifestyles and budgets. Pioneering space tourists must undergo health checks to satisfy tour operators, safety authorities and insurance companies. Both compulsory and optional training programmes about surviving an emergency and coping with space sickness will also need to be developed (Ashford, 2002).

The 'best deal' options with the lowest amounts of travel, training and mission time have formerly been 'zero gravity flights', on which tourists experience the feeling of weightlessness, and 'edge of space' flights, where the curvature of the earth can be witnessed. The latest, however more expensive, suborbital flights will offer both weightlessness and a view of earth. Future translunar cruises could include travel to the Moon or space hotels (relatively) nearby in lunar orbit (Anderson, 2005).

Development of the space industry has been constrained by entrenched thinking, but the monopoly of large government space agencies is becoming increasingly untenable. Indeed, the market has come to recognise that clear opportunities to expand space travel to the wider public will exist in the future. An actively growing space tourism movement can now be found, benefitting in the last decade from governmental initiatives such as NASA's Space Launch to prepare the technology for a reusable launch vehicle. Numerous companies competed for the $10 million XPRIZE, awarded in 2004 to SpaceShipOne, the first NGO to demonstrate a reusable and piloted suborbital vehicle capable of carrying three people up to 100 km (Ansari XPRIZE, 2018).

Space tourism is forecast to become a lucrative business, with a significant potential for expansion (Global Information, 2018). Swiss finance firm UBS analyses space tourism industry to be worth $4 billion by 2030 (UBS, 2021). Plans by the US to reform their oversight of space development and regulations for commercial space flight launch and re-entry operations are also being developed, possibly motivated by the fact that the country may soon be eclipsed by China in space exploration. In June 2019, NASA declared a directive that further opens the International Space Station for commercialisation and space tourism with the goal of developing a robust economy in low-Earth orbit (NASA, 2019).

NASA's (1998) feasibility study presented some positive outcomes of space tourism, acknowledging its revolutionary political, social and economic potential. One of the main challenges in the development of space tourism has been finding economic funding. In the last decade, Silicon Valley-based private sector billionaires such as Elon Musk (Space X), Jeff Bezos (Blue Origin), as well as Richard Branson (Virgin Galactic) in the UK**,** entered the space race by establishing their own private space tourism companies that target the public. However, critics have questioned the synthesis of influential private sector commerce and publicly-

funded infrastructure, as it raises concerns regarding policy and the concentration of power (Tett, 2018).

The next section focuses on the potential for commercial space tourism to become a key aspect of the contemporary adventure tourism industry, and – with reference to different futuristic theories and interviews – analyses some important issues regarding the industry's attempts to become sustainable in the future.

Futures Mapping as Future's Methodology

International tourism research has traditionally reflected on previous tourism research in order to envision its future. The forecasting of new travel phenomena has tended to be based on the history, current trends and perspectives of researchers (Ryan, 2018). Futurist thinking helps anticipate the future, how changes occur and how they are predicted. In the beginning, when a change emerges, few people know of its novelty. Eventually, the novelty affects the everyday lives of most people and everyone is familiar with it. At its foundation, anticipating a change involves stable factors, megatrends, trends, weak signals and wild cards (Hiltunen, 2013).

Future road-mapping represents an extended look at the future, composed of the collective knowledge and imagination of visionaries, and can be used as a planning tool to predict developments and decision-making (Matos & Afsarmanesh, 2004). One of the current megatrends in the tourism industry is sustainability (Mojic & Susic, 2014). Becken (2015), for example, suggests that environmental assessments should always be undertaken prior to any development of tourism activities and projects. Given that tourism was originally framed as co-existing with its environment, research concentrating on new resources and survival

planning is capable of facilitating new, environmentally based discussions in space tourism discourse.

There are existing futures research road-mapping frames such as 'Futures Map', which handles road-mapping as one of the aspects of futures mapping (Kuusi *et al.*, 2015:4). In the Futures Map (see Figure 5.1), the scenario is a specified path connecting the present state to at least one picture of the future. The map identifies possible futures with a 'planning horizon' and a 'mapping horizon'. The Futures Map has different quality criteria to improve its pragmatic validity. Criteria 1 and 2 identify most relevant or important possible futures, criteria 3 and 4 cover casually-relevant facts by their identified futures, and criteria 5 and 6 concentrate on the needs of key customers (Kuusi *et al.*, 2015: 6).

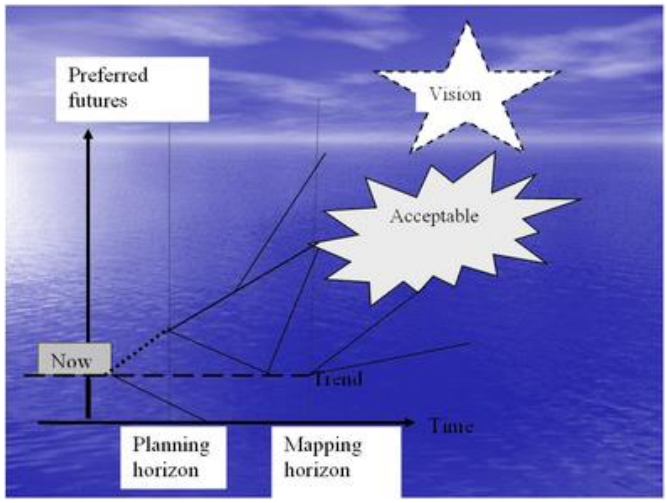

Figure 5.1 Futures Map (Kuusi *et al.*, 2015)

For this chapter, a new roadmap for sustainable space tourism was constructed by the methods of grounded theory (Glaser & Strauss, 1967). The data were attained via five in-depth, 45-minute interviews. The participants included senior researchers in futures fields (Interview 1) and space technology (Interview 2); a Finnish Green Party politician (Interview 3): a space tourism entrepreneur whose current focus is virtual reality (Interview 4) and an internationally renowned space engineering professor (Interview 5). The interviews were conducted in Helsinki, because Finland become a new space nation in 2017. The participants' visions of the future of space tourism were treated anonymously. The number of interviews was decided to be comprehensive after similar observations began to occur.

The interview questions were developed regarding understandings of reflective practice and attention to ethics and values, which have stimulated critical theoretical developments, especially in sustainable tourism planning. The questions could be placed under three themed categories: space tourism, sustainability and the future. The interviews were transcribed word-for-word, to ensure reliability of the data for analysis.

The first part of the analysis, open coding, involved coding the interview line-by-line. The aim was to compare similarities across the respondents' visions for the future. The emerging concepts then were moved from describing such Future Visioneering to broader concepts such as Searching for Knowledge. A tentative core variable for these dimensions was named Making Space Human.

A delimitation of categories was achieved through selective coding; the primary categories related in some ways to the core variable. The compartment of concepts and categories established the patterns named by eight categories. In the last stage of the analysis, the sorting of analytical memos took place and the linkages between the variables and the eight

categories were identified. Following the grounded theory principles, the findings were reflected with the literature.

Based on the data analyses, eight themed categories were formed. The categories were named: space legislation, economic impacts, alternative energy sources, circular economy, contemporary trends, health space tourism, space colonies, and virtual travel and robotisation. All these categories were linked to the core variable, Making Space Human, by describing some current elements of the human society that are considered to be important also in the space environment.

The findings were placed on the Futures Map (Kuusi *et al.*, 2015). The 'planning horizon' reflects historical trends and aims for more enhanced future and 'the mapping horizon' opens more visions for a longer time scale. The themes placed under planning horizon were economic impacts, legislation, alternative energy sources and circular economy (named as group 1). These represented the historical or current ways of living of the developed world. Contemporary trends, health space tourism, space colonies and virtual travel and robotisation (named as group 2) are acceptable trends or exist in visioneering minds so they were set under the mapping horizon. Planning horizon was established as a subcategory for Searching for Knowledge and mapping horizon for Future Visioneering, both under the umbrella core Making Space Human.

Planning Horizon

Economic impacts

Duval and Hall (2015: 451) claim that a concern exists regarding the planning and policy implementation of future space tourism, especially with respect to: (a) the impacts of future agreements developed by politicians and the private sector, and (b) the importance of mutual accords geared toward leaving some parts of space completely untouched by tourism.

The data supported this statement and also highlighted the significance of economic modelling and global legislation.

The new era in space exploration has brought about a completely new commercial market sector. In the past, considerable expertise, scientific research and economic capital was required to become a space nation, without any guarantee of direct rewards.

> Today a complete rocket can be purchased privately for a cost of approximately $100 million from the previous national owner. Private launch providers selling space inside such rockets – and customers, including small satellite companies, can already be found. The cost of the space inside a rocket is shared; hence, even academic institutions with relatively small budgets have been able to test small measuring satellites in a real space environment. (Interview 2)

For example, Finland became a space nation in 2017 after Aalto 1 was launched to measure electrons hitting the upper atmosphere (Aalto University, 2018).

> Numerous possibilities exist to use space economically. For example, it would be more efficient to run solar panels in space than on the ground because UV light energy is more abundant in space. Plans have already been devised to locate solar panel stations in orbit and beam down energy using microwaves. (Interview 5)

However, unsolved issues with asteroids and other debris have hitherto prevented such activity from taking place. Aside from space tourists simply experiencing the space environment, other

actors than the tourism industry may initiate mass space travel in the future. For instance, asteroids are full of precious metals such as diamonds and platinum, and thus space travel may become work related (Ross, 2002).

> The development of synergies or by-products could be facilitated, including adventure products and services that do not yet exist. Indeed, space tourism could pioneer the creation of such services, which may be provided by other industries in the future. (Interview 4)

At present, considerable foresight and capital are required to forecast the economic potential of space tourism. With the assistance of governmental planning, companies should mutually plan, invest and share operational facilities to recuse the economic costs involved. Eventually, the expense will help determine whether space tourism can become a mass product or whether it will be practised only by the elite.

Space legislation

As space becomes commercialised, mutual global legislation will be required to supervise future business and trading. The Outer Space Treaty (1967) corresponds to maritime law and constitutes the only legislation in existence for common space responsibilities. Otherwise, space is equivalent to the former 'Wild West' with a 'first come first own' attitude and approach to rights.

> For example, a future hotel or mining colony located on the Moon will raise questions as to whether the Moon should be regarded as a separate state as well as which country's (or countries') legislation would be legally binding there. If the development of a mutual global space law proves too challenging, space should be treated similarly to Antarctica, which is divided into sectors belonging to different nations. (Interview 2)

Space is no longer only entered by countries with space programmes, but also various private companies working as subcontractors or even commercial contractors such as satellite operators. The military has diverse interests in space and is constantly developing technologies from which corporate space tourism companies may benefit (Insinna, 2018). However, there is currently a risk that a 'no mans' land' attitude will arise, with the potential to cause ownership wars and jeopardise such synergistic operations.

> Once the private space tourism industry has developed infrastructure that can run independently, government sponsorship and funding is likely to cease. Without the support of a governmental legislative framework and preventative space law, private companies will face new problems related to owning and immaterial rights. (Interview 1)

In addition to ownership, a further major legislative concern comprises responsibility for space debris. Even a small particle of debris from a former satellite or similar may prevent a safe landing back to earth. This type of safety threat could seriously harm the entire space tourism industry.

> Some existing technologies may help remove debris from orbit without requiring a propellant. An electric sail (1–2 km in length) can be attached to a small satellite and, once the decision is taken for it to leave orbit, the wire is unspooled from the satellite and the solar wind pushes it into outer space. (Interview 2)

Preventative space legislation should make such debris collectors compulsory in the future to ensure safe access to space and protection of the space environment in general.

Alternative energy sources

According to Fawkes (2006), space tourism and sustainable development are connected at 'resources and survival' levels. It is today a major business risk not to include sustainability in a business model; for example, the aviation industry already practises voluntary carbon offsets paid both by the industry and the customer (Broderick, 2009). Space tourism will contribute to higher levels of emissions, although research into alternative fuels to lower their impact, is ongoing (Carter *et al.*, 2015).

Purposeful integration with the disciplines of transportation and engineering is required in order to develop new renewable energy technologies and efficient transport systems that are free of fossil fuels (Becken, 2015). In particular, the data highlighted alternative energy sources and the importance of the circular economy.

The development of space tourism works against sustainability trends and international climate agreements such as in Paris in 2015, which sought strong actions to reduce global emissions. The main disadvantage that initial space tourism is forecast as having an increased

atmospheric pollution. However, with the assistance of new technological innovations and energy solutions, the levels of such pollution may be limited.

> Many existing space rockets use toxic propellants and enormous amounts of energy in burning kerosene and oxygen. The latest technology is already able to produce rockets that only burn hydrogen and oxygen, rendering them more environmentally friendly. However, energy is also wasted in the production process of the rockets, enhancing the creation of greenhouse gases. The next century is likely to see innovations such as nuclear-powered ships, solar wind sails and space elevators, which may, over times reduce reliance on rockets. (Interview 4)

> If liquid hydrogen and oxygen propellants are used as the future energy source of space rockets, the exhaust product will comprise non-toxic water vapour rather than toxic fumes. Space tourism could become the first large-scale commercial use of hydrogen, breaking the familiarity barrier and advancing its use in aeroplanes and other ground transport systems. (Interview 5)

Entering space requires considerable energy, which ultimately has negative consequences for the climate and environment. At first, space tourism should not have a destructive impact on the earth's environment. New, innovative energy sources and production knowledge are required, as advanced technology is the key to sustainable future developments. A sustainable, lower orbit economy must be created for private companies to operate and utilise these possibilities.

Circular economy

Sustainability issues must be the core of environmental planning, involving everything from the oceans and land to atmosphere and space. The sustainable way of thinking will become increasingly common in space tourism, not simply owing to ethical requirements, but also because every kilogram brought into space costs a lot of money. The technologies developed for space travel and space tourism might also assist in day-to-day living on earth.

> NASA has already developed a number of products for astronauts, such as in food production, which are now used by millions of people. Once space becomes more accessible, contemporary resource wastefulness will no longer be possible, as everything is likely to be created in a recyclable format. (Interview 5)

Education is required for sustainable and resourceful practices, including in space. However, even the dream of the space circular economy may advance sustainable thinking on earth. It highlights concerns regarding the daily living environment and ensuring the protection of the environment, so there will be no need to escape from the planet in order to save humanity.

New circular economy ideas will also emerge after having landed on the moon, given that it offers substantial beneficial metals such as platinum on its surface.

> Everyday items, historically made of aluminium, could eventually be replaced by platinum. With the assistance of the latest technology, it may be possible to transport some materials from space rather than manufacture them on earth. However, if asteroids are brought too close to earth, there will be a risk of collision, destroying part of the

> planet. The particles transported from asteroids or other planets may also contain unknown bacteria that are dangerous to humans. (Interview 2)
>
> A global pollution compensation or taxation scheme would ensure greater social and environmental sustainability. (Interview 1)

Energy-sorting quality measurements, and even sustainable certifications, will also be required for future space tourism operators. Such certifications may facilitate greater feelings of safety, as companies will be deemed as taking environmental matters seriously.

Mapping Horizon

Contemporary trends

Current trends in tourism overtly promote sustainability and its transformation into transmodern eco-luxury. Space tourism represents a new era of innovative start-ups, electric cars and the 'show-off styled' experience of sharing via social media platforms. In particular, the findings highlight consumer trends and health space tourism.

The world of experience represents the new luxury, as consumers seek to experience something that is hard to access but not necessarily owned. New trends can be identified in entrepreneurship, such as collaborative consumption-based virtual platforms like Airbnb and Uber.

> At present, it is difficult to forecast how far these can expand without jeopardising feelings of collective security and trust inside a society. If the sharing economy

> becomes an enduring global megatrend, the private space tourism sector will benefit, if not in virtual existence, then at least in shared physical hubs between private sector parties, the military or space nations. (Interview 1)

> The space environment raises questions about how to eat properly and enjoy music and other sensory cultural activities, whilst remaining in a non-gravity-based environment. (Interview 4)

Providing food culture and other high cultural activities such as music concerts in the same format as on earth will be difficult in space. For example, if Mars were to become inhabited, new solutions to producing tasty culinary experiences or perhaps even making new culinary discoveries that only the space environment could authentically offer will be required.

Health space tourism

In the preferred future, the current trends may become acceptable or remain as visions (Kuusi *et al*., 2015: 4). The time horizon may vary but, eventually, an activity previously existing only as a vision may become a reality. This may be because of technological developments or other changes in the society.

> Space is an unpleasant environment for the human body, and so pioneer space tourists will not travel to relax but to perform. Astronauts train for many years, and the handful of wealthy tourists who have already visited space spend numerous months in physical training before travelling. Mass space tourists will not have such time. The physical

> consequences for those without previous physical training remain unknown. (Interview 5)
>
> Some bed-rest studies simulating blood flow patterns in zero gravity with regard to cardiovascular diseases have demonstrated that it might be beneficial to spend time in zero gravity for an extended period of time. Blood pressure drops to zero and the heart can pump more easily – of benefit for people with heart diseases. The almost complete absence of gravity pushing on the intervertebral discs in the spine would also be beneficial for people with back problems, as these discs would be allowed to regenerate. (Interview 2)

Even though there is some knowledge of how a human body performs in space conditions, the impacts and long-term consequences for mass tourists or people travelling to Mars yet remains unknown. The space environment could become a new treatment and health tourism option for people with health issues, especially once transportation becomes more appropriate for them. Eventually, if space becomes part of humans living area, the evolution may start changing the human structure to a condition more suitable for space habitation.

Space colonies

Space is a challenging environment for a human body and hence for it to become inhabited. A large number of new technologically advanced innovations will be required. Certainly, the South and North Poles were conquered just over a century ago, yet remain largely inhabited – even though they have the same gravity and greater potential to transport goods such as food.

> In order to ensure human survival, such as in the case of a global catastrophe like a comet impact, it would be sensible and advantageous to begin developing space colonies. This will require advanced technological innovations, although some already exist in some capacity. The first permanent settlements will most likely be located on the Moon or Mars. Instead of just admiring the curvature of Earth, future space tourists may also travel to visit friends and relatives living in such settlements. (Interview 4)

> The earliest time span estimated for initial settlements on the Moon is 20 years. The development is likely to commence with the erection of greenhouses to ensure food production and to test survival-related technologies. Within the next 100 years, self-sufficient colonies will exist on the moon. Whether colonies will become viable on Mars depends on factors that are currently unknown, such as the impacts of long-term exposure to cosmic radiation while travelling. (Interview 2)

Following an initial period of excitement, space tourism is likely to experience a sharp decline owing to its unpleasant conditions for humans. The industry will advance if space hotels or stations providing gravity are developed, and if permanent colonies on the surface of the moon or Mars support and necessitate regular travel.

Virtual travel and robotisation

Sci-Fi franchises such as *Star Trek* and *Star Wars* have provided fascinating and addictive stories about space travel for generations. Their large audiences are clearly interested in the notion of space; accordingly, the first space tourism products will be rooted in people's curiosity.

> Virtual travel will represent the most likely means of 'visiting' space in the future, given that this environment is exceptionally hostile to humans. Although space tourism is physical, it can also be facilitated by nanorobots or avatars. Indeed, nanorobots may advance sci-fi storylines before humans are physically capable of such travel. (Interview 3)
>
> Robots and artificial intelligence (AI) could be used to help develop future spaceships from the materials of asteroids. (Interview 2)
>
> 'Second Life' platform studies have already demonstrated that, even though people are afforded the freedom to use limitless imagination in virtual reality, they tend to carefully copy real-life structures. (Interview 1)

People are interested in the idea of space, and the first space tourism products may be based on this curiosity factor. However, the desire to feel at home is likely to remain also in the future and hence influencing both the creation of virtual space tourism experience and designing for future space colonies.

Discussion

This chapter illustrates the futures research traditions for the development of a complex field with various interacting causal processes (Kuusi *et al*., 2015: Kahn & Wiener, 1967). However, the academic discourse on sustainable space tourism is still taking its first steps; indeed, there are only few existing investigations, against which to consider the current findings.

Duval and Hall (2015) have offered some environmentally-informed points for space tourism as part of a sustainable tourism research agenda and Toivonen (2017) has introduced a 'Sustainable Future Planning Framework', suggesting that sustainability, planning, weak signals and future scenarios act in synergy with one another to formulate the future aspects of space tourism. The findings of the current chapter can be especially linked under the 'Sustainable Future Planning Framework' and forming new additional categories under that core conceptual structure. Economic impacts and legislation can be placed under 'planning'; alternative energy sources and circular economy under 'sustainability', contemporary trends and health space tourism under 'weak signals' and space colonies and virtual travel and robotisation under 'future scenarios' (Toivonen, 2017: 27).

Within the notion of grounded theory, eight categories generated from the data were divided in Group 1 or Group 2 and placed on the Futures Map, in the section of planning horizon or mapping horizon. Economic impacts, legislation, alternative energy sources and circular economy (Group 1) placed on the map's 'planning horizon', shared similarity in representing the current ways of living of the developed world. The Group 1 findings especially highlighted the gathering of facts and new knowledge based on the existing traditions; thus, they validated the Futures Maps criteria 3 and 4 (for facts). This kind of gathered knowledge may also prove useful to new commercial space tourism companies, validating the criteria 5 and 6 (for customer needs).

Contemporary trends, health space tourism, space colonies and virtual travel and robotisation (Group 2) shared a similarity in being acceptable trends or possible futures visionary ones; they could thus be placed on the mapping horizon. Group 2, similarly, identified preferred futures developments by pointing out alternative futures for the human race to exist, even though the earth's living conditions may become too challenging. The findings validated

criteria 1 and 2 (for possible futures) by pointing out what may be relevant from the point of view of the vision.

Group 1 was directly linked under the subcategory Searching for Knowledge and Group 2 under Future Visioneering. Both subcategories linked to the core variable Making Space Human. Altogether, the findings created a scenario funnel, starting from the 'now' point and defining the range of scenario paths for the future. Making Space Human is already inside the current time horizon, with satellites assisting the living on earth and the international space station providing long-term shelter to the astronauts. Depending on the future technological innovations and legislative allowances, the time horizon for the wildest visioneering could be shorter than yet imagined.

Concluding Arguments

Space tourism has recently turned from science fiction into reality. The original excitement created by Hollywood productions was followed by decades of passivity, until the 2000s saw a number of technological innovations that enabled the space tourism industry to make rapid steps towards the first commercial space flights. Paradoxically, consumer trends in travel simultaneously shifted to more sustainable forms of practice. In order to survive, the space tourism industry needs to respond to this megatrend as well as follow increasingly stringent international climate change agreements. Appropriate regulations to encourage businesses to use a combination of different advanced technologies, so they can avoid having destructive environmental impacts, are required. For the most optimistic or imaginative, space tourism could become a distant 'nature tourism', as seeing the earth from a distance might enhance people's desire to protect the only planet that can offer suitable living conditions for humans.

This chapter has introduced space tourism as a future component of the tourism industry and has presented a future roadmap discussion of some key aspects of sustainable space tourism. Through analysis of interviews and grounded theory, it has been demonstrated that economic impacts, space legislation, alternative energy sources, circular economy, contemporary trends, health space tourism, space colonies, virtual travel and robotisation could constitute some of the sustainable areas for the industry's development.

Current weak signals suggest that travelling to near space is likely to become a trend in the future, especially if space tourism becomes cost-effective for the masses and conscientiously adheres to environmental and safety requirements. The space tourism industry currently appears to be aiming to reach a similar state as early aviation. Ultimately, a customer may simply purchase a ticket at a launching site and shoot up to space to visit his/her friends living in a moon settlement.

Space tourism could become the first large-scale commercial user of hydrogen, influencing its future use in aeroplanes and other ground transportation systems. The breaking of the familiarity barrier may even enhance the current development of environmental knowledge and protection. The sustainability requirements in space are demanding and must be solved on the surface of the earth before being practised in a space environment. The focus should be on sustainable science, achieved through understanding the psychology of new types of tourism behaviour as well as global environmental agreements.

References

Aalto University (2018) Aalto-1 launch, 21 May 2018. See http://www.aalto.fi/spacecraft/aalto-1-launch (accessed 13 September 2018).

Anderson, E. (2005) *Space Tourist's Handbook*. San Francisco: Chronicle Books.

Ansari XPRIZE (2018) A $10 million competition to usher in a new era of private space travel. See https://ansari.xprize.org (accessed 20 October 2018).

Ashford, D. (2002) *Spaceflight Revolution*. London: Imperial College Press.

Becken, S. (2015) *Tourism and Oil: Preparing for the Challenge*. Bristol: Channel View.

Broderick, J. (2009) Voluntary carbon offsets: a contribution to sustainable tourism? In S. Gössling, C.M. Hall and D. Weaver (eds) *Sustainable Tourism Futures: Perspectives on Systems, Restructuring and Innovations* (pp. 169–199). New York: Routledge.

Blue Origin (2021) Blue Origin safely launches four commercial astronauts to space and back. See https://www.blueorigin.com/news/first-human-flight-updates (accessed 17 August 2021).

Carter, C., Garrod, B. and Low, T. (2015) *The Encyclopaedia of Sustainable Tourism*. New York: CAB International.

Duval, T. and Hall, C.M. (2015) Sustainable space tourism: new destinations, new challenges. In C.M. Hall and S. Gössling (eds) *Routledge Handbook of Tourism and Sustainability* (pp. 450–460). New York: Routledge.

Federation Aeronautique Internationale (2018) Space records. See https://www.fai.org/sport/space (accessed 10 December 2018).

Fawkes, S. (2006) Space tourism and sustainable development. *BIS European Developments in Space Tourism Conference*. 29 November. See https://www.slideshare.net/guidofawkes/space-tourism-and-sustainable-development-presentation (accessed 18 May 2020).

Glaser, B.G. and Strauss, A. (1967) *The Discovery of Grounded Theory: Strategies of Qualitative Research*. Chicago: Aldine.

Global Information (2018) Global space tourism market size, status and forecast 2025. Market Research Report. See https://giiresearch.com (accessed 12 December 2018).

Hiltunen, E. (2013) *Foresight and Innovation: How Companies are Coping with the Future*. Basingstoke: Palgrave Macmillan.

Insinna, V. (2018) Trump's new space force to reside under Department of the Air Force. DefenceNews. See http://defencenews.com/space/2018/12/20 (accessed 20 December 2018).

Kahn, H. and Wiener. A. (1967) *The Year 2000 A Framework of Speculation on the Next Thirty-Three Years.* New York: Macmillan.

Kuusi, O., Cuhls, K. and Steinmuller, K. (2015) The futures map and its quality criteria. *European Journal of Futures Research* 3 (22), 1–14.

Matos, L. and Afsarmanesh, H. (2004) *In Collaborative Network Organizations – A Research Agenda for Emerging Business models.* Alphenaan den Rijn: Kluwer Academic Publishers.

Mojic J. and Susic, V. (2014) Planning models of sustainable tourism development destination. *Proceedings of International Scientific Conference. The Final and Real*

Economy. Towards Sustainable Growth. Faculty of Economics, University of Nis, 17 October.

NASA (1998) General public space travel and tourism. In D. O'Neil, I. Bekey, J. Mankins, T.F. Rogers and E.W. Stallmer (eds) *NASA/STA Joint Study*. NP-1998-03-11-MSFC, March.

NASA (2019) Space tourism and commercialization. See https://www.nasa.gov/johnson/HWHAP/space-tourism-and-commercialization (accessed 3 August 2019).

Ross, S. (2002) *Near-earth Asteroid Mining. Space Industry Report*. US: Virginia Polytechnic Institute and State University.

Ryan, C. (2018) Future trends in tourism research – Looking back to look forward. The future of tourism management perspectives. *Tourism Management Perspectives* 25, 196–199.

SpaceX (2018) Starman in space. See https://www.spacex.com/falconheavy (accessed 20 August 2018).

Tett, G. (2018) America unleashes billionaires to boost the space race. *Financial Times*, 1 June 2018.

The Outer Space Treaty (1967) Treaty on principles governing the activities of states in the exploration and use of outer space. See http://www.state.gov/t/isn/5181.htm (accessed 15 December 2018).

Toivonen, A. (2017) Sustainable planning for space tourism. *Matkailututkimus* 13 (1–2), 21–34.

UBS (2021) Future of space tourism: Lifting off? Or has Covid-19 stunted adoption. See https://www.ubs.com/global/en/investment-bank/in-focus/2021/space-tourism.html (accessed 18 August 2021).

Virgin Galactic (2018) Richard Branson welcomes astronauts' home from Virgin Galactic historic first space flight. See https://www.virgingalactic.com/articles/first-space-flight (accessed 20 December 2018).

Wall, M. (2011) First space tourist: How a US millionaire bought a ticket to orbit. See https://www.space.com (accessed 16 June 2018).