Annette Toivonen

THE EMERGENCE OF NEW SPACE:

A GROUNDED THEORY STUDY OF ENHANCING SUSTAINABILITY IN SPACE TOURISM FROM THE VIEW OF FINLAND

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To my mother Inkeri Toivonen,
and to my father Mauri Toivonen beyond the stars

Abstract

The excitement of public space exploration was for decades captured only in Hollywood science fiction productions, until the 2000s saw the emergence of the New Space industry, combining the activities of private space companies and governmental actors. As a sector of New Space, the commercial space tourism industry aims to satisfy the postmodern traveller's desire for new experiences, and is forecast to develop as a multi-billion tourism sector in the future. The emergent New Space tourism industry has three major operators, SpaceX, Virgin Galactic and Blue Origin, all from private and influential backgrounds and all originally benefiting from United States governmental initiatives, such as that to improve technology for a reusable launch vehicle. The first operational New Space tourism flights took place in 2021, however, the technological revolution has simultaneously created new possibilities for travellers to join various travel adventures virtually, thus democratising the space experience for the wider public, but also limited the physical experience in the pioneering stage to the wealthy elite.

The global megatrend of sustainability was furthered by the concerns of the Intergovernmental Panel on Climate Change report (2018) regarding the future effects of climate change on Earth. The growth of tourism has led to a significant increase in its environmental impact which can no longer be ignored, and thus the need for more sustainable future scenario planning in the New Space industry, including tourism. Apart from being an energy- and emissions-related driver of new technological developments, sustainable development has also brought responsibility and ethics to global tourism operations, and influenced the creation of global regulations. Rapidly advancing technological developments also contributed to Finland becoming a New Space industry nation in 2017. One of the objectives of Finland´s space strategy is to provide an attractive and sustainably-approached global environment for space-related business by 2025, and the country´s recently established space legislation advocates such future points of action.

This PhD thesis expands the academic research on space tourism by creating alternative future scenarios to enhance elements of sustainability in the New Space tourism industry. The focus was on investigating how elements of sustainability could be included in development planning for New Space tourism, and identifying concepts relating to the contexts of space tourism and sustainability that could be highlighted through futures research, and how space tourism and sustainability is currently envisioned by the public and professionals in the field in Finland. The empirical research was conducted through in-depth interviews, a public survey

and a professional Delphi study. The analysis, using futures methods to interpret weak signals, following the principles of grounded theory, and supplemented by the Delphi method and comparative content analysis, was collated into two peer-reviewed articles and a book chapter, written between 2017-2021. The findings demonstrate that sustainability in New Space tourism industry could be supported through three alternative future scenarios: through the planning of global space regulations, through improving global fairness, and through the implementation of virtual and technological innovations.

Keywords: space tourism, New Space, virtual tourism, sustainable development planning, future scenario, space ethics, Delphi method

Tiivistelmä

Avaruusmatkailu on vuosikymmenien aikana tullut suurelle yleisölle tutuksi etenkin Hollywood-lähtöisten fantasiamaailmojen kautta. Askel kohti operatiivista toimintaa otettiin kuitenkin vasta vuosituhannen vaihtumisen jälkeen, jolloin uusi kaupallinen avaruusliiketoimintasektori, ”New Space”, kehittyi tuoden uudet yksityiset avaruusyritykset toimijoiksi perinteisten avaruusvaltioiden rinnalle. Kaupallisen avaruusturismin tavoitteena on luoda postmodernille matkailijalle uusia elämyksiä ja alan ennustetaan tuottavan tulevaisuudessa useiden miljardien liikevaihdon. Virgin Galactic, SpaceX ja Blue Origin ovat avaruusmatkailuliiketoiminnan tunnetuimmat, yksityisen rahoituspohjan omaavat yritykset, jotka toteuttivat ensimmäiset avaruusturismilentonsa vuonna 2021. Yritykset myös hyödynsivät toimintansa alkuvaiheessa Yhdysvaltojen hallituksen hankerahoituksia uudelleenkäytettävien kantorakettien tekniikan kehittämiseksi, edistäen massoille suunnattavan avaruusturismin kehitystä. Teknologian nopea kehitys on luonut uusia mahdollisuuksia kokea matkailua myös virtuaalimaailmojen kautta, mitä voisi tulevaisuudessa hyödyntää myös avaruuselämyskontekstissa - etenkin kun fyysinen avaruusturismi rajautuu alussa vain varakkaimpiin matkailijoihin.

Kaupallinen avaruusmatkailu on alkamassa aikakautena, jolloin kestävän kehityksen globaali megatrendi vahvistui synkkäennusteisen kansainvälisen ilmastoraportin (IPCC, 2018) myötä. Matkailuteollisuuden kasvu on lisännyt myös negatiivisia ympäristövaikutuksia, minkä vuoksi uuden New Space matkailuliiketoiminnan tulevaisuusskenaariot tulisi luoda kestävän kehityksen linjauksia mukaileviksi. Samalla kun eri teollisuusalat toteuttavat yhä ympäristöystävällisimpiä energia-ja päästöratkaisuja, myös yhteiskunnallisen yritysvastuullisuuden sekä lainsäädännön merkitykset ovat korostuneet entisestään. Piensatelliittiteknologian kehitys ja kaupallisen avaruusliiketoiminnan edistys mahdollisti Suomen liittymisen perinteisten avaruusvaltioiden joukkoon vuonna 2017. Suomen avaruusstrategian yksi tavoitteista on luoda kilpailukykyinen ympäristö kaupalliselle avaruusliiketoiminnalle vuoteen 2025 mennessä, painottaen kansallisessa avaruuslaissa esiintuotuja ja kestävää kehitystä mukailevia toimintamalleja.

Tämä väitöskirja laajentaa avaruusmatkailukontekstin akateemista tutkimusta luomalla vaihtoehtoisia skenaarioita kestävän kehityksen vahvistamiseksi uudessa New Space matkailuliiketoiminnassa. Tutkimuksen tavoitteina oli selvittää, miten kestävää kehitystä voidaan sisällyttää New Space matkailuliiketoiminnan tulevaisuussuunnitteluun, tunnistaa avaruusmatkailun ja kestävän kehityksen

kontekseihin liittyviä käsitteitä, jotka korostuvat tulevaisuuden tutkimuksen avulla ja kartoittaa avaruusmatkailun ja kestävän kehityksen näkemyksiä suomalaisen väestön ja asiantuntijoiden keskuudessa. Empiirinen tutkimusaineisto koostui asiantuntijoiden syvähaastatteluista, yleisökyselystä sekä Delfoi asiantuntijapaneelista. Tulevaisuuden tutkimusta ja grounded theory- metodologiaa hyödyntäen, Delfoi-menetelmällä ja vertailevalla sisällönanalyysilla täydennettyinä, julkaistiin tutkimustuloksista kaksi vertaisarvioitua tiedeartikkelia sekä vertaisarvioitu kirjaluku vuosien 2017-2021 aikana. Tutkimustulokset osoittivat, että kestävää kehitystä New Space matkailuliiketoiminnassa voidaan tukea kolmessa vaihtoehtoisessa tulevaisuusskenaariossa: globaalin avaruuslainsäädännön edistämisen kautta, globaalin oikeudenmukaisuuden huomioimisen kautta sekä virtuaalisten ja teknisten innovaatioiden käyttöönoton kautta.

Avainsanat: avaruusturismi, kaupallinen avaruusliiketoiminta, virtuaalimatkailu, kestävä kehitys, skenaario, avaruusetiikka, Delfoi-menetelmä

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List of acronyms and abbreviations

DWEP	Western Environmental Paradigm
ESA	European Space Agency
FAI	Federation Aeronautique Internationale
IATA	International Transport Association
IPCC	International Panel on Climate Change
ISS	International Space Station
NASA	National Aeronautics and Space Administration
SITRA	Finnish Innovation Fund
STEEP	Social, Technological, Environmental, Economic and Political
STEM	Science, Technology, Engineering and Mathematics
TALC	Tourism Area Life Cycle
TEM	Ministry of Economic Affairs and Employment in Finland
UNWTO	World Tourism Organization

List of original articles

This thesis is based on the following peer reviewed articles and a book chapter, which are referred to throughout the text by their alphabetical letters, as follows:

A
Toivonen, A. (2017). Sustainable planning for space tourism. *Matkailututkimus (Finnish Journal of Tourism Research)*, *13*(1-2), 21-34.

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.

C
Toivonen, A. (2020). Sustainability dimensions in space tourism – the case of Finland. *Journal of Sustainable Tourism*, DOI: 10.1080/09669582.2020.1783276

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Author contributions:
All articles and the book chapter were developed and written solely by the author.

Table of contents

1. The era of human space travel

There have been many visions of what space travel and tourism would entail since the 1960s space race, and the kind of conceptual designs of passenger space vehicles and infrastructure that would be available. Those demonstrated a potential demand, especially in research connected to US National Aeronautics and Space Administration (NASA), at least based on people's desires to experience the Hollywood movie-styled setting of space. This chapter firstly introduces the background to human space exploration. This is followed by the definitions of the New space industry and the concept of space tourism, as well as Finland´s role in the current New Space economy. The academic literature on space tourism is then explored, followed by the aims and scope of this doctoral thesis.

1.1 Timeline of space exploration

The first steps on the path to suborbital passenger spaceflight were taken during the Second World war, when Germany´s rocket programme proved the most significant transformative force for developing space technology (Launius, 2019; Toivonen, 2020, p.2) "*Do you realize what we accomplished today? Today the spaceship was born. This third day of October 1942 is the first new era in transportation, that of space travel*" (Dornberger, 1942). The United States space programme emerged in large part because conquering space represented the ultimate symbolic power during the Cold War, when the United States and the Soviet Union were fearful of each other's capabilities and intentions (Launius, 2019; Toivonen, 2020, p.3). The Soviet Union space programme declared a victory by successfully launching the first human, Yuri Gagarin, into space on 12 April 1961. His flight orbiting the Earth on the Soviet Union's Vostok spacecraft lasted 108 minutes, and after returning safely to Earth he became a cultural hero in the Soviet Union (Redd, 2018). This victory spurred the United States to take the attitude of "saving" the planet from "evil intentions". President Kennedy famously declared in his speech in May 1961, *"If we are to win the battle that is going on around the world between freedom and tyranny, if we are to win the battle for men's minds...I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to Earth"* (Toivonen, 2020, p.3).

The national hero attitude towards the Soviet Union's first cosmonaut was also reflected in early US astronauts, and helped NASA to create bold future space plans

with large budgets and start the race to the Moon (Ashford, 2002; Toivonen, 2020, p.3). On 20 July 1969, Neil Armstrong and Edwin 'Buzz' Aldrin became the first humans to set foot on the Moon's surface, with Armstrong's (1969) world-famous words *"that´s one small step for a man, one giant leap for mankind"* leading the way forward for future human endeavours in space. The American public, however, started to question the value and cost of undertaking further human expeditions to the Moon at a time when society was in crisis over the Vietnam War, race relations and urban problems (Launius, 2019). The last US Apollo mission was completed in 1972, resulting in the world-famous "Blue Marble" picture of planet Earth that later became a symbol of environmental movements (Fawkes, 2007; Toivonen, 2020, p.3).

The 1960s space race between the United States and the Soviet Union also provided a great opportunity to start forming and transforming space transportation for public use, but this prospect was completely overlooked, with consequences that still have an impact today (Cole, 2015). Fully reusable launchers were already considered feasible, and were the next logical step in the 1960s, but were not advanced for a number of reasons, primarily short term vested interests, budget pressures and the political environment creating a lack of desire to pursue and further advance such projects (Ashford, 2002; Toivonen, 2020, p.4). During the Cold War, rocket development was dominated by the competition between the USA and the Soviet Union, which led to the production of tens of thousands of long-range missiles, resulting in a more than half-a-century's delay in developing passenger space travel. In this light, the rockets used to launch satellites today, rather than being considered "futuristic", could reasonably be described as "obsolescent", as they could have been replaced by reusable launch vehicles several decades ago if policymakers had so chosen (Cole, 2015). For example, satellites were launched using ballistic missiles, or similar, which have the fundamental disadvantage that they cannot be reused, creating higher launch costs and more emissions into the environment (Ashford, 2002). The X-15 orbital space flight model based on ballistic missile technology (from 1968) was the only fully reusable vehicle to have been to space for many decades, was capable of reaching space, and had the ability to land like a conventional aeroplane, using wings for lift (Ashford, 2002; Toivonen, 2020, p.4). Although design teams in large aerospace companies carried out studies on reusable launch vehicles, it wasn't until 2018 that private sector New Space tourism operator SpaceX introduced its reusable space vehicle (SpaceX, 2019a).

In December 2017, US president Trump announced that the United States would send astronauts back to the Moon. Policy Directive 1 was signed to provide an integrated programme for a human return to the Moon followed by missions to Mars and beyond, which would be US-led with private sector partners such as SpaceX (NASA, 2019a). According to the new policy, NASA would "lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new

knowledge and opportunities" (NASA, 2019a; Toivonen, 2020, p.13). So far there has been some, although still limited, global space tourism market research, demonstrating that the public is interested in the idea of experiencing space tourism, and concluding that the commercialisation of space in terms of tourism could have many synergies, creating positive effects for business, as without space tourism the rapid development of reusable and reliable low-cost launch vehicles could not be guaranteed, and the goal of affordable access to space could not be achieved (Cole, 2015; Collins & Autino, 2010; Toivonen, 2020).

1.2 The emergence of New Space companies

Some of the elements of private space exploration (not including actual travel) can be traced back to the nineteenth century, when dozens of astronomical observatories were privately funded in America, with a relative economic significance comparable to modern robotic spacecraft (MacDonald, 2017). The first mentions of a "space industry" date back to the 1950s, when the *Nevada State Journal* explained that this industry would involve manufacturing goods and materials with space technology. The beginning of commercially operated space tourism was also forecast in professional journals in the same decade (Cornog, 1956; Dornberger, 1956), with the general assumption that ordinary people would also be able to afford space travel once it reached the same level of maturity as the airline industry, and that high-speed air transport would be available.

The term "New Space" emerged in the 1980s to refer to commercial space markets, with the intention of differentiating the developing businesses in the space industry from the traditional business structures and norms established during the first space race (Hay, Guthrie, Mullins, Gresham & Christensen, 2009). According to Ronci, Christensen, Ocasio-Christian, Backes, Lincoln-Hines and Paul (2020), a consistent terminology for New Space and commercial space is a key factor in state-to-state communication on space development; for being able to direct strategy in business, for a public understanding of the benefits of space technology, for achieving positive benefits from further commercial activities in space, and in establishing supportive and appropriate regulatory frameworks. Davidian (2020) suggests that the meaning of the word "commercial" in New Space can be perceived as "nongovernmental", applied to activities rather than firms, and including three criteria: being subject to "free" market forces, operating within a legal market place, and being driven by nongovernmental goals.

The characteristics of New Space include competition (due to technological improvements), an increase in private investment leading to reduced cost (thus increasing the profitability) and public demand for increasing data contributing to increased commercialisation (Ministry of Business, Innovation and Employment of

New Zealand, 2021). According to Hay et al. (2009), New Space companies have business attributes and technology development activities associated with their business models, such as flexible organisations, a willingness to take risks, and a focus on new technology solutions. New Space thus provides alternatives to, for example, the publicly funded NASA programme, allowing it to benefit from new innovative products, space services and processes that create added value for traditional space operations (Ministry of Business, Innovation and Employment of New Zealand, 2021).

During the global millennial dot.com boom, Silicon Valley-based private sector billionaires Elon Musk (SpaceX) and Jeff Bezos (Blue Origin), and British-based Richard Branson (Virgin Galactic), established a new technologically-driven private space race by introducing their own private space tourism companies that targeted the public (Wall, 2019; Toivonen, 2020). *Virgin Galactic´s* main aim is to provide commercial suborbital spaceflights for space tourists, suborbital launches for space science missions, and also to transform the current cost, safety and environmental impact of space launches, and to pioneer the next generation of reusable space vehicles (Virgin Galactic, 2020). The first space tourism flight was originally due in 2009, but there were delays on a number of occasions due to failures in test flight safety. The company has already sold tickets costing approximately 250,000 US dollars each for the estimated 90-minute flight to almost 700 passengers. In 2018 the company achieved the first suborbital commercial space flight, followed by a successful flight with a team member in a passenger seat. This did not, however, count as the first official space tourism flight, as the passenger was not a paying customer, but an astronaut trainer, who also validated some of the cabin design elements (Virgin Galactic 2019a; 2019b; 2020).

SpaceX´s ultimate aim is to colonise Mars and enable people to live on other planets, as well as to revolutionise space technology and reduce space transportation costs (SpaceX, 2019a; 2019b). SpaceX was the first private space company to successfully launch and orbit the Earth in 2008, to recover a spacecraft in 2010, to deliver cargo to and from the International Space Station in 2012, and to achieve the first reuse of an orbital rocket with Falcon9 in 2017. In 2019 SpaceX started to work in partnership with NASA, transporting cargo and astronauts to the International Space Station (SpaceX, 2019a; 2019b; 2020). SpaceX also has an interplanetary transport mission in which building bases on the Moon and cities on Mars will require the affordable delivery of significant quantities of cargo and space tourists (SpaceX, 2019a).

Blue Origin has been developing technologies to enable private human access to space with the goal of dramatically lowering costs and increasing reliability. The company does not claim to be in a space tourism race, but to be promoting a slower step-by-step development process than its rival companies, and traveling to space specifically to benefit the Earth, with a mission "to build a road to space with

reusable launch vehicles so our children can build their future" (Blue Origin, 2019). In 2019 *NASA* also announced plans to open the International Space Station to tourists in 2022 as a means to gain more funding for other space exploration projects in the future. NASA will enable private astronaut missions of up to 30 days to perform duties that fall into approved commercial and marketing activities (NASA, 2020a). If supported by the market, the agency can accommodate up to two short duration private astronaut missions per year, which will be privately funded, as well as dedicated commercial spaceflights (NASA, 2019f).

New Space companies such SpaceX currently play an increasingly important role in the global space sector, supporting NASA, for example, in maintaining the International Space Station (Airbus, 2021). NASA started a $4.5 billion programme in the new millennium, Space Launch Initiative, to support technology creation for a reusable launch vehicle (Cater, 2019). SpaceShipOne won the Ansari XPRIZE competition in 2004, which invited commercial companies to compete to be the first in space, with the requirement of completing two successful flights within a two-week period. In December 2018, Virgin Galactic's VSS Unity achieved the first suborbital flight status, reaching an altitude of 82.9 kilometres, officially entering outer space by US standards. In February 2019, for the first time, a passenger (a company employee) joined the flight team onboard and floated within the cabin during the flight (Virgin Galactic, 2020). In July 2021, sub-orbital space tourism for the "masses" (customers able to afford the cost of the ticket) finally started both Virgin Galactic and Blue Origin successfully accomplishing their first space tourism flights, with SpaceX gaining similar status in September 2021.Although it was thought at the time of the Ansari XPRIZE competition that the suborbital tourism experience offered by the winning SpaceShipOne would be available to the public within four years, it instead took over 15 years; safety issues and regulations were the biggest contributors to the delay (Webber, 2019).

1.3 Defining space tourism

The boundary between Earth's atmosphere and outer space is defined as the Karman line, which the Federation Aeronautique Internationale specifies as an altitude of 100 kilometres, and NASA defines as 80 kilometres (FAI, 2018; NASA, 2019a). This complicates regulatory measures, as aircraft and spacecraft fall under different global treaties, especially as global space legislation is currently almost non-existent (FAI, 2018; NASA, 2019a; Article A; Article C). Duval and Hall (2015, p.450) define space tourism as "the temporary movement of people for non-military reasons beyond the Earth's atmosphere". Harrington (2017, p.118) defines a space tourist as "someone who tours or travels into, to, or through space or a classified body for a pleasure and/or recreation".

According to Reddy, Nica and Wilkes (2012), new adventures and unique experiences, such as the sense of weightlessness and watching the earth from space, drive the demand for space travel. Hossein, Olya and Heesup (2020, p. 541) similarly clarify that adventure, gratification, social motivation, the experience of a new service and acquisition of information about space and space travel motivate travellers to undertake a space trip. Crouch, Devinney, Louviere and Islam (2009, p. 451) claim that a significant proportion of the public, in general, and including high-income or high-net-worth individuals in particular, are favourably disposed towards engaging in some form of commercial space tourism flight activity.

There are various types of space tourism, including terrestrial space tourism, such as Earth-based activities and cyberspace tourism; atmospheric and low Earth orbit tourism; astrotourism, referring to experiences beyond Earth's orbit; and lunar and Mars experiences (Carter, Garrod, & Low, 2015; Cater 2019; Crouch et al., 2009). Terrestrial space tourism is quite well-established, and includes Earth-based simulations and entertainment experiences such as visits to space observatories, museums and exhibitions, star gazing with a telescope and watching the aurora with the naked eye (Cater, 2019; Toivonen, 2020, p.9). The Kennedy Space Visitor Centre in Florida is the most popular terrestrial space tourism facility, hosting over 1.5 million visitors per year, despite also being an active spaceport (Kennedy Space, 2019). There are several alternative forms of space tourism possible, and, within each, according to Crouch et al. (2009, p.451) it is likely that there will be a growing number of competing space tourism ventures emerging over time. Cyberspace tourism, another form of terrestrial space tourism, includes experiences such as virtual gaming environments and virtual reality space travel (Toivonen, 2020, p.8). According to Ceuterick and Johnson (2019, p.105), interactive media and contemporary video games are "a major site at which future visions of space tourism can be displayed and directly interacted with, allowing players to experiment with modalities of extraplanetary transit".

A zero-gravity flight is an atmospheric space tourism experience at a higher altitude, in which the passenger does not leave Earth, but has the opportunity to experience true weightlessness (Toivonen, 2020). For example, the ZERO-G modified Boeing 727-200, at a cost of about $6,000 per person, performs parabolic arcs at an altitude of 32,000 feet to create a weightless environment that allows passengers to float, flip and soar as they would in space (Space Adventures, 2019). The edge of space flight is at the upper edge of the Earth's lower atmosphere and is the altitude limit for jet aircraft. Russian MIG flights, offered by various private entrepreneurs, have provided space tourism opportunities since the 1990s, at a cost of around $20,000 (MigFlug, 2019). Suborbital tourism flights, which Virgin Galactic started in July 2021, focus on attaining the altitude required to qualify as reaching space, and combine the excitement of a rocket-assisted jet flight to orbit with an extended period of weightlessness and a view of Earth (Anderson, 2005).

Suborbital space tourism will be the first stage of so-called common space tourism, as it does not require passengers to undergo astronaut training beforehand. Some intensive flight training is required, covering weightlessness, inflight acceleration and safety and equipment training (Toivonen, 2020).

The International Space Station (ISS) in low Earth orbit has so far been the ultimate destination in orbital and astrotourism for adventurous space tourists, offering a floating apartment complex with several activity areas and observation ports to take advantage of good views of Earth and outer space (Toivonen, 2020). When staying at the International Space Station, tourists have also been able to operate and visit the different modules and devices developed by numerous countries (Anderson, 2005). The Moon, with its low gravity, is, so far, the only reachable physical space destination, but to date only 24 people have visited the Moon, and the last visit was in 1972 (NASA, 2019b). Mars is the most Earth-like of all the other planets in the solar system, and could become a destination where humankind could survive; currently the International Space Station serves as a microgravity and space environment research laboratory for the equipment required for missions to the Moon and Mars (NASA, 2019b). Doubts have been expressed, however, as to whether the private companies championing human missions to Mars will actually succeed "as firstly Mars is a difficult undertaking for robotic probes, but especially human missions and secondly, there is no compelling rationale at present for undertaking the mission other than prestige and bragging rights, which is not a sustainable reason" (Launius, 2019, p.49).

Only about twenty people have so far visited space as paying tourists in orbital spaceflight, compared to some 550 professionals, mostly US astronauts (NASA, 2020a). Prior to Virgin Galactic, Space X and Blue Origin, Space Adventures was the only private company to arrange for paying passengers to go into space, in conjunction with the Federal Space Agency of the Russian Federation and Rocket and Space Corporation Energy (Space Adventures, 2019). Dennis Tito became the first paying space tourist in 2001, travelling on a Russian Soyuz rocket to the International Space Station. Tito ′s trip made the opportunity of space travel real for millions of "ordinary" people without experience as astronauts (Toivonen, 2020). Tito preferred, however, to be classified as an "independent researcher" rather than a "space tourist", as his weeklong $20 million stay had involved six months of astronaut training and hours of physical exercise (Wall, 2011). This creates a valid question about whether the first pioneering space tourists can be described as tourists, as they all underwent months of training to actually become temporary astronauts (Spector, 2020a). Reddy et al. 2012, p.1101) clarify that "two aspects in particular have to be taken into consideration when explaining space tourism motivation. First, there is the pioneering aspect, which motivated the first private space explorers to push the barrier and experience something that only astronauts have done before and, secondly, it is the space flight experience which attracts many people with all the excitement and uniqueness

Peeters' (2013) four step approach to commercial endeavours based upon product-life-cycle concepts classifies space tourism as a first step paralleling that commercial air transportation, and leading to a new economic sector. The second step will include payload transfer, the third step cargo transport, and the fourth step the commercial point-to-point transport of passengers. In May 2021, Blue Origin announced that it would fly its first astronaut crew into space, with one seat on this first low Earth flight reserved for the space tourist paying the highest price in an online auction (Blue Origin, 2021). This tested the pricing matrix among potential space tourists for the first time. So far, terrestrial space tourism has been the only option for the greater public to experience space-related activity, as there has been no initiative to involve them in the actual space environment (Ceuterick & Johnson, 2019).

In this thesis, I examine existing terrestrial space tourism through the Northern Lights, which is a space phenomenon naturally present in Finland and also experienced virtually. I define emerging low Earth space tourism as a "space jump" activity, similar to extreme adventure tourism activities previously only practised by professionals (Beedie & Hudson, 2003), and which also increase concerns regarding the health and safety of tourists (Marsh, 2006). As New Space companies´ Space X and Blue Origin have already announced their ultimate goal of space operations which involve building future space colonies, I define such beyond the Earth astrotourism as meaning business tourism to human colonies, before the actual space tourism destination, including hotel infrastructure, is built to provide more mass-characterised tourism (Cole, 2015; Cooper, Fletcher, Fyall, Gilbert & Wanhill, 2008).

1.4 The New Space economy in Finland

The era of commercial space activity has also brought new countries to the global space business, characterised by a mixture of start-up companies and privately funded space companies that service both governmental and non-governmental customers (Business Finland, 2020). The European Union has fostered space research since 2007, and established three major space programmes through the European Space Agency (ESA), which have addressed key societal challenges, fostered economic growth and ensured European autonomy (European Commission, 2021). For example, the Galileo navigation system has supported the formation of autonomous transportation in urban air mobility, and the Copernicus Earth observation program has assisted authorities in natural disaster management (Airbus, 2021). The New Space Strategy for Europe responds to growing global competition, increasing the involvement of the private sector, and major technological shifts, and the objectives of the space strategy include the maximisation of benefits for society and the

European economy, as well as improving access to space data for start-ups (European Commission, 2021; European Global Navigation Satellite Systems Agency, 2021).

As a member of the European Union, Finland became a space nation in 2017 with the launch of the Aalto 1 research satellite (originally scheduled to be launched on the SpaceX Falcon 9 rocket in 2015, however due to many delays finally on board the Indian Space Research Organisation rocket) (Aalto1, 2021). Prompted by this satellite launch, the government of Finland issued its first national space law, which entered into force on 23 January 2018, an act regarding space activities and establishing authorisation for national space activities (Ministry of Economic Affairs and Employment, 2020). The new space legislation encompassed a positive approach to environmental and space sustainability, and created a legally transparent environment to ensure the safety of space activities, as well as the sustainable use of outer space (Lönnqvist, 2021). For example, Article 5 of the Space Act includes specific references to space debris mitigation, involving the disposal of satellites and their potential for re-use on a second mission (Tapio, 2018). Ensuring economically, socially and environmentally sustainable growth in the Arctic is also one of the general political priorities of Finland, and also reflects the space policy (Lönnqvist, 2021). Finland is also committed to reaching the sustainable development goals set by the United Nations 2030 Agenda, including ensuring wellbeing in an environmentally sustainable manner, and both internal and international cooperation (Ministry of Foreign Affairs of Finland, 2020).

Despite not having any operational spaceports, Finland has for decades accomplished high-quality space research, firstly in bilateral collaboration with neighbouring countries, and from the 1980s more in the context of the European and international frameworks (Lönnqvist, 2021). Finland has been a member of the European Space Agency since 1995, and Finnish industry and research organisations have participated in various ESA programmes, especially involving the thematic priorities of Finland, including the sustainable use of space and development of the Arctic region (Space Finland, 2020; Lönnqvist, 2021). Indeed, Finnish Lapland has also for years been an internationally renowned and popular tourism destination for witnessing the Northern Lights (Visit Finland, 2020), a type of terrestrial space tourism that allows tourists to explore the universe using the naked eye from the Earth's surface (Cater, 2019).

The Ministry of Economic Affairs and Employment of Finland (2020) defines four key areas of Finnish space activities; scientific research into space and Earth, satellite remote sensing, satellite positioning and the space industry. Current space research mainly concentrates on the development of satellite technology, space weather and sustainable space solutions. The objective for Finland´s space strategy is to provide the most attractive global environment for space-related business, which benefits all companies operating in Finland, by 2025 (TEM, 2020). Business Finland´s New Space Economy program currently provides funding for Finnish space companies,

universities and space research facilities, with a focus on accelerating Finnish space know-how and ecosystems (Business Finland, 2020). As the sustainable use of space is a core of the Finnish space policy, Finland also actively investigates the implementation of guidelines for the long-term sustainability of outer space in its national policy (Lönnqvist, 2021).

According to Business Finland (2021) Finland has fast become a "technological superpower" with innovations that have led to the rise of space entrepreneurship and the establishment of national New Space economy. Such initiatives include microsatellites by Finnish start-up ICEYE, which monitor the impact of climate change on the environment, such as floods and the natural environment, and improving the sustainable use of space with new space debris removal technologies via systems developed by Aurora Propulsion Technologies to bring non-functional satellites back to earth (Business Finland, 2021).

1.5 Academic research on space tourism

For decades, academic space research has referred to space technology, and the discourse of space tourism remained in science fiction-styled writing (Fawkes, 2007; Toivonen, 2020). Despite the fact that commercial space tourism began to emerge after the millennium, and the full operation of this economically prosperous industry sector of future tourism has just started, the academic discourse and other written literature on space tourism have remained very limited compared to other sectors of the tourism industry –most probably because investigating and researching new developments of the future is a challenging task full of various uncertainties. So far, the literature reflecting the actual physical experience of space travel has concentrated mainly on the experiences of specialists, such as astronauts (Toivonen, 2020; Article A; B; C).

When my PhD research process started in early 2015, I soon realised that there was very limited academic literature available on space tourism, with the first comprehensive book (edited by Cohen and Spector) published in October 2019, however, there are researchers of space tourism whose findings greatly assisted writing of this thesis. Firstly, it is important to note that in the early 1990s Collins (1994) pioneered the analysis of market demand, and later made other contributions to space tourism, such as exploring space economics, reusable launch vehicles and space solar power. Abitzsch (1996) explored the prospects of future space tourism, and measured market potential, and Marsh (2006) defined some ethical and medical dilemmas of space tourism, especially pointing out there are grey areas separating minimum legal requirements and what is ethically responsible. Ashford (2002, 2009) approached space transportation, noting that the immediate requirement for space tourism is to be included in the mainstream

space policy agenda, and Peeters (2013) introduced a four-step approach for suborbital commercial passenger spaceflight. Ross and co-authors (Ross, Mills, & Toohey, 2010; Ross & Sheaffer, 2014) analysed environmental rocket emissions, publishing two sets of opposing results regarding environmental impacts, and pointing out that further scientific studies are needed to fully understand the long-term implications for the climate. Cohen (2017) investigated the paradoxes of space tourism, such as the subversion of adventures in space tourism, and Collins and Autino (2010) connected the development of space tourism to reducing the danger of human extinction on Earth as a result of disaster, a view similarly emphasised by cosmologist Steven Hawking (2010).

Space tourism and sustainable development were first academically linked by Fawkes (2007), who defined different levels of sustainability in space tourism, such the operational (infrastructural sustainability), cultural (increased awareness and education), economic (cost efficiency through re-use), resource (alternative resources to explore) and survival levels (saving *the Homo sapiens* species). Cole (2015) further explored prospects for space tourism planning, such as the limitations of tourism planning methods for space tourism, and Duval and Hall (2015) analysed space tourism and policy implementations as regards the challenges faced when forming a new tourist destination. Peeters (2017) critiqued the concept of space tourism sustainability, addressing various climate-related reasons that space tourism cannot be part of sustainable tourism. During the late 2010s, Spector and Higham (2017, 2019a) analysed the conceptualisations of sustainability and anthropogenic relationships with space tourism, pointing out the potentially immense resources of outer space, and the consequent formation of colonies to ensure the long-term survival of humans (Article A; Article C). Otherwise the sustainability approach to space tourism has so far been limited, and Fawkes′ (2007) classification of sustainable development space tourism, for example, has a human-centred approach that lacks consideration of the implications for flora, fauna and the space environment.

The concept of space sustainability was present in the "old space" governmental industry, but less than, for example, the concept of space technology in the literature regarding space legislation; for example, Durrieu and Nelson (2013) investigated Earth environmental sustainability observed from space. From a space logistics perspective, He, Shen, Wu and Luo (2013) reviewed the formulations of new logistics in sustainable space development strategies, and Grogan and de Weck (2012) simulated a model to analyse capability for space exploration sustainability. From a space material sciences perspective, Kukartsev, Boyko, Tynchenko and Bukhtoyarov (2019) investigated sustainable development of a rocket in a governmental complex, and Gohardani, Elola and Elizetxea (2014) reviewed potential implementations of advanced materials in next generation aircraft and space vehicles. From a space engineering perspective, Janhunen (2004) introduced an electric sail for spacecraft propulsion, Shan, Guo and Gill (2016) compared active methods for the capture

and removal of space debris, and Kawashima, Nakasuka, Schilling, Yasuyki and Sweeting (2015) considered the long-term sustainability of engineering in space activities, such in improving educational awareness of space sustainability among universities across the world.

Ideas about sustainability still appear limited in the New Space industry academic literature, as the field has just emerged, however, there is some academic literature, for example, in the context of re-useable space transportation developments (Musk, 2018), in the creation of future science, technology, engineering and mathematics (STEM) space education (Messina, Garagnani, Ricci & Tagliamonte, 2018), in analysing the responsibility of corporate stakeholders in space exploration (Ehrenfreund, Race and Labdon, 2013), and in the legislative examination of sustainable private activities in outer space (Tapio, 2018). There is a gap in our understanding of the various social sustainability effects of the New Space sector for future generations, including employment opportunities, and questions of equality. Space tourism in theory is an idealised experiment for future international and domestic policy implementation, as it can determine to some extent whether private and public valuations of an environment can co-exist (Webber, 2013). Such co-operation between governments and the private sector have previously tended to be economy-based, however, with environmental issues addressed voluntarily (Duval & Hall, 2015). The opening of space for activities such as space tourism, instead of its previous political and military purposes, has also made it necessary to specify new types of legal regulations not covered by the Outer Space Treaty (1967), as beyond this, space is still equivalent to the old 'Wild West', with 'first come first served' attitudes and approaches to rights and actions (Cofield, 2017; Vereshchetin, Vasilevskaya, & Kamenetskaya, 1987; Viikari, 2007; von der Dunk & Tronchetti, 2015).

1.6 Aims and scope

In this thesis I expand the academic discourse on space tourism with a focus on *how sustainability can be improved in the context of the New Space tourism industry* (see Figure 1). The sub-questions of this main question are:

1) How can sustainability be included in future space tourism planning?
2) What concepts relating to the context of space tourism and sustainability can be highlighted through research into a future that doesn't yet exist?
3) How is the combination of space tourism and sustainable development currently envisioned by the public and professionals in Finland?

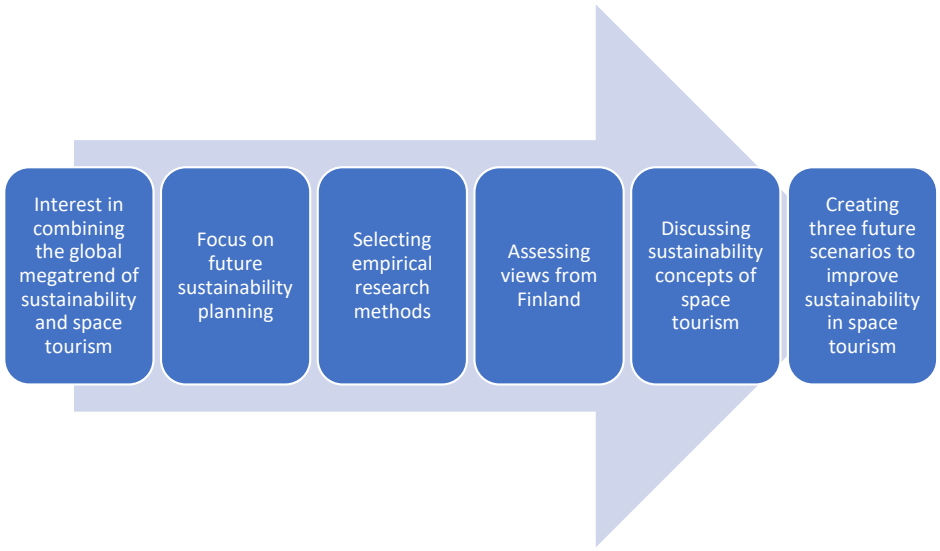

Figure 1. *The process of this thesis*

This doctoral thesis consists of two peer reviewed academic articles (Articles A & C) and a book chapter (Article B), which are presented at the end of this thesis. In these three contributions I elaborated the theoretical concepts, explained the process of grounded theory to gain new knowledge, and illustrated the futures frameworks created or utilised in this thesis. To find the answers to my research questions I investigated the kind of future frameworks that could be used for future space tourism planning (Articles A & B), the concepts of sustainable development that are currently linked to space tourism (Articles A, B & C), and how the combination of space tourism development and sustainability is envisioned by the public and professionals in Finland (Articles B & C) (see figure 1 and table 1).

The first sub-study (Article A), published in the *Finnish Journal of Tourism Research* in 2017, explored the relationship between space tourism and sustainable tourism from the perspective of future planning and development. On the basis of contextually-related theoretical readings, I created a new theory-based framework, called the "Sustainable Future Planning Framework" after discovering that there is a lack of existing space tourism models, which involves four themed clusters that are all synergistically related. The academic literature on sustainable space tourism was more limited at the time of writing (between 2016-2017), with one of the first academic articles being published in 2015 (Duval & Hall) and a few other related articles (Spector, Higham & Doering, 2017; Peeters, 2018) published after my own 2017 article. The framework was thus also designed as guidance for my research process, as it contextually gathers sustainability-related aspects in a visual context. The article concluded that the infrastructure of the New Space tourism industry is

still in the development stage, and that there was thus an opportunity to promote more sustainable practices and values to different operations within the industry. It was recommended that in order to improve sustainability, the space tourism industry should adopt a long-term perspective for short-term actions, and simultaneously consider different policy domains at multiple levels.

The second sub-study (Article B), published as a book chapter in *Science Fiction, Disruption and Tourism* (2021), used an empirical study to examine the views of various field professionals regarding sustainability concepts related to the future space tourism industry. The study used a Futures Map (Kuusi, Cuhls & Steinmuller, 2015) to place concepts on the "planning horizon", which reflects historical trends and aims for an improved future, and the "mapping horizon", which creates visions on a longer time scale. Grounded theory analysis of the interviews demonstrated that economic effects, space legislation, alternative energy sources, a circular economy, contemporary trends, health space tourism, virtual travel and robotisation could all be sustainable concepts in the New Space tourism industry.

The concepts of economic effects, legislation, alternative energy sources and the circular economy involving current ways of living in the developed world, placed on the "planning horizon", and contemporary trends, health space tourism, space colonies and virtual travel and robotisation, were either classified as acceptable future trends, or as still in visioneering minds and placed on the "mapping horizon". It was emphasised that the New Space tourism industry needs to act regarding environmental protection, and that the focus should be on sustainable science, achieved by understanding the psychology of new tourism behaviour as well as through global environmental agreements. It was pointed out that the environmental approach would be especially important, as the requirements for sustainability in space are demanding, and must therefore first be solved on the surface of the Earth.

The third sub-study (Article C) was published in the *Journal of Sustainable Tourism* (2020), and explored views held by the Finnish populace in relation to space tourism and sustainability. The data was derived from both a survey and Delphi panel, the survey gathering Finnish public opinion on the sustainability of space tourism, and the professional Delphi panel used for in-depth qualitative explanations. The findings resulted in four sustainability dimensions in space tourism; "virtual travel", "comparative fairness", "technological innovations" and "ecopolitics". It was concluded that terrestrial space tourism is already part of the New Space economy in Finland, however this "space perspective" has not yet been considered in national tourism and development strategies. The findings indicated that space tourism sustainability is significantly affected by issues related to environmentally innovative technology (such as enhancing the multi-sensorial virtual space experience) and tightened national initiatives prompted by global climate change related regulations. The main ethical concerns raised in connection with further developments in space tourism, included an increase in confrontations between the rich versus the poor,

responsibility for compensation, and fairness in determining ownership of the space environment. It was also suggested that the "Sustainable New Space model for Finland" model could assist in the process of developing a national or even a global scale New Space tourism planning strategy.

Table 1. *The articles in brief*

	Article A	Article B	Article C
Main focus	To point out some necessary elements needed for future planning processes on sustainably oriented space tourism	To investigate concepts related to sustainable development in conjunction to New Space tourism industry	To explore the views held by the Finnish populace and field professionals in relation to space tourism and sustainability through empirical study.
Data	Theoretical readings from tourism and planning fields	Five in-depth interviews from field professionals related to space tourism	132 responses from the public and 10 participants in the professional Delphi panel
Method	Content analysis	Futures mapping and grounded theory	Grounded theory, comparative content analysis and Delphi method
Key outcomes	A new futures framework, the "Sustainable Future Planning Framework" created based on the main aspects of sustainability in theoretical readings.	Economic effects, space legislation, alternative energy sources, circular economy, contemporary trends, health space tourism, space colonies, virtual travel and robotisation identified as concepts for improving sustainability.	Virtual reality, comparative fairness, technological innovations and ecopolitics identified as sustainability dimensions in space tourism

1.7 Structure of synthesis

There are five chapters in this doctoral thesis. Chapter 1 introduces human space travel and the emergence of the New Space industry, defines the concept of New Space tourism, explains Finland´s role in the current New Space economy, explores the existing academic literature, introduces the research objectives, and summarises the published articles and book chapter, including their main findings. Chapter 2 examines the theoretical contexts by firstly exploring the conceptual background to futures studies, involving science fiction, future scenarios and the identification of trends. It then explains the features of postmodern tourism and authenticity, and explores sustainable development in tourism, and lastly examines futures policy and tourism planning. Chapter 3 explains the different methods and materials used in this thesis by describing the process of grounded theory throughout the research, and also presenting the comparative content analysis and the Delphi method for

the empirical data in more detail. Chapter 4 puts together the empirical research findings by illustrating two future frameworks related to conducting research on futures that do not yet exist, and then analysing in detail the public and professional views on space tourism in Finland. Chapter 5 introduces three scenarios through which sustainability could be improved in the New Space tourism industry. Finally, the conclusion highlights the major topics raised across the chapters, evaluates the research contributions, discusses the limitations of this research, and provides suggestions for further research.

2. Conceptual background

This chapter introduces the theoretical concepts utilised in the thesis. The forecasting of a new travel phenomena is based on the history, current trends and perspectives of researchers (Ryan, 2018), and so different theoretical contexts from the fields of futures and tourism had to be explored to create a holistic view. Features of futures studies are highlighted through concepts from science fiction, scenario planning and the identification of trends. Space tourism is a new type of postmodern tourism, affiliated with not-yet-existing tourism destinations in space environment as well as its relation to authenticity. The tourism industry has acted upon the trend of environmentalism for many decades, and this trend was noticeably strengthened to a megatrend after the International Panel on Climate Change (IPCC, 2018) forecast a forthcoming climate change crisis that required immediate action from all industries, thus validating sustainability as an essential concept for inclusion in future scenario planning for the New Space tourism industry. Finally, the concept of tourism planning is explained as regards the development of future policy and tourism destinations.

2.1 Science fiction, future scenarios and the identification of trends

There have been written predictions of the future for centuries and the era of industrialisation moved the focus to the technological transformation of the future. Writer H.G. Wells introduced the term "foresight" in his technology-oriented future-oriented books in the early twentieth century, and is considered the founder of futures studies (Bell, 1997). Futures research can be described as "a multidisciplinary field that is concerned with a wide range of views about possible, probable and preferable futures" (Benckendorff, 2008, p. 26). According to Sardar (2010), as disciplines and discourses have a history and cultural context, terms such as futurology and foresight emphasise plurality and diversity. The study of the future is best served by the term "futures studies". The field of future studies is a relatively new research area, although its origins are linked to ancient prophecy and early science fiction, connecting it more closely to the social sciences than other sciences (Slaughter, 1996). Futures studies attempts to explicate the possible prospects and consequences of different decisions in order to question or promote certain values or procedures. This leads the field into a unique epistemology which differentiates it from the principles and methodologies of all other sciences (Malaska and Holstius, 1999, p.354).

It has been argued since the 1990s that research into the future is a social science in its own right, as the traditional social sciences tend not to pay full attention to future prospects (Wagar, 1991). Futures research into tourism has been prominent in the tourism literature since the 1980s, when van Doorn (1982) launched the discourse by first connecting futures research tools to tourism-related research. The nature of tourism relations in futures discourse has tended to involve an understanding of complex systems and transitions, informed by new knowledge, and these are also prominent features of futures research (Cooper et al., 2008; Farrel & Twining-Ward, 2004).

Futures studies, expanding the interdisciplinary field of futurology, can be presented as four paradigms; prediction, prognosis, utopia and science fiction (Bergman, Karlsson & Axelsson, 2010). Science fiction is a broad genre involving speculation based on current or future science or technology, and is described as "realistic speculation about possible future events, based solidly on adequate knowledge of the real world, past and present, and on a thorough understanding of the nature and significance of the scientific method" (Heinlein, Davenport, Kornbluth, Bester & Bloch 1959, p. 1908). It differs from fantasy in that its imaginary elements are largely possible within scientifically established or scientifically postulated laws of nature, and settings may depict new scientific principles such as time travel and new technologies (Yeoman, 2012, p.5). The contributions and warnings of utopia and dystopia can be explored through science fiction as mechanisms for innovation, visions and business (Bell, Fletcher, Greenhill, Griffiths, & McLean, 2013). Dystopia can be defined as an "imagined state or society in which there is great suffering or injustice, typically one that is totalitarian or post-apocalyptic" and utopia defined as an "imagined place or state of things in which everything is perfect" (Oxford Dictionaries, 2021).

Science fiction tends to evoke a visualisation of the future, a better future for humankind, with some sort of scientific representation through a fictional account, hence "science" and "fiction" combined as science fiction (Forster et al., 2011). According to Yeoman, McMahon-Beattie and Sigala (2021, p. 256), "fictional images of the future are powerful and influential in shaping our image of tourism". Rovelli (2019) argues that reality can also be judged as a temporal structure that describes "becoming"; by asking "what is real?" and "when does something become real?". Throughout the history of science fiction writing there have been technological stories, such as those about space exploration, that eventually have become true, as science fiction has a history of influencing popular culture and inspiring engineers to turn ideas into reality (Chen, 2010). Science fiction has also been used to construct futures based upon technologies which have not yet been invented, to think about the transformation of tourism, and to predict the end of tourism based upon a natural disaster (Yeoman et al., 2021).

There are two main approaches to futures research, one using Delphi technique that evaluate how probable and preferable some specified futures are, and involve

a professional panel with expertise related to the future issues. The other approach uses scenarios and related methods for the examination and evaluation of alternative futures (Kahn, 1965; Article B). These two paths may occasionally be combined to use some versions of Delphi technique, and form a scenario funnel describing a range of possible futures, looking forward from today's standpoint (Kosow & Gassner, 2008; Kuusi et al., 2015). Scenario planning is one of the main research methodologies in futures studies and also connected to the weak signals emerging from science fiction (Lukka, 2014).

A future scenario may be described as a specific path connecting the present state to at least one vision of the future, and creating answers to questions such as how a hypothetical situation might develop step by step, and what alternatives exist for each step as regards facilitating or preventing the process (Kahn & Wiener, 1967; Pauwels & Berger, 1964). Lindgren and Bandhold, 2009) claim there are a number of rationales for the success of the scenario planning method, as the method produces a new complexity-reducing framework to allow a more collectively-understood structure of thinking outside known parameters, and offering a means to communicate more efficiently. One type of scenario involves binding and non-binding plans for municipal strategies via a spatial representation of future development policies that can extend over a few years or decades, and is thus a useful tool to support policy and guide action towards sustainability (Faure, Arushanyan, Ekener, Miliutenko and Finnveden, 2017).

Scenarios can be applied in order to learn from a variety of alternatives, or they can be focused on raising questions and challenging conventional wisdoms (Guimarães Pereira, von Schomberg & Funtowicz, 2001). Future scenarios can also be formed by identifying factors, such as environmental issues, economics, governments, politics and technology, and can by nature be predictive, explorative or normative (Börjeson, Höjer, Dreborg, Ekvall, Finnveden, 2006); for example, predictive scenarios focus on what will happen, defining the potential problems and opportunities. The suitability of a scenario may depend on the time horizon assessed (Faure et al., 2017).

In order to anticipate future changes in developments, it is essential to look for emerging weak signals from society, and to practise environmental scanning, which is a process of acquiring information (Hiltunen, 2013). Weak signals and environmental scanning have been discussed in the futures literature since the late 1960s by Aguilar (1967), followed by the different aspects of environmental futures by Ansoff (1975), and can, for example, be used in the future consumer trend analysis of a tourism company. Weak signals are emerging ideas, intentions, discoveries and innovations, and anticipating a change basically involves stable factors, megatrends, trends, weak signals and wild cards (Choo, 2006; Hiltunen, 2013; Smyre & Richardson, 2015). As weak signals are the early signals of emerging trends, "a collection" of weak signals can be used to recognise the pattern of an emerging trend (Choo, 2007; Hiltunen, 2007). Weak signals are also an important feature of science fiction, where they

can be seen as the embryonic seeds of the future, but the key is explaining how this future could occur (Yeoman et al., 2021).

An emerging trend can only be seen in the form of weak signals, and involves some examples of the trend taking place, but with no clear evidence present (Hiltunen, 2019). When an emerging trend matures into a trend it becomes visible, and already has some history. Trends can exist locally and globally, in all kinds of industries, and under different classifications (for example the STEEP classification model consisting of social, technological, environmental, economic and political classifications) (Nordin, 2005). Not all trends become mainstream, but some even develop into global scale megatrends. Megatrends are trends that exist much longer than trends, have deeper historical roots, a longer timescale of changes, and affect larger geographical areas more than trends (Hiltunen, 2019). Naisbitt (1982) claims that megatrends do not emerge or disappear quickly, and conversely, that some extensive social, economic, political and technological changes form slowly. Megatrends can therefore be harnessed in the shaping of a new business era, and become part of the formative process (Naisbitt, 1982).

A megatrend can be expected to continue for years unless something radical and surprising happens that reverses its direction (Dufva, 2020). Taleb (2007) classified an event that comes as a surprise, has a major effect and is often inappropriately rationalised after the fact with the benefit of hindsight, as a "black swan". For example, the September 11 2001 attacks in the USA could be defined as a major surprise event with a major effect on the entire global tourism industry. Similarly, "wild cards", as defined by Petersen (2000) and experienced in the Covid-19 pandemic, are low probability, high impact events that severely affect the human condition in the place that they occur. A wild card imagination approach may be used to improve the resilience of companies by evoking out of the box thinking on positive and negative wildcards, and opening up new possibilities in thinking (Steinmuller & Steinmuller, 2004).

An annual list of megatrends by the Finnish Innovation Fund (SITRA) is an interpretation of the direction of global change-related phenomena (meaning the megatrends) (SITRA, 2020). The megatrends highlighted for 2020 included many related to climate change, such as themed clusters noting that "ecological reconstruction is a matter of urgency" and that "technology is becoming embedded in everything" (Dufva, 2020; Solovjew-Wartiovaara, 2020). Some of the trends expected to affect tourism and hospitality during the 2020s, which may turn into global megatrends, firstly concentrate on the travel motivations of "Generation Z", who are very involved in digital solution trends such as social media platforms, and are generally accustomed to changing lifestyles and environments. Secondly, there has been a rise in "ethics" that involves consumption. As a result, there have already been travel destination boycotts and public social media shaming of participants (for example in animal trophy hunting in Africa). Adaptation to climate change

will also require various ethically-based competences among the travel industry operators involved (Hiltunen, 2019; SITRA 2020; Young, 2019).

2.2 Postmodern tourism and authenticity

The term postmodernism was first introduced in 1942 by H.R. Hays as a new form of critically oriented literature. The philosophical thought of postmodernism emerged in the social sciences between 1960-1970, and involved a "core idea to criticize nationalism, which is emphasized by modernism" (Wang, Niu, Lu & Qian, 2014, p. 370). Even though postmodernism can be considered a paradoxical phenomenon (D'Urso, Disegna, Massari & Osti, 2016), the term "postmodern" has been widely applied in a variety of disciplines, such as history and marketing, since the 1980s. The first investigations of a new type of tourist appeared in the tourism literature during the 1990s, reflecting the post-modern era, and describing the enjoyment of tourists moving from one tourist experience to another (Uriely, 1997), the nature of which is "both-and" rather than "either-or", and thus the postmodern consumer experience may involve the coexistence of both the real and the artificial (Munt, 1994).

The Western perspective on travel has become more dominant than ever, and the problems of tourism are thus considered from that perspective (Mowforth & Munt, 1998; Yeoman, 2012). Postmodernism arguments related to tourism have often led to the conclusion that just as an increasingly globalised world has resulted in a global economy, the same process has at the same time also resulted in the emergence of a global culture characterised by the same global status symbols and material products (Harvey, 1989). This phenomenon has become especially visible since the emergence of social media, as increasing numbers of younger Western travellers, who take similar travel photos in the same destinations and post these on the internet for others to see, join the mass of "status" travellers (Toivonen, 2020, p.83). This has also resulted in a highly polarised and simplified debate concerning the most appropriate way to holiday (Mowforth & Munt, 1998).

Postmodernism is considered to shape world society through preferences, choices and behaviour, but postmodern travellers cannot be classified under one rigid term (Wang et al., 2014). Popular culture and tourism are already intertwined, predominantly through the tourism industry utilising trends in popular culture for product development; film tourism is an example of how trends in pop culture become visible in tourism (Reichenberger, 2021). Baudrillard (1973) argues that postmodern culture is a world of signs that have made a fundamental break from reality. Feifer (1985) identified three features of a postmodern tourist who: enjoys experiences without leaving home (via simulations such as virtual gadgets); desires change and choice in tourist experiences to prevent boredom setting in; and is aware

of tourism experiences that are inauthentic or contrived, meaning that the overall experience is only a "game".

Postmodern tourists, in contrast to modern tourists, can be described "as individuals who enjoy multiple experiences embracing different, sometimes contrasting, life values" (D'Urso et al., 2016, p. 298), such as tourists looking for authentic cultural attractions but also visiting artificial tourist destinations such as Disneyland. There is thus a need for multiple and disjointed tourist experience perspectives to properly segment postmodern tourism, and this can be achieved by investigating tourist motivations and personal opinions captured through the different scales often present in the tourism field literature (Konu, Laukkanen & Komppula, 2011; Prayang & Hosany, 2014).

According to Gren and Huijbens (2014, p. 15) ethics has traditionally foregrounded human subjectivity, but existence can no longer be reduced to "humans among themselves", as humanity is confronted for the first time in its history, with the task of "having to carry the Earth on its own shoulders", such ethical responsibility appearing to be fundamental in a planetary boundaries approach to global sustainability. Postmodern tourism, its tourist imaginations and the ability of Earth to sustain the human species, have at best become de-territorialised, as nature, landscapes and destinations are cared for through the generic concepts of conservation and sustainability (Gren & Huijbens, 2009, p.9).

Yeoman (2008) argues that consumer values in Western society have changed, with a lessening emphasis on material possessions, and an increasing concern for experiential issues. Travel is the most obvious luxury product experience, offering an opportunity to spend time in unique locations. Commercial space tourism, however, appears to offer a unique experience only to affluent travellers, and one that is difficult for the average person to replicate (Wittig, Beil, Sommerock, & Albers, 2017; Article C). Previous trends in adventure travel have blurred the boundaries between adventurous activities and tourism (Beedie & Hudson, 2003), and many adventure travel activities have also been financially possible for middle-income travellers. For example, mountain climbing, previously practised only by the experienced elite, has gained popularity with holidaymakers who attend guided and safety-checked experiences (Article A). The desire of affluent tourists to undertake more unique and challenging experiences has been one of the driving forces behind the demand for public space travel, enabling them to experience a new untouched area that it is difficult for the masses to copy (Toivonen, 2020).

According to Cohen and Taylor (1992), daydreaming and space tourism are attempts to escape, in which people participate non-physically or by actually jetting away from social monotony and from themselves. Utopias paint a picture of perfect worlds, and are thus seen as a form of pure escapism in an ideal world in which people feel happy and comfortable (Yeoman et al., 2015). It is said that in the globalised economy, future tourists will increasingly search for authenticity (Yeoman et al.,

2012). For the foreseeable future, however, physical escapism in space tourism is likely to involve those already in the most powerful economic, social, cultural and political positions, reinforcing issues related to responsibility and fairness (Höckert, 2015; Ormond & Dickens, 2019; Article C).

Steiner and Reisinger (2006) suggest that a postmodern society involves a constant search or stimulation through events and images. Such stimulation experiences and images are also increasingly expected to be shared through social media (Bolan, 2021). Scenario planning can create context and a sense of reality (Keough & Shanahan, 2008) as the planners build upon weak signals in the narratives in order to bring a degree of authenticity (Robertson and Yeoman, 2014). Knudsen, Rickly and Vidon (2016) argue that tourists seek a fantasy to escape the alienation of their daily lives in their pursuit of authentic experiences. Authenticity is something that is highly contested, however, given modern consumerism, and tourists are today seen as "embracing fast authenticity, manufactured authenticity, or false authenticity" (Yeoman et al., 2021, p.298).

The emergence of virtual reality in tourism provides an alternative to real travel and the tourism sector has rapidly realised potential uses for virtual reality; it has been adopted as a marketing tool for destinations and tourism suppliers (Yung & Khoo-Lattimore, 2017). Virtual reality and tourism involve seeking experiences that transcend everyday reality by providing an escape to a temporary alternate reality. The limitation of virtual reality tourism is that virtual reality does not represent an "authentically real" visit, however in the future people may perceive virtual reality experiences as acceptably real despite their artificiality (Guttentag, 2021). According to Hobson and Williams (1995), the realism that virtual reality experiences provide lends itself well to virtual tourism experiences. Once the sensations and emotions of visiting somewhere in virtual reality become essentially indistinguishable from visiting it in real life, the distinction between the two will become less dichotomous and more a matter of variations. Therefore, virtual tourism could eventually compete with real-world travel and alter tourism purchase patterns more broadly, with various effects on the tourism sector (Guttentag, 2021)

2.3 Sustainability and tourism

Climate change places major transformational demands on societies and addressing climate change is thus considered a prerequisite to sustainable development and advancing sustainable tourism research: Scott (2010, p.17) claiming that "any retreat from engagement with climate change issues by tourism industry or its researchers would be to their substantial detriment". Kajan and Saarinen (2013) state that the issue of adaptation has been emphasised in the relationship between tourism and climate change as an urgent research need in tourism studies. For example, an

emphasis on community- based research in relation to tourism and climate change has allowed highly contextual adaptation challenges to be met in a more sustainable way (Kajan & Saarinen, 2013). Many conceptualisations of sustainable tourism have focused on destination scale issues, and there is therefore a need to further highlight the environmental and social effects of tourism´s travel phase (Scott, 2010). The importance of the role of sustainability has been acknowledged for new sectors that develop fast, but it has not yet been widely researched (Faure et al., 2017).

The Bruntland Commission (1987) classified sustainable development as development that satisfies current needs without jeopardising the future generation's ability to fulfil theirs, and aims to incorporate the essential principles of intra-generational and inter-generational equity by persuading many governments to endorse the notion of sustainable development. The definition addresses the main concerns around the use of non-renewable resources, ensuring economic growth for an increasingly global population without undue impact on the environment, urbanisation and the inequality of wealth, power and opportunity (Fletcher, 2008). Sustainable tourism practises are defined by Word Tourism Organization (UNWTO) (2005, p.11) as "tourism that takes full account of its current and future economic, social and environmental impacts, addressing the needs of visitors, the industry, the environment and host communities".

Benckendorff (2008, p.26) characterises futures research as "everything connecting with everything else" and this makes the study of futures particularly compatible with the study of sustainability "which inherently requires a systematic, long-range analysis of activities, impacts and outcomes". Tourism research, particularly with a sustainable thread, can thus potentially benefit from a better understanding of the future. Budeanu, Miller, Moscardo and Ooi (2016, p.285) claim, however, that sustainability in tourism lacks a criticality, as "sustainability occupies a prime place among the topics of concern in tourism academia". Indeed, the meaning of sustainability is contested, as there are over 300 different definitions (Dobson, 1996) in tourism, involving economic, environmental and socio-cultural aspects, although the nature of tourism means that they can be complex and even work against sustainability (Fletcher, 2008). Critics (Hunter, 1997; Sharpley, 2000) also argue that sustainable development involves inbuilt assumptions about the need for the continued expansion of the world economy, and that it fails to stress the radical changes in lifestyles and society required to overcome the problems inherent in the Western model of development (Dovers & Handmer, 1992; Lele, 1991).

According to Scott (2010), there have been climate science debates over climate change policy responses and research findings, such as Weavers´ (2005) view that sustainable tourism´s current expanding engagement with climate change may not necessarily be conductive to the interests of tourism sustainability. The term "sustainable" has also become widely used to "refer merely to practises that are reputed to be more environmentally friendly sound that others" (Heinberg,

2012, p.1). In the current era of climate crises, however, both scientific awareness and practical actions will be crucial for the tourism operators, stakeholders and policymakers, in order to convincingly react to future climate change challenges and support Earth's environmental longevity.

Tourism is itself a major contributor to global emissions (Gössling, Hall, Weaver, 2009; Gössling, Scott and Hall, 2015), and between 2009 and 2013, for example, tourism´s global footprint increased four times more than estimated, from 3.9 to 4.5 GtCO2e, accounting for about 8% of global greenhouse emissions (Lenzen et al., 2018). This constitutes a growing part of the world´s greenhouse gas emissions, among other significant contributors such as food and shopping (Lenzen et al., 2018). The International Transport Association (IATA, 2020) reported that 2% of global CO2 emissions come from the aviation industry. Travelling beyond the biosphere will have new environmental effects on the climate of the Earth; the launch stage of space travel pollutes by creating emissions, dust and noise in the local area, and it has been estimated that 1,000 space launches produce the equivalent carbon footprint of an entire year of global aviation (Ross et al., 2010). There are also increasing amounts of atmospheric aerosols; small sub-micron particulates creating changes in atmospheric thermal structure and contributing to "global dimming", threatening, for example, star gazing activities for tourists (Ramanathan, 2007; Scott, 2020).

According to Gössling et al. (2015), renewable fuels to reduce emissions will play a key role in the future of the air transport sector, especially as the IPCC (2018) report raised concerns around global greenhouse gas emission pathways, and urged the strengthening of the global response to the threat of climate change in the form of sustainable development within societies. The IPCC (2018) report drew together everything scientifically known about the effect of global warming, strongly concentrating on the 1.5°C warming effects (above pre-industrial levels) on the global environment, indicating that the emissions created by humans must be sharply reduced in the next few years, and that achieving the goal requires far reaching cuts in global net emissions (IPCC, 2018).

Sustainable tourism rests largely upon questioning the capitalist ideology of the dominant Western environmental paradigm (DWEP), and recognition that tourism is a political and socially constructed phenomenon, in which "some voices and agendas are heard – and others are not." (Wilson, 2015, p. 203). The social norms currently determining the kind of travel that is socially acceptable, and even desirable, among Generation Z, also result in other social sustainability-related issues within space tourism development, concentrating on the implications for those who are excluded or otherwise left behind (Spector & Higham, 2019b; Article C). Offering another perspective, Carter et al. (2015, p.457) claim that "space tourism presents an important philosophical challenge that can be harnessed for sustainability, forcing participants to consider their place in the universe, relationship to other beings, and especially concepts of time".

Fawkes (2007) considered space tourism and sustainability at five different levels; operational, cultural, economic, resources and survival. Operational sustainability involves the inclusion of sustainability in all infrastructural and development processes; cultural sustainability highlights space-related education and an empirical awareness of the Earth ′s fragile positioning in the universe; economic sustainability focuses on the generation of employment and multiplier effects; and resource sustainability involves the planetary resources to be utilised and the Earth ′s sustained and survivable level of sustainability involving the ultimate saving of *Homo sapiens* as a species (Fawkes, 2007). Carrington (2019) claims that the effects of climate change increase the suffering of humanity (according to many scientists), and so the survival imperative of space exploration is of increased importance. However, a solely human focus on sustainability is already identified as one of the key issues in ever achieving sustainability goals (West, Haider, Stålhammar & Woroniecki, 2021).

2.4 Futures policy and tourism planning

Tourism planning is about prediction, and thus requires an estimation of the future (Gunn, 1979). According to Dror (1973, p.330), planning can be defined as "the process of preparing a set of decisions for action in the future, directed at achieving goals by preferable means". Hall (2008) suggests that the tourism planning process is not just about deciding what is to be provided in the future of a certain area or a community, but is more complex than that, and that the most important characteristic is the path toward the future. Friedmann (1973) explains that there are two different types of planning; development planning, which often merges into policy making, and adaptive planning, where most decisions are contingent on the actions of others external to the planning system.

Planning and policy are intimately related terms, and Cullingsworth (1997, p. 5) defined them together: "planning is the purposive process in which goals are set and policies elaborated to implement them". Public policy is the focal point of government activity, and influenced by the economic, social and cultural characteristics of society, as well as by the formal structures and features of government and its political system (Hall, 2008). Policy thus becomes a consequence of the political environment, values and ideologies, the distribution of power and of the decision-making process (Dredge & Jenkins, 2007; Hall, 2008; Simeon, 1976). Agenda 21 (Rio Summit 1992) set a series of principles as guidelines for environmental legislation, and many environmentally stringent standards for global companies in manufacturing and tourism to meet, and the practical planning tools for sustainability later included environmental impact assessments, carrying capacity calculations and sustainability indicators (such as resource use and pollution (Mowforth & Munt, 2015). The newer forms of tourism, prefixed for example by "sustainable" and "eco", have also

attempted to signal that there has been an attempt to move away from "plain old tourism" with its negative effects, and let the tourists believe that the "old problems" have now been overcome sensibly (Mowforth & Munt, 2015).

Sustainable tourism innovation, including adaption to climate and other negative environmental change, needs to be better understood, as governance, institutions and resources all serve to affect the future actions taken by the New Space tourism industry, for example, in order to be able to implement measures for sustainable development strategies and global and local policies, as well as utilise the benefits of the technological evolution (Firoiu & Croitoru, 2013). It is thus important to acknowledge natural politics and decision-making in order to evaluate their environmental, social and cultural effects. The responsibility of policymakers is especially paramount, because high costs often create a barrier to practical sustainable actions. According to Verbeek and Mommaas (2008) the focus on sustainability planning in tourism is present from an actor–network perspective when making an inventory of sustainable tourism initiatives, in the effect of transport in tourism, in sustainable tourism and transport policies, and in prevailing questions in the field of sustainable tourism development.

There are post-disciplinary perspectives that focus on explaining tourism planning processes (Dredge & Jenkins, 2011), however so far planning for future space tourism has not commonly been included in a particular perspective or tradition. Space tourism could be placed under two existing tourism planning traditions, which include boosterism, an economic-industry-oriented approach, a physical and spatial approach (Hall, 2011), a community-oriented approach and a sustainable approach. It could also be included in the sustainable planning tradition, reflecting the current values in sustainability in order to secure the future livelihoods of the younger generation, and secondly under the physical and spatial approach, where tourism acts as a division of space by allocating specific activities to specific areas, as in the case of spaceport hubs (Article A).

Butler's Tourism Area Life Cycle (TALC) is a model developed in the early 1980s explaining the stages involved in the development of a tourism destination. The TALC model identifies six stages in the life cycle of a tourism destination. After reaching the stagnation stage (visitor numbers reaching their peak), there are five future scenarios between the stages of rejuvenation (change in tourism attractions) and decline (no longer unable to compete), including exploration (small number of tourists), involvement (emergence of secondary tourism facilities), development (control of tourism declines) and consolidation (tourism growth slows down) (Butler, 1980; Cooper et al., 2008). In New Space tourism, the number of tourists, as measured in Butler's (1980) Tourism Area Life Cycle model, will not automatically reflect the success of "space", as there are certain limitations regarding reaching and living in the destination. If all the targets related to stages are successfully met, space as a destination may even reach the stagnation stage, where the original facilities

become old and run down, leading space as a destination either to rejuvenate or decline (Article A).

Cole (2015) claims the stages of the TALC embody the ideas of congestion and sustainability, and considering the volume of visitors anticipated, future space destinations – orbital, moon-based, or otherwise other-worldly – are likely to become over-crowded. There may thus be a multiplier effect, another major concept in tourism planning. This effect is created as money that is brought into an area is re-spent on additional goods and services, encouraging growth in the primary and secondary sectors (Khan, Seng & Cheong, 1990). The tourist activity itself determines the most relevant multiplier, and whether it is related to factors such as employment, but the net contribution from tourist activities to the local community acts as the main element. There may be problems for locals (living close to a spaceport) if international private industries become involved without, or with only a limited, intentions to involve the local community, mostly related to Earth spaceport towns. For example, in the worst-case scenario, the model for conceptualising space tourism could follow the example of the cruise ship industry, where spaceports become all-inclusive multifunctional spa resort experiences, leaving revenue for the "Earth community towns" almost non-existent, and possibly even minimising the tax paid to the host country (Cole, 2015; Toivonen, 2020, p.89).

In many tourism destinations, there has been a paradigm shift from "tourism growth" to "tourism degrowth", as "overtourism" has become a rapidly evolving contemporary tourism phenomenon, often uncontrolled and unplanned, resulting in social movements in the form of protests and activist campaigns (Milano, Novelli & Cheer, 2019). Destination space" is in its pioneering stage, and not yet facing socioecological conflicts due to "overtourism" as its high costs will limit potential clientele (Toivonen, 2020). This tourism degrowth discussion will eventually be relevant, however, to predicting future planning as the debates concerning "overtourism" offer valuable opportunities to re-politicise the discussion of tourism development generally, in order to facilitate genuine sustainable tourism (Fletcher et al., 2019).

2.5 Plurality

There is a need for conceptual plurality in the fields of futures and tourism studies (Yeoman et al., 2021). Plurality in futures studies directs practitioners towards multiple possibilities, and opening minds to pluralistic potentials (Sardar, 2010, p.182). Healy (2003, p. 689) argues that "the destructive effects of the hegemony of scientific rationality on society, culture and politics can be countered by an approach of 'epistemological pluralism' that legitimises and deploys other ways of knowing". Epistemological pluralism can be intended as a step in the direction of

reconceptualising knowledge, and, consequently, reconfiguring the power relations and pluralist knowledge in political decision making; it thus indicates that the reality is very much a matter of human choice (Healy, 2003). Epistemology also leads to questions about the forms of knowledge associated with science fiction and how it can be seen as tool for gaining knowledge. According to Yeoman et al. (2021) such forms of knowledge could involve, for example, a plurality of futures and authenticity through which to focus on the contextuality.

This thesis includes different forms of plurality. The future itself may mean tomorrow, in the next 20 years or even in forthcoming centuries (Asselt, Klooster, Notten & Smits, 2010). "Thinking the impossible or making the impossible possible is one of the roles of science fiction in tourism futures research" (Yeoman & McMahon-Beattie, 2021, p. 27): representing a degree of truthfulness as the difference between myth and reality, or alternatively a mechanism to explain how something could become true. Current future visions for space tourism developments are in symbiosis with earlier science fiction films and literary writings, some dating back over a hundred years - hence a plurality in time horizons. Planning and policy making in countries has also started to move more from an evidence-based approach to a futures perspective (Boston, 2017), and this transformation can be seen in the fast-paced policy making resulting from the uncertainties caused by the Covid-19 pandemic. Boston (2017) characterises the future according to different levels of uncertainty, and the further the time horizons extend, the greater the uncertainties encountered; such with the emergence of black swans (Taleb, 2010).

As uncertainty increases, the time horizons shrink, and it is therefore necessary for policy making to reflect such time horizons. There is therefore a plurality present in future planning approaches. In order to achieve sustainable global tourism, there needs to be an acknowledgement of future uncertainties and how they relate to developments in future tourism (Postma, 2021). This is especially important as the space tourism experience can take place in multiple locations: on Earth, in the space environment and in the virtual world. There is thus a need to explore multiple futures and anticipate the possible changes that they will bring, setting a domain of scenario planning. Anticipating the future in current complex world can be politically unrealistic, however, as politics tends to reflect a society's existing issues and concerns (Boston, 2017). Creating global and local regulations for newly emerging industries, such as New Space, with timescales of hundreds of years (space colonies), is therefore very challenging, especially if existing "factual knowledge" is mainly based on visions originating from science fiction movies. Future scenario planning, however, which predicts the future through academic research methods and principles, including the science fiction method, could form "credible enough" visions to assist with the planning of the New Space tourism industry.

There is also plurality of concepts originating from futures studies and tourism studies. Hybrid research involving futures and tourism implies that there are many

truths to be seen through different lenses and perspectives, as gained through multiple sources of knowledge (Searle, 1995). In previous research in the field of futures studies, Heinonen, Kuusi and Salminen (2018) recognised a gap between futures research and policy making, and suggested the use of hybrid research methods to open up more complex issues, such as those related to climate change, in order to support future decision making. Krawczyk and Slaughter (2010) investigated the broader role of young people as agents of cultural change in societies from many perspectives. Miller (2007) analysed the topology of storytelling about the futures using a hybrid strategic scenario method, and Trujillo-Cabezas (2021) investigated future alternatives to decision-makers to facilitate the further exploration of the future.

Research combining both tourism and futures studies is present in the academic literature; for example, in forecasting future demands for tourism (Song, Qiu and Park, 2019), investigating the nature of collaboration in projects of academic activism and co-creative research in theory and in practice (Cave & Higgins-Desboilles, 2017), and in the strategic planning of tourism, adjusting to changes in the future operational environment (Kajanus, Kangas & Kurttila, 2004). Hybrid methods of research within futures and tourism studies, which involve using several techniques in one study, are present, for example, in exploring improvements in tourism performance for making sustainable development strategies (Peng and Tzeng, 2019), in presenting a strategic approach to help to develop sustainable tourism in touristic destinations (Kisi, 2019), in assembling learning paradigms for tourism forecasting (Shabri, 2015), and in evaluating the green performance of airports (Ashwani, Aswin & Himanshu, 2020).

Lastly, there is a plurality present in the conceptualises of truth (referring to facts), and falsities (referring to imagination), reminding us of the existence of scepticism. For example, the IPCC reports provide mathematically-based facts regarding Earth´s environmental condition to support the knowledge and dissemination of different institutions, nations and industries. Science fiction can involve soft falsification or distortions of truth, and therefore, any predicted future of value should involve a degree of scepticism (Dator, 1986). Also obtaining exact data for the future is impossible, as the future has not yet occurred (Yeoman et al., 2021). Scepticism is important, as it challenges the notion of truth and asks the question of what else is possible, or indeed impossible. It is however common for visions of the future to face scepticism from the members of society who see the future differently, therefore, weakening the confidence of futurists, an effect enhanced by the need to also compromise for various institutional and bureaucratic interests (Sardar, 2010). Scepticism about future issues also often appears as the only ethically sound approach, originating over two thousand years ago when Pyrrho of Elis, one of the first postmodernists and the founder of "Pyrrhonism" as scepticism, declared: "everything is indeterminable, hence to suspend judgment about the reality of things, happiness is only possible by being suspicious of claims" (Hankinson, 1998).

3. Methods

This chapter explores the methods used in this thesis. The methodology sets the guidelines for conducting research, and the chosen tools guiding the collection and analysis of data, and the interpretation and (re)construction of empirical materials (Sarantakos, 2005). A research paradigm sets the common beliefs and agreements about how questions should be addressed; the ontology, epistemology and methodology create different holistic views of how the knowledge is approached (Kahn, 1965). This thesis is guided by the grounded theory method and epistemology, which focuses on what is known to be true, and where the conception of justification can be based on having sufficient evidence that the belief is at least likely to be true (Alston, 2005). Visions and forecasts are thus epistemological activities, as they are based on some theory of knowledge, but do not yield knowledge of the future itself (Sardar, 2010, p. 178).

Grounded theory is a research approach that focuses on interaction and responses (Savin-Baden & Major, 2013), and where the theory is derived from data (Glaser & Strauss, 1967). The epistemological stance of grounded theory is often objectivism (Annells, 1997), which is the "belief that truth and meaning reside within an object and is independent from human subjectivity" (Levers, 2013 p.3). As the New Space tourism industry has barely emerged, however, it is difficult to measure a single reality or truth, and so constructivism was utilised as a grounded theory research philosophy instead, as in futures studies it implicit in underlying assumptions and interprets reality to discover the underlying meaning of activities (Crotty, 1998). There are different types of meanings when understanding futures under epistemology, which is useful in envisioning futures planning processes. A predictive futures approach (Gidley, 2016), commonly used among planners, was taken regarding epistemological futures in the empirical research, which followed grounded theory methods, supplemented by comparative content analysis and the Delphi method as additional techniques to gain more specific data. Expert knowledge was thus essential to provide more in-depth understanding and visions to create future scenarios

3.1 Grounded theory

Grounded theory is both a method of enquiry and a product of that enquiry, and has various definitions. Glaser and Strauss (1967), who are recognised as the founders of

grounded theory, originally developed the constant comparative method, which is the key element in the theory. The analysis provides conceptual theories that explain the studied empirical phenomena by looking for similarities in data, comparing incidents to incidents, and then creating new data with theoretical sampling (Glaser & Strauss, 1967). Strauss and Corbin (1998, p.12) define grounded theory as "a theory that was derived from data, systematically gathered and analysed through the research process". Charmaz (2006, p.187) has a more constructivist perspective, defining the theory as "a method conducting qualitative research that focuses on creating conceptual frameworks or theories through building inductive analysis from the data".

In the various orientations of grounded theory, Glaser and Strauss (1967) explain that the research question arising from the data has not really been reconceived beforehand, whereas Strauss and Corbin (1998) suggest that questions and problems can be drawn from the literature, or from personal interests as the basis of research. In Glaser and Strauss´s (1967) approach all the categories emerge from the data, while Strauss and Corbin (1998) allow the data to be forced, to some extent. Grounded theory offers the ability to transcend other current theories and raise the conceptual level of action itself to a theory, using a constant comparative method (Glaser & Strauss, 2007; Glaser & Holton, 2007).

Generating theory involves several steps, and a researcher may move back and forth between these steps, even working on two different processes at time, collecting data, and open-coding incidents line by line, while constantly comparing incidents (Untamala, 2014). A researcher generates memos by name and writes about the ideas connected to the codes, and their relationships throughout the entire research process. The analysis continues with more selective theoretical sampling, coding and memoing, concentrating on the core problems until the memos are saturated (Untamala, 2014). Theoretical saturation occurs when no new information emerges from the coding and analysing, and the same properties repeatedly emerge (Glaser, 1978, p. 53).

I used Charmaz´s (2006) constructivist variation of grounded theory for this thesis synthesis, both to direct the elaboration and to assist in opening up the research questions in order to form new future scenarios for discussion. According to Syafini, Suhairi & Hussin (2016, p.189), in Charmaz´s (2006) variation a researcher may "go outside of the shell in looking for meaning in the data, seeking for and enquiring implicit meanings about standards and principles". Charmaz´s (2006) grounded theory generation consists of adapting certain categories as theoretical concepts, the re-examination of earlier data, and sensitising the concepts.

A classical variation of grounded theory by Glaser and Strauss (1967) was, however, used for the published articles and the book chapter, because I felt it fitted more comprehensively in order to gain basic information to make the emerging theory more understandable (Levers, 2013). Such clarity was important, as my approach

to grounded theory was "minus-mentoring", a term generated by the originator of grounded theory, Glaser (1967), referring to the use of grounded theory without access to formal training. Grounded theory is less utilised as a research methodology in Finland: it however particularly enables the creation of data from a smaller sample group, which is often necessary in "futurist" subjects without many available professionals (Hämäläinen, 2019).

3.2 Adopting categories to theoretical contexts

In order to start finding answers to my research questions, I first drafted a theory-based framework which grouped the different sustainability elements often present in tourism planning into similar themes. I explored existing theoretical space tourism and sustainability readings selected according to my own personal interests (Strauss & Corbin, 1998), and was able to create a new futures framework by grouping similar topic-related themes together, calling it the "Sustainable Future Planning Framework" (Article A, p.27). The main intention of the framework was to support the writing process of my thesis, however, as the New Space tourism industry is forecast to have significant economic prospects, attracting businesses from various different backgrounds, I also perceived it as prudent to visually demonstrate he sustainability elements of importance for this new sector in tourism industry.

For Article B I interviewed a small (five) group of New Space tourism-related professionals, with the main aim of obtaining more detailed information on the emerging New Space industry and space tourism. The data gathered involved five 45-minute in-depth interviews. The participants included senior researchers in fields related to futures and space technology, as well as a politician and a space tourism entrepreneur, whose visions of the future of space tourism are reported anonymously. The interview questions were developed with regard to understanding the theoretical and conceptual elements of this thesis. The interviews were transcribed word-for-word, to ensure the reliability of the data for analysis. The number of interviews was defined as comprehensive after similar observations began to occur, and so only five interviews needed to be conducted (Glaser, 1978).

After initial sampling of the data I first asked "what is going on in the data?" which is defined as a key question in grounded theory research, with the aim of providing new knowledge about "what is happening" regarding the phenomenon under investigation (Untamala, 2014). For Article B, open coding involved coding the littered interview line-by-line. The aim was to compare similarities across the respondents' visions for the future. For example, when a person interviewed mentioned "debris" I initially coded this as "environmental impact" and in the category of "space legislation". I coded the data into several categories by comparing

one incident to other incidents. The delimitation of categories was achieved through selective coding; the primary categories related in some way to the core variable.

After theoretical sampling the data was coded using both open coding and selective coding. In open coding the researcher identifies incidents in the data, naming the properties of each category and coding a category, similarly asking "what category does this incident indicate?" (Glaser, 1978, p. 57) to generate the core theory. In order to avoid simple paraphrasing, some "theory-generating" questions could be asked of the text, such as "what aspects of the phenomenon are addressed or not addressed?" and "for what reason or purpose?" (Böhn, 2004, p. 271). The researcher can use their background knowledge about the context and their knowledge about the area under investigation when coding, making it possible to specify different aspects of the phenomenon being investigated (Böhn, 2004; Untamala, 2014). As the data is broken down analytically, line by line, or in longer paragraphs, I was able to discover how the respondents reacted to the main question by naming concepts and categorising them according to incidents in the data to form the body of the theory.

I originally had no knowledge of the amount of coding the data required, nor the actual results possible. I had some specific coding decisions in mind from the secondary data gathered from reading about space tourism on various internet pages and in newspaper articles from the beginning of my theoretical sampling process. The first emerging concepts were codes that helped me to start the comparison of incidents to form more categories, and this open coding led to the discovery of the core variables. The categories were found during the open coding process, and I read the data through many times to ensure nothing was missed. Some new coding decisions evolved as I analysed the data, however, as I noticed there was a need to be more specific and selective.

The change from open coding to selective coding is an important move in the process of grounded theory, as the decision to code for a single core category helps the researcher to see the other categories as subservient to the main category (Untamala, 2014). According to Glaser (1978, p.61) in selective coding the researcher is limiting the coding to only those "variables that relate to the core variable in sufficiently significant ways to be used in a parsimonious theory". The concepts discovered can be named according to substantive coding, which begins with open coding and proceeds into selective coding. "Theoretical codes conceptualize how the substantive codes may relate to one another as hypotheses to be integrated into a theory. They, like substantive codes, are emergent; they weave the fractured story back together again" (Glaser, 1978, p.72).

Finally, I was able to establish the set of concepts and named eight different categories: space legislation, economic impacts, alternative energy sources, the circular economy, contemporary trends, health space tourism, space colonies, and virtual travel and robotisation. I then moved those emerging concepts into

broader concepts called *Future Visioneering* and *Searching for Knowledge*. I named the main tentative core variable for all the concepts *Making Space Human* (Article B, p.60).

3.3 Theoretical sampling for specific data

As the number of participants for Article B comprised a relatively small sample, I decided that more theoretical sampling was needed to gain new knowledge and more comprehensively answer the research questions. According to Glaser and Strauss (2007, p. 45), "theoretical sampling is the process of data collection for generating theory whereby the analyst jointly collects, codes and analyses their data and decides what data to collect next and where to find them, in order to develop his theory as it emerges". Theoretical sampling could be described as an essential procedure in grounded theory, as it is a way of bringing forward codes from the data through constant comparison (Untamala, 2014). It is an ongoing process, guiding the work of the researcher by pointing out emerging categories which lead the researcher to look at the incidents that should be coded next, even utilising secondary data that has been collected for other purposes, and the overall literature (Glaser & Strauss, 2007). I decided to use additional techniques, comparative content analysis and the Delphi method for Article C, to ensure focused coding in the process of gaining new specific data.

3.3.1 Comparative content analysis

The quantitative data for Article C was collected using Webropol online survey, which is a commonly used research tool in Finnish universities. The gathered data was analysed using principle component analysis, which first emerged in 1933 in the *Journal of Educational Psychology* alongside factor analysis. Principal component analysis aims to reduce the dimensionality of a multivariate dataset, and illuminate its interpretation by identifying a smaller number of variables which summarise the larger set (Bartholomew, 2010). Creating original variables (Hair, Tatham, Anderson, & Black, 1998) helped me to gain a better understanding of the data (from the survey). I first used Kaiser-Meyer-Olkin (KMO) and Bartlett's test for sphericity (Child, 2006) to test the components and indicate the proportion of variance in the variables. I was able to calculate the strength of Cronbach´s alpha for each component using reliability analysis (Hair et al., 1998). I was then able to derive five components, describing them as *environmental*, *social*, *ethical*, *political,* and *technological*, to reflect similar themes classified in the STEEP model of future tourism (Nordin, 2005; Article C, p.7).

I visited various public places to find the participants for the survey, including two libraries (located in Vantaa and Espoo) and two university campuses (located

in Espoo and Porvoo), so as to access different age groups and backgrounds. Computer access was required to complete the survey, and I provided a web link for the people, aged between 18-75 years old, who were willing to participate. Data collection took place between February and March 2019, and the sample size was 132 respondents out of 336 people originally given the link (152 people started the survey but did not finish it). Eighty-seven of the respondents were female and 45 were male. The majority of the respondents had university level education; 49 holding a Bachelor´s degree, 42 a Master´s degree, and two a Doctoral degree, and 39 had at least a secondary school level of education. The respondents came from various of backgrounds, including senior professionals (28), employees (35), students (55), pensioners (6), and (8) unemployed or stay at home parents. Fifty-five of the respondents were under 30 years old, 64 between 30-50 years old and 13 between 50-75 years old. There were limitations to the data collection, as some people over 50 considered the survey topic too unrealistic and therefore declined to participate. Admittedly, the New Space tourism industry was not publicly active or recognised at the time of survey, resulting in less participation in the survey.

The respondents were asked to share their views on space tourism by endorsing (or not) 29 statements on a Likert scale from 1 ("strongly disagree") to 5 ("strongly agree"). The Likert scale is a psychometric scale often used in academic research, where respondents specify their level of agreement or disagreement on a symmetric agree-disagree scale for a series of statements (Likert, 1932). The scale format used for this survey included five level items: 1= strongly disagree, 2=disagree, 3=neither agree or disagree, 4=agree, and 5= strongly agree. The questions related to the environment and to space tourism, highlighting current concerns and actions involving climate change as presented in the Finnish media, with one open-ended question on sustainable space tourism. The first half of the questionnaire concentrated on the environmental-related aspects and personal behaviour of the respondents, asking, for example, for scaled responses regarding whether "I am concerned about global warming", and "I feel it is hard work to act in an environmentally-conscious fashion". My purpose was to determine the general public's environmental attitudes towards the current global megatrend of sustainability. The second half of the questionnaire concentrated on views regarding space tourism, asking, for example, for scaled responses about whether "I would like to go on a space trip if it were economically possible for me". Lastly, an open question, "what kind of space tourism is sustainable?" gathered the views of the respondents about sustainability in space tourism (Article C, p.5).

3.3.2 Delphi method

The Delphi method is a technique for structuring the communication process of a group in order to help understand and deal with the future development of a complex problem (Linstone & Turoff, 1975). The method employs a phased process

based on the interaction between the managerial researcher and a panel of experts, and is suitable for complex research where the content or solution is still unknown, often in a future time axis, and therefore important as the subject of a multifaceted discussion (Linturi, 2020). The problem or unresolved issue appears in the present, but its solution or solution options will appear in the future. Anticipation thinking simplifies the dynamics of looking at the event by looking to the future to find ways to deal rationally with the current situation (Bell, 1997). The panel consists of a diverse group of experts on the phenomenon under consideration, expertise is sought from different directions, and the diversity of perspectives is further increased by the fact that different panellists have varying interests in the phenomenon. The phenomenon is studied round by round, and the experts are assigned to interact with each other in a way that can be defined as community learning (Kuusi, 1999; Linstone & Turoff, 2002).

The qualitative data for Article C was based on a variational argument Delphi, which aims to develop relevant arguments and identify the underlying reasons for different opinions on a specific issue (Hasson & Keeney, 2011; Kuusi, 2017). The survey took place on the virtual eDelphi platform between 1 -14 April 2019, and the instruction letter was sent to the participants two weeks previously. I played a proactive key role as a "research manager", initially defining the research questions (future claims), implementing the survey and finally analysing the findings. Before sending the invitation to join the electronic panel environment, I designed the future questions with an open and clear structure, aiming to encourage the panellists to justify their choice of answers. My selection criterion for the panellists included professional backgrounds involving diverse angles on the future phenomenon of space tourism, and previous national media or press statements based on their field of expertise.

Ten Finnish professional experts were able to join the panel out of 12 invitations, and included professors and researchers from the field of tourism, futures foresight, law, and meteorology; a politician, governmental space industry executive and a space tourism entrepreneur. Timeline scaling was used in the question setting, and the year 2040 was selected as a reasonable point in the future: sufficiently soon for contemporary events to be forecast but not so far away that the forecasting became utopic. The panellists were grouped into three categories depending on their professional background; a *tourism* group, a *future* group, and a *space technology* group. These groups were needed to clarify the background context for the in-depth citations. All the panellists were able to respond to each other's comments during the panel round – but, however, remained anonymous.

The Delphi panellist responses consisted of two parts, the first being a scale response and the second justification for this scale choice. The panellists were able to comment to each other as well as change their original responses throughout the response round. Usually there are two or more rounds in Delphi, in which case the

questions also evolve during the session (Kuusi, 1999; Linturi, 2020). In my study, two complete rounds of Delphi were modified innovatively as the first round, and the quantitative estimates were sought from the online survey instead of from the panellists. It is typical of Delphi that the results are analysed between the rounds, and the processed data is shared for panel use to deepen and expand the future scenarios (Linstone & Turoff, 2002). In the second Delphi round, the component-based results were finally presented to the professional panel to allow them to make judgements and arguments deviating from the first-round estimates (Article C, p.6).

The panel was presented with future claims involving quantitative findings on the environmental, social, ethical, political, and technological prospects of space tourism, and the formation of the environmental claim, for example, consisted of concerns expressed about the amount of resulting emissions (claiming space tourism would be abandoned by 2040). The future claims were: 1) space tourism will be completely abandoned by 2040; 2) by 2040, space tourism will have enabled humankind to establish new colonies in space; 3) space tourism will only be an activity for the elite before 2040, 4) the future law of space tourism emphasises, in particular, sustainable development extending to 2040; and 5) virtual travel is the most likely means of visiting space by the year 2040 (Article C, p.6).

Before commenting on each question, the panellists were asked to decide the probability and desirability of the futures claim, similarly to on a Likert scale (i.e., from "least likely" to "most likely"), and their responses were placed as a median and quartiles. For example: the environmental claim reflected concerns about the impact of climate change, and claimed that space tourism would be completely abandoned by 2040; most panellists agreed that sustainable space tourism was desirable; they also agreed that the probability of it occurring soon was unlikely. Grounded theory was then used to analyse the views of panellists regarding the different future claims. The data was first sorted conceptually. This was followed by selective coding to identify connections between the in-depth responses to the future claims (for example, to identify similar sustainability themes in relation to space tourism). Finally, the responses were grouped into categories to create sustainable dimensions in relation to future space tourism (Article C, p.7).

For Article C, I followed Glaser and Strauss (1967) by looking for similarities in data and comparing the incidents. I analysed the data involving the qualitative explanations from the Delphi panel line by line, and compared each incident to another incident, which could be with a couple of words, and coded the incidents by associating them with a concept. For example, the emergent concept for the code "equality" triggered a shift to selective coding that meant it required theoretical sampling, as did the categories related to it, leading to the emergent concept of "comparative fairness". I also compared the properties of the categories such as *space debris is a threat* to other similar incidents, and conceptualised it first as *causing financial loss as not safe* and then as *new technological innovations needed*.

The category "technological innovations" was then formed, which later became a property of "new green space economy", a sub-category under the core category of "national sustainable development goals" (there is usually only one core category in a grounded theory study; Glaser, 1998, p.150).

While coding I simultaneously wrote memos and notes that captured the ideas of coding. The writing of memos, which are a "theoretical write-up of ideas about codes and their relationships as they strike the analyst while coding" (Glaser, 1978, p.83), is an essential part of grounded theory methodology, and the generated memo fund can be used as a basis for the theory. My memos were spread over many pieces of paper, handwritten using both Finnish and English, and included some spelling mistakes, which is however irrelevant (Glaser, 1978) as the main purpose of the memos was to restore my thoughts in the further sorting process and later be able to compare codes and memos with additional data. An example of a memo, written in English and not paying attention to grammar or length was: *space tourism no equality, negative attitudes. How about prospects, imaginations, solutions?* At the end of each analysis session I sorted my memos into different title piles (of paper), according to the category addressed, so that they could be used later. Lastly, I sorted my memo piles, defined by Glaser (1978, p.130) as a "construction job", to start writing Article C.

3.4 Validity and reliability

Validity as a concept refers to quality and trustworthiness (Golasfshani, 2003). According to Creswell and Miller (2000), the validity of research is not a singular universal concept with a clear explanation, but rather depends on the fact that the research community accepts the results as true and trusts the data is gathered and analysed properly. This thesis research thus followed responsible conduct according to the research guidelines of the Finnish National Board of Integrity. Reliability ensures the quality of the research, including the researcher´s credible explanation of the methods used (Davies & Dodd, 2002; Golasfshani, 2003), and the concept should be included throughout the research process from the early planning of the research to the final analysis of the results (Patton, 2001). Reliability is ensured by describing the research process in detail, including possible limitations or mistakes (Golafshani, 2003). Research also needs to involve ethical principles such as openness and trustworthiness, to be integrated with reliability and validity (Davies & Dodd, 2002).

In this thesis I followed the principles endorsed by the research community when evaluating the research results. All the necessary permits were acquitted and ethically followed, such as respecting the anonymous status of all respondents, and individual respondents thus cannot be identified. The existing literature supporting the

formation of the theoretical conceptuality of this research was cited appropriately to give credit to achievements made by any earlier authors. The results were publicly communicated in the published articles in an open and responsible fashion that is intrinsic to the dissemination of scientific knowledge. There were, for example, no conflicts of interest to report, nor other commitments arising from sources of financing (as there was no external funding for this research).

The planning and conduct of the research complied with the standards set for scientific knowledge and gathered data, such as the littered text from the recorded professional interviews and the handwritten notes for the grounded theory process being obtained over many years of research. All data was archived following the European Union data protection protocols. The data for this research was gathered from multiple sources which also complicated the interpretations, however, the chosen methods generally complemented each other well, even though each of the methods also had weaknesses. The grounded theory method suited the empirical data collection, as the method enabled the creation of data from a smaller sample group. This was especially important as New Space tourism related professionals are still scarce. The collected data was enough to provide similar incidents to create new data with theoretical sampling (Glaser & Strauss, 1967), however, as the method was based on minus mentoring, and existing parallel results were not available (which normally increase the validity of research and widen the applicability of the findings), there is a possibility of misinterpretation.

There were two sets of corrections made in this thesis for Articles A and C. The Sustainable Future Planning Framework, found in Article A, involved a graphical mistake as an arrow between the boxes of sustainability and weak signals pointed in the wrong direction, and this mistake has been corrected in this thesis (figure 2). The correct graphic can already also be seen in the non-fiction book *Sustainable Space Tourism – An Introduction* (Toivonen, 2020). Article C had incorrect interpretations in two sentences involving negative factors and their correct interpretation should had been expressed in the opposite way. Firstly, on page 7, the sentence "the findings indicated positive individual values attached to sustainability and the practice of environmental actions, although the practice of environmentalism was also considered challenging: indeed, "I feel it is hard work to act in an environmentally conscious fashion" (-.329)" is corrected in this thesis as "the practise of environmentalism was not considered challenging", as a negative factor opposed the question. Secondly on page 7, the sentence "the development money used for space tourism should preferably be used to solve the problems of humankind" (-.458)" is corrected in this thesis as "there was support to development funding for space activities", as a negative factor opposed the question. There was also some justification to the creation of space debris as result of space activities, as a negative factor opposed the question "humankind has no right to litter the space environment (-.364)".

Even though these public opinions were interpreted the opposite way in Article C, the lack of clarity (caused by the ambiguous format of these questions) did not affect the creation of future claims for the Delphi panel. It can be noted that the correct interpretations for the questions strengthened both the environmental and social factors: as "the practise of environmentalism was not considered challenging" is in line with the answers to other environmental questions, hence supporting the consideration of the environment and "there was support to development funding for space activities" is in line with the positivity expressed towards space activities, which emerged from other "social" questions. "There was some justification to the creation of space debris as result of space activities" indicated a certain realism to operations in space to cause some space debris, especially as the question itself was unconditionally formatted as: "humankind has no right to litter in the space environment". Otherwise especially the qualitative findings expressed a desire to minimise the creation of space debris.

As the New Space tourism industry has only just started to operate, the available knowledge and actual experience, and its potential effects barely exist yet, meaning that it is difficult to compare results. Many future space tourism related spin-offs, such as space colony travel, are also still considered pure science fiction, and so the futuristic topic itself affects the reliability and validity of the research. The quantitative data sample, analysed using comparative content analysis, turned out to be relatively small despite an online link given to the respondents, and even though there was no need to separately travel to a physical site to participate. Insights regarding future travel that does not yet exist were limited in the 50+ age group, as almost half the respondents starting the survey did not complete it. Most of the completed responses came from the 20-30-year-old group, which affected the overall parallel data comparison, and also the interpretations of the open question. Conversely, the invited Delphi panellists were leading experts in Finland (in their own fields) which contributed comprehensive reliability and credibility to the study, and also provided an ideal communication level between the panellists. As the panel took place in an eDelphi (online) format, however, some of the questions lacked argumentative follow-up discussions, despite my managerial prompting. Some opinions could thus have been strengthened or weakened in a real-life panel situation, affecting comparisons to similar future research if not repeated in a similar eDelphi platform.

4. Findings

This chapter explains the empirical findings reported in the articles and the book chapter, supplemented with theoretical concepts from the fields of futures and tourism research. Sensitising the concepts (Charmaz, 2006) involved opening up sub-research questions asking "how can sustainability be included in future space tourism planning?" through Article A, "what concepts relating to the context of space tourism and sustainability can be highlighted through research into an as-yet-non-existent-future?" through Articles B and C, and "how is the combination of space tourism and sustainable development currently envisioned by the public and field professionals in Finland?" though Article C. This supported the creation of perspectives (future scenarios) for the main research question to be discussed in Chapter 5.

4.1 Framework for planning future sustainability for space tourism

The study of tourism draws on a multiplicity of disciplines, and tourism futures thus needs theoretical frameworks to contribute towards the evolution of tourism research (Yeoman et al., 2021). There are tensions between the planning and futures frameworks, as planning seeks to control the future, while futures studies seeks to open up the future, moving from "the" future to alternative futures. A cogent theoretical framework is thus needed in order to understand the future(s). A predictive futures approach has been commonly used among planning and policy makers as the future is used to improve the probability of achieving a certain policy, phrased as "responding to the challenge of the future" (Inayatullah, 2013). In the current world full of uncertainties (Boston, 2017), however, questions should be raised about the way that policy-making processes and analytical frameworks should be designed to increase the likelihood of long-term interests, not just for the existing populace, but also future generations.

In order to prompt answers to the first research sub-question, "how can sustainability be included in future space tourism planning?" I created a future tourism framework to guide the futures planning process in Article A. Theoretical readings from the fields of both futures and tourism research assisted in the formation of the framework´s main themes and sub-themes. The "Sustainable Future Planning Framework" demonstrated that planning, sustainability, weak signals and future scenarios should act in synergy with each other, and thus formulate a contextual framework for future space tourism planning.

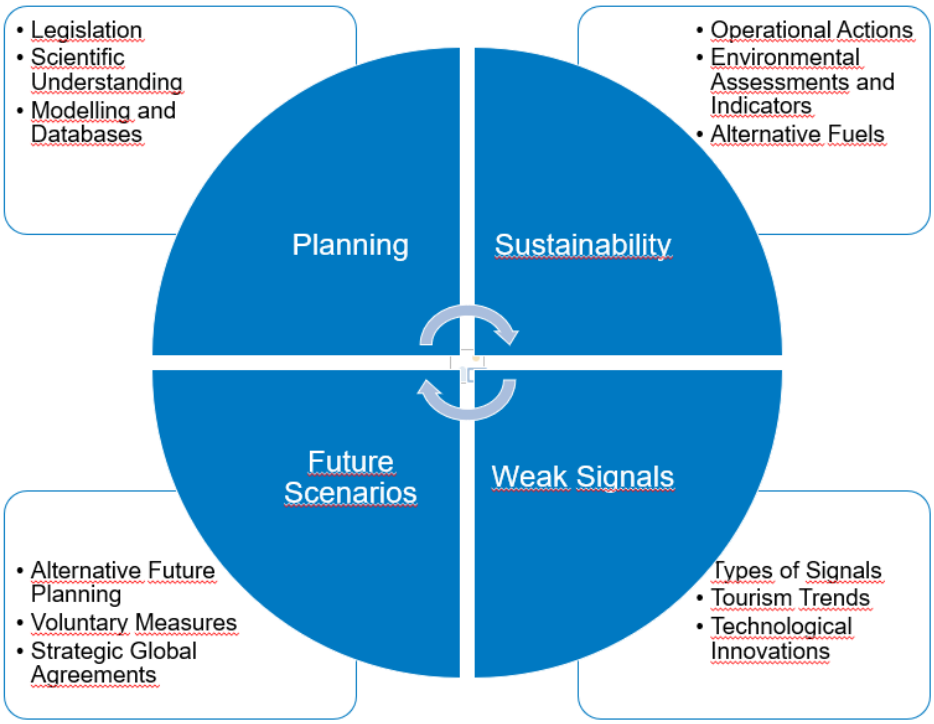

Figure 2. *Sustainable future planning framework (Article A, p.27)*

In the framework, "planning" involves current governmental legislation and action plans, scientific understanding, as well as modelling and databases that may be used as predictive tools to offer a consideration of the future, composed of the collective knowledge used to predict developments and decision-making. As tourism planning and policymaking are also a result of the ideas, actions and collaboration of diverse agencies, and draw from many disciplines, including politics, economics and history (Dredge & Jenkins, 2011), space tourism in this context could be seen as an objective or political consensus resulting from discussion among stakeholders (Rametsteiner, Puelzl, Alkan-Olsson & Fredriksen, 2011; Article A, p.27).

A question may be asked; how can the likelihood of short-sighted policy-decisions, meaning those threatening or undermining the long-term wellbeing of citizens, be minimised? (Boston, 2017). According to core message from recent IPCC reports (2018, 2019) and Gössling et al. (2009, p.4), "the most relevant issue for environmentally sustainable tourism is climate change, both because tourism is affected by climate change and because the sector is a considerable force of climate change". It is thus necessary for the Sustainable Future Planning framework to involve the megatrend of "sustainability", consisting of operational actions, environmental assessments and indicators, and alternative fuels.

Sustainable tourism products have related to eco-tourism since their introduction in the mid-1980s, when sustainability was a core component of the product's definition, especially in the marketing and academic literature (Fletcher, 2008). The sustainability discourse itself assumes objectivity regarding environmental issues and the intellectualisation of travel (Sharpley, 2015). Sustainable space tourism may at first appear to be an impossible task due to the elements commonly associated with both tourism and space travel, as fashionable practices in tourism concentrate on keeping nature and destinations as untouched as possible (Mowforth & Munt, 2015). In the tourism industry and within tourist activities, however, the status of "becoming sustainable" begins when the tourism business is not only concerned about its economic future success, but also wants to introduce environmental and social aspects as part of its future operational activities and business strategies. According to Garcia-Rosell (2019, p. 229), "any kind of tourism can be responsible if it adheres to the principles of responsibility, requiring the responsibility of stakeholders involved in the travel activities and the achievement of the sustainability goal requires that operators take responsibility for the action and their consequences."

Indicator-based sustainable tourism strategies can be complicated, due to the actual process of selecting, measuring, monitoring and evaluating a set of relevant indicators (Weaver, 2005). For example, a transformation to more electric air transport instead of the traditional fuel-based fleet, cannot be classified as a fully sustainable process, despite the direct emissions measurements from the actual fleet showing otherwise, if the production line of the new fleet uses fuel-based energy sources, simply moving the creation of emissions to the production line. The aviation industry has so far practised sustainable actions by, for example, concentrating their focus on a more energy-efficient fleet and voluntary carbon offsets, paid by both the industry and the customer (Broderick, 2009). There is also ongoing research into alternative fuels in both aviation and the New Space tourism industry, to lower the impacts of the emissions (Carter et al., 2015; Article A, p.28).

The rapid development of interest and investment in space tourism has created its own trajectory, which introduces a new dimension to conventional notions of sustainability, and questioning how that could be applied to the space industry, space-related tourism and tourism as a whole (Scott, 2020). Spector et al. (2017) have proposed that the traditional scales of sustainability in local, regional, national and global areas now need to be expanded beyond the biosphere, as the Earth should no longer be considered the "sole realm" of human influence and responsibility. According to Spector (2020b), inter-generational notions of sustainability are now moving beyond the national and international boundaries encompassed by the four objectives of space expansion: resources, energy, survival and military dominance.

In the framework, "weak signals" involve types of signals, tourism trends and technological innovations (Coffman, 1997; Uskali, 2005; Hiltunen, 2013). Even

though the fundamental idea of the creation of space tourism works against the current trends of sustainability, the implementation of the industry could eventually incline more towards a modern eco-luxury operational level. Space tourism fits within the wave of current trends in modern technology seen in electric cars and innovative internet start-ups (Article A, p. 29). The first space race enabled the public to benefit from different technological innovations developed for both astronauts and inhabitable space stations decades ago. Future space vessels may enable more comprehensive research to inform the design of experiments on longer-term physiological changes due to space flight. These discoveries could eventually help the human species to colonise the Moon or Mars (Caplan, Winnard & Lindsay, 2017; Article A, p.29).

According to the TALC model (Butler, 1980), the weak signals suggest that the New Space tourism industry is still in the pioneering stage, however the industry has passed the 'feeling' and 'uncertain' stages, and is heading towards the 'almost certain' stage, as most of the infrastructure needed is now available for passenger use. The New Space tourism industry is already reflecting current trends in adventure tourism: for example, Virgin Galactic has raised (in the company website) the possibility of digitally recording one´s experience whilst in the space environment (Virgin Galactic, 2020), to be shared later on social media. Similar media coverage was also seen through media channels showing live global scale coverage of the first touristic launches of Virgin Galactic, Blue Origin and SpaceX (2021). The new technical innovation of re-usable space rockets (introduced by SpaceX in 2018) could be considered a game changer by initiating more sustainable operated future space exploration (Toivonen, 2020). Such space vessels may enable more comprehensive research to inform the design of experiments on longer-term physiological changes due to space flight. These discoveries could eventually help the human species to colonise the Moon or Mars (Caplan et al., 2017; Article A, p.29).

In the framework, "future scenarios" involve alternative future planning, voluntary measures and strategic global agreements. In the current postmodern era, characterised by uncertainty and contingency, various types of scenario planning have been used in the tourism industry and government decision-making to promote broader perspectives on the "landscape" (Yeoman, 2012). The capacity to anticipate and exercise foresight is thus important in contemplating possible problems and considering alternative scenarios and solutions required to gain sound anticipatory processes of sustainable governance and good long-term results (Boston, 2017). Alternative futures for the New Space tourism industry could be perceived through industry´s influence in global and local economies, its role in developments for space technologies and its positioning regarding future societies, including the formation of future space colonies.

There are already different voluntary measures being taken in the New Space tourism sector to improve actions for sustainability, especially at the operational

level practised in the building of "Spaceport America" (Fawkes, 2007; Toivonen, 2020). Also, for example, Blue Origin envisions lowering the access level to space with reusable launch vehicles, to enable a future where millions of people work and live in space (Blue Origin, 2020), increasing the economic level of sustainability (Fawkes, 2007). The strategic global agreements for space sector that currently affect the global tourism industry (such as Paris Agreement 2016) could also be adapted for the New Space tourism industry. There is still no global legal framework on the most prominent issues, such as the mutual definition of outer space and the demarcation of a boundary between outer space and airspace, which is currently governed by different legal regimes, but not commonly agreed upon (von der Dunk, 2019). The New Space tourism industry will be a private sector participant in the space environment, alongside the previously exclusive national and military usage, and so various legal issues will need to be resolved quickly, or alternatively voluntarily pursued. Such issues include, for example, voluntary guidelines for dealing with space debris, which could be a future safety threat to touristic space activities (Sharma, 2011; Article A, p.29).

4.2 Conducting research into a future which doesn´t yet exist

It is important, when future forecasting, to also look at history, and not just the future, so as to be aware of what lies before and beneath the future horizon (Sardar, 2010). Karl Marx concluded in the 1800s, that science and applied science technology would create progress, be the motor of social change and solve all human problems. McHale (1969) argued during the 1960s, that changes in the society are increasingly rapid and interrelated, and faster the pace of change, the further we should be looking forward. The 2010s drew attention to the global power of wealthy individuals, such Space X´s Elon Musk, influencing and accelerating the technological revolution both on Earth and in space environments (Toivonen, 2020). According to Inayatullah 2013), as technology creates new economies, new tensions will result, if society lags behind. It is therefore important to forecast how the new technology will affect future societies, and how planning and policy timescales can become more beneficial in accordance with such a futures perspective (Boston, 2017).

Compared to planning timeline, futures visioning is more longer-term, ranging from five to fifty years (even up to thousands of years, as in nuclear waste forecasting), thus connecting different time horizons. Timescales focus on macro-, meso- and micro-patterns of change to better affect social reality (Inayatullah, 2013). The shape of time may be linear, with progress ahead (Comte, 1875); cyclical, with ups and downs (Watson, 1958), or spiral with parts that are linear and progress-based and parts that are cyclical (Sarkar, 1987). So far, the New Space tourism industry

has appeared as spiral, as there have been delays with setbacks relating to safety, but also progress finally leading to the start of the industry. Developments in New Space technology, such as the satellites providing the internet network, could already be seen as creating a macro-pattern of change in ways of working, especially in Western countries (Toivonen, 2020).

As the New Space tourism industry has only recently taken its first operative steps, futures forecasting is necessary to understand this new sector, which is still commonly related to science fiction among the public. To find answers to the second sub-question, "what concepts relating to the context of space tourism and sustainability can be highlighted through research into a future that doesn't yet exist?", I used an existing future model, the "Futures Map" (Kuusi et al., 2015), to place the concepts created from Article B's findings on two different time horizons.

A "Futures Map" is based on two concepts: the planning horizon, focusing on history and the current situation, and the mapping horizon, focusing on future visions, with both time horizons being defined during the framing process (Kuusi et al., 2015). The planning horizon can be compared to the concept of a roadmap, as during the time of framing, the involved actors are committed to following the specified road on the map. The mapping horizon is the anticipated horizon of the map, where the possible futures and a scenario path may in fact have ended. Most scenario paths are defined by the mapping horizon, and there may even be many scenario paths leading to the same end point on the mapping horizon (Kuusi et al., 2017).

I placed the findings on either the planning or mapping horizons to create a picture of the possible futures. The concepts placed on the planning horizon were economic effects, legislation, alternative energy sources and the circular economy. These represented either historical or current ways of living in the developed world, or current global megatrends (Article B, p.61). An example of economic impact is that commercial space tourism was established in the wave of technological innovation hype after the Millennium, and similarly to the rapid development of social media and electric cars, space tourism-related prospects could become economically lucrative. Consumer trends in tourism will simultaneously shift to more sustainable practices in the development phase of the space tourism industry, resulting in an increase in awareness of more environmentally friendly fuel options and circular economy solutions among tourists. Lastly, even though new phenomena often start with ideas that are almost styled on science fiction, these ideas will be sooner or later be followed by an awareness among the wealthy elite (Markley, 2011). There is thus a need for awareness in governmental legislation that new policies need to be enacted as soon as possible (Article B, p.62).

When researching future phenomena in the tourism industry, ideas can remain imaginary concepts, or current travel trends can potentially be enhanced and later

adapted over a sustained timescale (Bergman et al., 2010). I identified the concepts of contemporary trends, health space tourism, space colonies and virtual travel and robotisation as either acceptable trends, or as existing in visioneering minds, and so placed them on the mapping horizon (Article B, p.61). As an acceptable future trend, the virtual travel concept follows the features of the postmodern tourist, who enjoys experiences even from home via virtual gadgets, and even accepts an inauthentic experience in order to prevent boredom (Feifer, 1985). The concepts discovered were then grouped into two established sub-categories through Glaser and Strauss' (1967) classical grounded theory categorising, to clarify their joint contextuality. The concepts on the planning horizon were placed in the *Searching for Knowledge* sub-category, the name reflecting the concepts on the mapping horizon in the *Future Visioneering* sub-category. The conceptual categories were then all gathered under the main category *Making Space Human* (Article B, p.68).

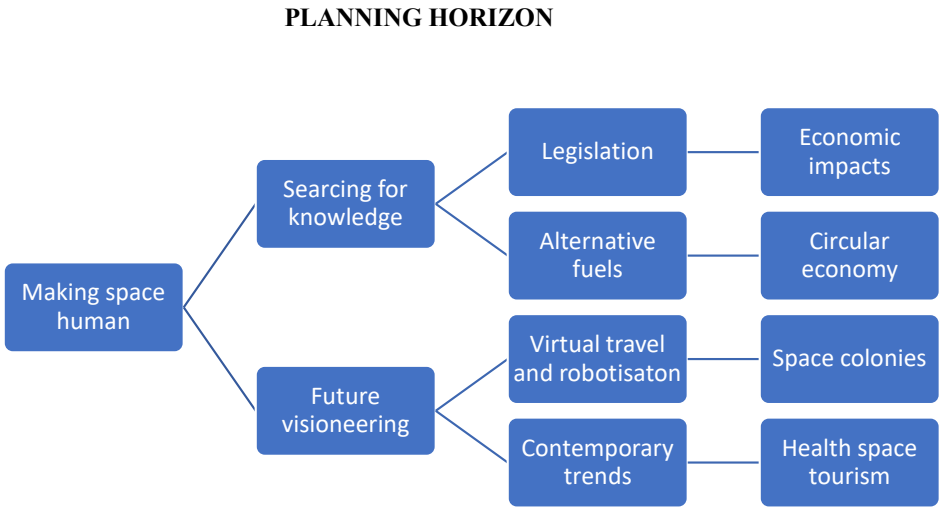

Figure 3. *Visual representation of concepts on planning and mapping horizons*

The empirical findings from Article C also provided additions to the same sub-question. According to Slaughter (1996) academia has traditionally valued the "past" more highly than the future, and thus discounted futures research, as the work presented is by nature speculative, and often lacks empirical testing, making wider scale collaborative agreement difficult. Future-predicting in tourism research is often demonstrated using different quantitative models, resulting in a lack of in-depth qualitative insights. According to Boston (2017), however, the

challenge of protecting the interests of future generations has many dimensions and there are multiple approaches; for example, for some it may be a priority to ensure that the world is safe and sustainable for their children and grandchildren in the future.

I was able to form four different sustainability dimensions for space tourism that were originally derived from the quantitative estimates sought from the public survey. I called the dimensions *virtual reality, comparative fairness, technological innovations and ecopolitics*, building up those conceptual areas from panellists' views. *Virtual travel* was so named to reflect the completely mutual Delphi panellist view of such activity, presenting a sustainable way of experiencing space tourism. *Comparative fairness* was named to reflect the concerns voiced about the world's equality issues. *Technological innovations* were named to reflect concerns, in light of climate change, about the future of Earth and humans. *Ecopolitics* was named to reflect mutual concerns over the current lack of space legislation. The idea of each dimension is to act as category, where similar concepts related to space tourism sustainability may be added later by other future researchers to widen the contextual meaning. An individual dimension in the New Space tourism industry, for example, might also be selected as the focus for improvement in a space tourism company's future sustainability plan.

Figure 4. *Visual representation of sustainability dimensions for space tourism*

The dimensions discovered were also visualised in a model in Article C, which elaborated sustainability-oriented future planning for the New Space sector in Finland. The model, "Sustainability New Space model for Finland" (Article C, p.6), included the main category called *"National goals for sustainable development"*. It was formed based on previous knowledge about the context of sustainable space tourism and the national planning process (Strauss & Corbin, 1998). A sub-category called *"Green New Space economy"* (referring to the positive approach in Finland´s existing space law to the environment and sustainability) was formed from various emerging concepts, combining both the environment and economy, from both qualitative as well as quantitative data (Glaser & Strauss, 1967). The sub-dimensions of virtual travel, comparative fairness, technological innovations and ecopolitics were separate sub-categories, each representing an area of improved sustainability.

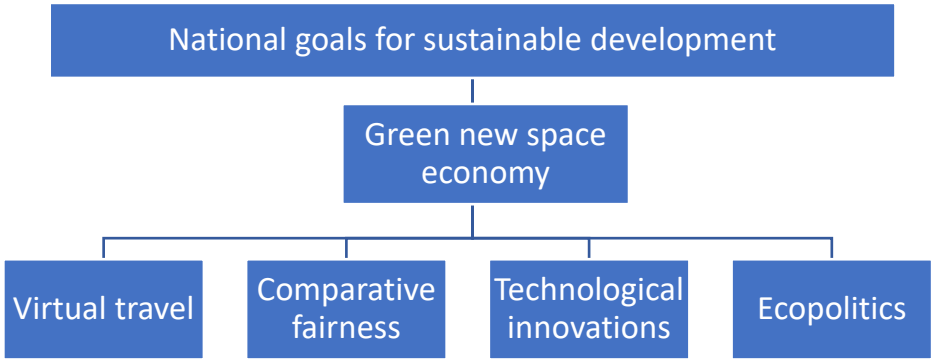

Figure 5. *Sustainable New Space model for Finland (Article C, p.6)*

As Finland was a case study country in Article C, some practical input was included to adapt the findings to "real life". The findings demonstrated that there could be a change in mindsets regarding the concept of space tourism; to include virtuality (virtual space tourism) as part of New Space tourism industry alongside operational tourism in the space environment. For example, different options for "virtual space tourism" in Finland could include connecting traditional naked eye viewing of the Northern Lights with other space-related, virtual multi-sensory possibilities, such as in purpose-built hubs.

Finland is committed to national social equality in education, and in Finland´s context "comparative fairness" highlights the importance of providing equal and affordable opportunities for space related higher education, instead of it only being accessible to a few from wealthy backgrounds. "Technological innovations" could be further promoted at the governmental level of funding for sustainably focused

space technology developments, exemplified by the Finnish invention of the electric solar wind sail (Janhunen, 2004), which collects space debris and thus also increases safety for space tourists. As Finland's space legislation involves environmental sustainability in space activities (Ministry of Economic Affairs and Employment, 2020), "ecopolitics" could be promoted in future global space legislation, with Finnish representatives highlighting (for example) obligatory regulations such as compulsory compensation schemes for emissions and space debris for an entirely New Space industry (Article C, p.14).

4.3 The views of the public and professionals in Finland on space tourism sustainability

Fictional images of the future are influential in shaping the image of tourism (Yeoman et al., 2021). Opening up pluralistic potentials as doubt can also be viewed as an instrument of positive change, questioning what else is possible, what other perspectives there are, what impacts the future will have on others, and who benefits from future outcomes of certain trends (Sardar, 2010). Such outcomes may then inspire others to work on new paths to better meet future human needs (Toynbee, 1972). Timely knowledge from various fields means that decision-makers are able to make more effective choices – for example, in the future sustainability planning process for the New Space tourism industry.

I used the results of the public survey to find answers to the third research sub-question, "how is the combination of space tourism and sustainable development currently envisioned by the public and field professionals in Finland?", reporting their opinions on space tourism and sustainability in Article C. The findings resulted in five themes according to the loading significance of each themed component formed, reflecting a "view approach". The survey was structured according to the Likert scale, and I analysed the results using comparative content analysis, identifying variables that summarised a themed larger set.

The public ranked *environment* as of the highest importance, including views such as "my values are similar to the principles of sustainable development (.737)" (survey respondent, Article C, p.7). The findings indicated that there were positive individual values attached to sustainability and the practice of environmental actions, and the practise of environmentalism was not considered challenging, as the question was mirrored in the negative: "I feel it is hard work to act in an environmentally-conscious fashion (-.329)" (survey respondents, Article C, p.7). *Social* was ranked as the second most important (.807), indicating positive responses to the idea that "Finland should aim to be a space tourism nation (.808)" and "Finland should invest in people and resources with technological expertise on space travel (.752)" – thus highlighting that it was commonly accepted that Finland

would become more deeply involved in future space tourism and space technology development (survey respondents, Article C, p.7).

There was support for development funding for space activities, as the question was mirrored in the negative: "the development money used for space tourism should preferably be used to solve the problems of humanity-.458)", and the existence of space debris was justified as a result of space activities, as the question was mirrored in the negative: "humankind has no right to litter the space environment (-.364)" (survey respondents, Article C, p.7). The respondents were also quite supportive of the emergence of the space tourism industry, "willing to experience it if economically possible (.707)" and accepted the future vision of space colonisation "space tourism ensures the creation of new living places in space if the Earth becomes non-viable (.658)" (survey respondents, Article C).

Political was ranked as the third most important aspect (.746), consisting of views such as "businesses should take responsibility for helping reduce climate change (.781)" and "politicians should take responsibility for helping reduce climate change (.650)" (survey respondents, Article C, p.9). This addressed the importance of companies creating their own sustainable operational strategies, as consumers expect them to be ultimately responsible for the climate, and also indicated that further political regulation should concentrate on businesses rather than penalising individuals. *Ethical* was ranked as the fourth most important (.706), consisting of views such as "I am worried about the impact of emissions caused by space tourism (.559)" and "space tourism will increase inequality between people (.478)" (survey respondents, Article C, p.9). This highlights the global equality discourse regarding the rich versus poor, and the consequences of individual actions taken by the elite for the rest of the world. There was also emphasis on the "creation of sustainable development in space law (.440)" implying that sustainable development has become part of society's values and needs to be included when planning future operations (survey respondents, Article C, p.9).

Technological was ranked as the fifth most important (.520), consisting of views such as "I think the sharing economy is a good thing (.493)" and "I would like to take part in a space trip other than physically (.451)" (survey respondents, Article C, p.9). The familiarity with, and acceptance of the use of virtual sharing platforms implied that such technologies could be used in space tourism, for example, by a company providing a social media tool for postmodern space tourists to share their experience with others from space (Feifer, 1985). There was acceptance of other forms of space travel apart from the physical activity, implying an interest in virtual space tourism as an experience.

For the open question in the public survey asking "what kind of space tourism is sustainable?", over half the respondents under 30 years of age leaned toward advancing reusable space technology and minimising the creation of new space debris: "*'Minimising space debris is paramount. The durability and reuse of used*

equipment must also be a priority. Significant resources must be invested in the selection and development of potential propulsion" (survey respondent, Article C, p.9). One-third of those aged 30 to 40 years old expressed ethical concerns about starting space tourism under the current climate crisis: *"In my opinion, as long as humankind is so thoughtless, we have no reason to go into space. This planet must first be balanced, and humanity must become much wiser before space travel makes any sense"* (survey respondent, Article C, p.9).

Two-thirds of those from 41 to 50 years of age talked about alternative fuels, and the virtual travel experience: *"No fossil fuels, virtual travelling from the couch at home"* (survey respondent, Article C, p.10). The majority over 50 years old leaned toward creating global sustainable space legislative frameworks: *"Organised by international communities following a mutually agreed legislative framework and regulations"* (survey respondent, Article C). Two-thirds of all age groups also implied that the nature of space tourism should be exploratory and research-based – not just for personal amusement – in order to qualify as environmentally acceptable (survey respondent, Article C, p.10).

I grouped the views of the field professionals under the themed dimensions. *Virtual travel* was commonly viewed as a sustainable way of experiencing space tourism. For example, different types of terrestrial space tourism, enhanced with elements of virtual reality, were suggested as Earth-bound destinations to attract tourists without the need for the actual space environment: *"I especially wish Lapland would use stargazing and virtual space travel opportunities more and not only promote the northern lights. Finland has great potential for such development, as a large number of people already want to watch the sky in Lapland."* (space technology group panellist, Article C, p.11).

C*omparative fairness* was mainly viewed from a social equality angle; for example, the panellists considered how ethical it would be to launch a niche luxury tourism activity for the pleasure of only a few: *"despite the rest of the world mutually been exploited to the environmental impacts caused"* (future group panellist, Article C, p.11). *Technological innovations* dimension was mainly viewed from the perspective of climate change; for example, emphasising the building of space colonies to ensure the survival of human beings. *"As social human beings, there will soon be a push towards having companionship in space, and being the first human to establish a colony is very attractive to people who can afford it. Creating a colony there would be a major scientific advance, and it is possible that after facing a tremendous catastrophe, it might be the only way to save humankind"* (tourism group panellist, Article C, p.12). *Ecopolitics* was mainly viewed as regards the lack of space legislation, including, for example: *"The sustainability issues of Earth will be above everything by the year 2040, making it absolutely imperative for the space tourism industry to be regulated, as well under the set sustainable targets"* (future group panellist, Article C, p.12).

5. Discussion

This chapter discusses the empirical findings reported in the articles and the book chapter in more depth, addressing the main research question of how sustainability can be improved in the context of New Space tourism. The earlier empirical findings indicated that sustainability in space tourism can involve various concepts and dimensions. Different future pathways to long-term challenges characterised by uncertainty and complexity can be addressed by creating futures scenarios (Faure et al., 2017). A Futures Map was utilised as a scenario method, where a scenario is a specified path connecting the present state to at least one picture of the future, the map identifying possible futures with a "planning horizon" and a "mapping horizon". The pragmatic validity of scenarios was interpreted with some of the quality criterion from the Futures Map; for example, causally relevant facts with effective explanations were demonstrated with only few scenarios (Kuusi et al., 2015, p. 22).

A re-examination of the data (Charmaz, 2006) identified three future scenarios within the themes, through which elements of sustainability could be increased in the New Space tourism industry: in Scenario 1 *through planning global space regulations*, in Scenario 2 *through recognition of the need to improve global fairness*, and in Scenario 3 *through the implementation of virtual and technological innovations*. All three scenarios were also in line with the Sustainable Future Planning Framework (Article C, p.27) "*Future scenarios*" cluster, Scenario 1 referring to the framework´s strategic global agreements, Scenario 2 referring to the framework´s voluntary measures (combined with the new supplemental theme of fairness), and Scenario 3 referring to the framework´s alternative future planning.

5.1 Scenario 1: Planning global space regulations

Scenario 1, named "*Planning global space regulations*", is placed on the Futures Map´s planning horizon, with its present state connecting to acceptable futures. The policies and regulations for the tourism industry are a combination of many sources; the industry currently interacting and overlapping with a range of other policy areas, such as transport, regional development and environmental management, supplemented with effective partnership, and rapport with governmental sources (Cooper et al., 2008; Dredge, 2015; Mowforth & Munt, 2015). This means there are existing variables to consider when planning for new tourism strategies and developments (Weaver, 2005). In this light, the policies and regulations planned

for the New Space tourism industry should be situated within a broader policy framework, of which tourism is only one component, however, according to Boston (2017), uncertainties arise if causality is poorly understood: for example, in anthropogenic climate change, there has already been much controversy over the ranking of different policy goals, thus complicating policy making and planning for new emerging fields (Faure et al., 2017). Overall, planning should aim to improve the capacity of governmental institutions to cope with potential "black swans", and thus create greater future resilience (Boston, 2017).

The emergence of the New Space industry brought a completely new commercial market sector to space operations. Space is no longer only entered by countries with space programmes, but also by various private companies working as commercial contractors, such as different navigation and satellite operators (Praaks, 2018; SpaceX, 2020). Such space activities involve multinational private businesses, which has typically tended to result in accelerated environmental destruction as the ideology in private space businesses revolves around the maximisation of economic profit (Viikari, 2007). It had already been noted in the 1980s that the increase in private space enterprise supporting governmental operations had created legislative problems requiring international political and legal settlement (Vereshchetin et al., 1987), however, existing global space legislation is still not current enough to reflect the use of the space environment for commercial purposes.

It is still being decided which regulations actually apply to private suborbital space flight and space tourism in the New Space tourism industry: those under space law or within both aviation and air law (von der Dunk, 2019). Clarification is needed to instruct the further policy planning for New Space tourism industry. The space environment is currently subject to a "first come first served Wild West" attitude, as the only existing legislation for common space responsibilities is the Outer Space Treaty (1967), which corresponds to maritime laws (Viikari, 2007; Toivonen, 2020). The opening up of the space environment to multiple private business activities, including space tourism, therefore makes it necessary to start specifying new types of regulations and legislative frameworks that have not been covered by the Space Treaty (van der Dunk & Tronchetti, 2015).

The findings of my research reflect a strong need for globally mutual legislation for New Space industry, including space tourism, as quoted by a space scientist (Article B, p.62): *"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"*. This would also guide business in the New Space industry, as explained by Space Scientist (Article B, p.61): "*Today a complete rocket can be purchased privately for a cost of approximately $100 million from a previous national owner. Private launch providers selling space inside such rockets, and customers, including small satellite companies, can already be found*".

The increased use of outer space means there are increasing environmental threats, such as increased emissions on Earth and more space debris in outer space (Janhunen, 2004). It has become obvious that the effective management of environmental problems related to space activities has not been assisted by specific sustainability-oriented international space law (Viikari, 2007). The findings support such an approach, as quoted from a Delphi panellist (Article C, p.12*): "space law is firstly needed to guarantee the constancy of the satellites, which have also produced enormous amounts of space litter, complicating future actions in space. Asteroid mining laws should also be set before regulating actual space tourism".* There have been some movements towards a new regulative framework for the New Space industry in recent years. For example, in 2017 US President Trump signed a NASA authorisation bill and announced that the White House would support the developing commercial space sector (Cofield, 2017). Finland´s current New Space legislation encompasses a positive approach to the environment and the sustainable use of outer space (TEM, 2020); for example, Article 5 of the Space Act specifies references to space debris mitigation, involving the disposal of satellites and possibilities for re-use (Tapio, 2018).

The lack of global regulation for the entire New Space industry, means that sustainable decision-making has been left as a choice to take ethical responsibility by private companies (McFadden, 2018). For example, increased constellations of New Space industry satellites create a risk of space debris from potential future collisions, which could further complicate and even endanger the safety of other commercial space activities such as space tourism (Wall, 2019). There are several ethical and legal questions around sustainability, such as at what cost should the private space sector be allowed to pursue its goals, and what the ethical responsibilities of private space entrepreneurs should be, both on Earth and in outer space (McFadden, 2018), as expressed by a Delphi panellist (Article C, p. 12): *"Sustainable development is important of course, but at least equally important is making sure conquering space does not lead to a war between humans and nations".*

According to Mowforth and Munt (2015), the interaction between globalisation and relationships of power may create issues for unequal future development, an idea also supported by the findings, and so the lack of coherent space legislation and the need for new global regulation for the space environment needs to be recognised (Viikari, 2007; Tapio, 2018). For example, in addition to limiting and regulating human activity in outer space, parts of space could be fully preserved from human intervention (Duval & Hall, 2015). Reddy et al. (2020, p.1093) emphasise that it is also important to understand perceptions on a country-specific and regional basis. The United States currently has space exploration plans to reform their oversight of space development, and regulations for commercial space flight launch and re-entry operations are being developed, possibly motivated by the fact that the country may soon be eclipsed by China in space exploration (Tett, 2018).

The findings suggest that in order to minimise mistakes similar to those made here on Earth (leading to climate change crises), the exploration of other planets could continue to be based on research, rather than used purely as a way for human beings to replicate the Earth's living conditions. Destination development has commonly prioritised economic growth, however, even at the cost of destruction to land, wildlife and local community (Cooper et al., 2008; Moore, 2015), and so learning from previous mistakes may prove challenging to human nature. It is thus essential that the New Space industry, including the space tourism sector, receives advice on how to operate in a sustainable manner to achieve an acceptable future outcome, and the policy making process emphasises environmental assessments prior to any new development of New Space tourism activities, as quoted from a Delphi panellist (Article C, p.12): *"the sustainability issues of the Earth will be above anything by the year 2040, making it absolutely necessary for the space tourism industry to be also regulated under the set sustainable targets".*

There is a strong human-oriented tradition evident in existing space law, and a continuing reluctance to see the space environment as worthy of protecting for its own sake, rather than as an economic resource for human use (Viikari, 2007). As the possibility of exploiting space's vast untouched resources has become a tempting alternative (justified as sustaining Earth´s natural environment), it also creates concerns that using the abundant resources of the solar system could fuel a further consumption boom on Earth, and lead in the long term to an unsustainable cycle (Cockell, 2007; Fawkes, 2007; Toivonen, 2020). In terms of sustainable operations, the dangers of space activities may not seem as imminent as those associated with similar problems on Earth, especially in light of the current environmental sustainability megatrend. Increased commercial space operations may, however, have negative future effects on both Earth and space environments if mutual sustainably-oriented global legislation is not thoroughly planned and activated to bind all New Space related operators (Viikari, 2007; Toivonen, 2020). It is thus essential to implement global sustainable development policies amongst all active actors, such as different nations and private companies, to avoid such an unsustainable future scenario, and to ensure a more acceptable future in terms of sustainability.

5.2 Scenario 2: Recognising the need to improve global fairness

Scenario 2, *"Recognising the need to improve global fairness"*, is also placed on the Futures Map´s planning horizon, as its present state is connected to acceptable futures. According to Braun and Whatmore (2010, p.82), the most important global ethical query is how to solicit a more profound attachment to the future of the Earth. Boston (2017) suggests that two ethical principles underpin this: firstly, all human beings are equally and intrinsically valuable, and their moral worth is irrespective of

space and time; and secondly that human beings have an abiding and non-negotiable moral duty to care for the Earth, and thus protect the welfare and well-being of all the species. The life-support systems of Earth, such as the environmental conditions and cultural resources, must thus be sustained to ensure a healthy future environment. The overall goal should aim for a better future, judged on multiple criteria, for the next generations, as consistent with the ethical values, principles and aspirations of most traditions which have informed the conduct of rulers and citizens over the course of human history (Boston, 2017). Taking future responsibility for Earth and humanity may also lead to the creation of another kind of ethics, however, such as justifying "a breaking of law on the grounds that the purpose is to protect humanity" from the threats of the modern world (Hamilton, 2010, p.226).

The ethics and philosophy of space exploitation arise from activities that are congruent with the last remaining imperial and mercantile frontier (Duval & Hall, 2015). The development of the space environment will have significant implications, yet only a small section of individuals, companies and governments are currently involved in New Space development (Scott, 2020; Spector & Higham, 2019a). The question of inequality has already been noted in the United Nations reports on climate change and poverty, and it has even been suggested that the world will soon face a "climate apartheid", in which, for example, the rich can escape the consequences of global warming by emigrating to space leaving the poor to suffer from the impact (Alston, 2019; Article C, p.13).

Human interest in space has often been related to scientific values, but the development of the New Space tourism sector introduces space as a new tourism destination to be experienced physically (McFadden, 2018). It is thus necessary to consider how ethical it is to launch niche luxury tourism activity for the pleasure of only a few (Wittig et al., 2017), and which will be difficult for most to replicate *"despite the rest of the world mutually been exploited to the environmental impacts caused"* as quoted from a Delphi panellist (Article C., p.11), as also described in ethical inequality perspective addressed by Braun and Whatmore (2010). My findings raised issues such as what right Western countries have to establish elite forms of tourism, from the rest of the world's perspective, when there are still enormous social issues related to poverty and hunger? Development money, according to Alston (2019), could instead be spent on first solving global problems such as those caused by overpopulation (Hiltunen, 2019).

The emergence of low-cost airlines and new forms of virtual accommodation reservation platforms in the 2010s made it possible for a postmodern tourist to gain travel experiences in a style formerly possible only for the wealthy (in terms of travel location and frequency of travel) (Yeoman, 2012; D'Urso et al., 2016). Questions to address also include whether the emergence of New Space tourism will divide Western travellers similarly to the divisions previously witnessed between developed and developing world countries, and if so, what that will mean for future

societies? For example, budget optimisation is not possible in the pioneering stage of "destination space", as space cannot be accessed without a specially designed space vehicle (Toivonen, 2020). This could result in a new class division among Western travellers, shaking up relatively stable travel behaviours, and potentially even leading to acts of anarchy, as younger Western generations in particular have become accustomed to equal accessibility (Ritalahti, 2021).

The divisions between different social groups will be extreme in the pioneering stage of space tourism. As the current estimated ticket cost is $250,000 per "space jump" (Virgin Galactic, 2020), it is obvious that only the wealthy elite are able to access the space environment unless someone is sponsored otherwise. As quoted from a Delphi panellist (Article C, p.11): *"there are always people who can afford it, while others cannot"*, and of course, space tourism will be considered luxury tourism, as the context of inequality is already present (Wittig et al., 2017). It already costs tens of thousands of dollars to be able to climb Mount Everest. It needs to be remembered that most Western travellers have so far been able to accomplish similar travel experiences to those of the wealthy elite simply by making slightly different selections, such as staying in a budget hotel instead of a destination´s five-star option. Common access to most physical tourism destinations, and even to Mount Everest, has formerly not been restricted just to the wealthy elite (Toivonen, 2020).

The environmental concerns raised in the Paris Agreement (2015) and IPCC (2018, 2019) reports prompted a megatrend involving concern for personal carbon footprints, and affecting the need for alternative, more sustainable ways of travelling (Ritalahti, 2021). This approach was also highlighted in my research findings as viewed by a Delphi panellist (Article C, p.11): "*indicating that many are already ashamed of their own flying, hence also making space travel embarrassing because of its unsustainable nature".* The aviation industry has voluntarily acted upon, offering more consumer options for carbon offsetting to mitigate the impact of air transport, and to "neutralise" the atmospheric consequences (British Airways, 2019). Such voluntary action has targeted a reduction in passenger stress caused by their ecological conscience, by offering an alternative option, such as a sustainable service or payment (Broderick, 2009). The effects of compensation schemes have primarily targeted the prevention of environmental deterioration caused by climate change (Williams, Noland, Majumdar, Toumi & Ochieng, 2007).

The findings also supported such voluntary actions, as quoted from a Delphi panellist (Article C, p.11): *"It might be possible for an international body to ban space travel altogether, but I don't think so. Instead, I would hope that more sustainable forms of space travel could be produced and tested, moving away from space travel as a hobby for a small elite. This could also provide climate compensation for space travel, which could try to address an uncomfortable conscience."* As it will take time to develop new green natural resources for use in New Space tourism industry, voluntary carbon offsetting programmes could be useful tools for New Space tourism companies as

a component of their actions towards sustainable tourism practices. Similarly to the current sustainable schemes by airlines, space tourists could also contribute their share and pay more for a "sustainably conscious" ticket (Fawkes, 2007). Compensation schemes could be set either voluntarily or by the policymaking process in environmental statements to the space tourism industry, to reduce the direct and indirect consequences on the environment (Cooper et al., 2008).

There are critical questions to consider, such as how flying with compensation compares from an environmental perspective to the option of not flying, and whether new destinations such as "space" will attract people who would not otherwise have flown, but because of the ability to compensate, choose to do so? (Toivonen, 2020). There is a further question around whether pioneer "space jump" tourists would also be willing to support sustainable planning that furthers the product palette of space tourism, such as travel to the Moon, or if they would only be interested in compensating for their personal footprint in the space jumps they make? (Spector, 2020a). In situations involving collective responsibility, polluters who pay by contribution appear particularly powerless, as they are not able to determine the entity that bears the costs, nor ensure a just process by which compensation can be secured (Viikari, 2007). It may thus be challenging to reach consensus in the space sector on a comprehensive application of the polluter-pays principle in outer space, and the ensuing channelling of all liability to the operators of environmentally harmful activities (Toivonen, 2020; Viikari, 2007).

Alternative ethical approaches to the economic benefits and environmental impact of tourism have already raised issues related to responsibilities and fairness (Gren & Huijbens, 2009; Höckert, 2015) as similarly addressed by a Delphi panellist (Article C, p.11*): "It is difficult to use the world 'inequality' in the context of a luxury service".* From this perspective, it could prove beneficial in the future for many Earth climate change and global equal fairness projects to receive more funding from wealthy space travellers or New Space tourism companies, for example in the form of voluntary compensation or charity donations. An elite-dominated tourism would thus be "justified" by offering fair compensation on a global scale to avoid a situation where the elite few cause pollutions at the expense of the rest of the world.

There are weak signs that the affluent behind New Space tourism are considering issues of fairness: for example, Jeff Bezos (the owner of the Blue Origin) announced a fund of $10 billion US dollars in 2020 to help scientists and activists address climate change, which he described as "the biggest threat to our planet" (Weise, 2020). Elon Musk (the owner of Space X) has funded a $100 million XPIZE carbon removal competition for inventions that remove carbon dioxide from the atmosphere. Voluntary donations were also made to different charities by Blue Origin, SpaceX and Virgin Galactic after their pioneering space tourism flights in 2021. Such funding could eventually lead to greater hegemony in the development of global sustainable policies to improve equal rights and opportunities, as distinct from the

current global power jigsaw (Mowforth & Munt, 1998). Ultimately indeed, there is not yet any real way for any human to escape the consequences (despite their wealth) if Earth´s atmosphere is destroyed (Hawking, 2010), as humans are all connected to Earth´s environment (Spector et al., 2017).

The findings support Fawkes (2007) in suggesting that the concept of sustainability in space tourism must be seen as a "hygiene factor", meaning that it is necessary to incorporate it into the future development processes of the New Space tourism industry, and even to expand the conventional notions of sustainability (Scott, 2020). As pioneering space tourists come from wealthy backgrounds (due to the cost of the ticket), they may at the same time be vulnerable to public criticism if the public identifies space tourism as "rich people polluting the Earth more". A space jump experience shared on a social media site could thus, in the worst-case scenario, affect an individual´s future business partnerships (Fawkes, 2007), if it becomes related to "flight shame", which is an anti-flying social attitude that has been promoted by Greta Thunberg (Coffey, 2019).

5.3 Scenario 3: Implementing virtual and technological innovations

Scenario 3, *"Implementing virtual and technological innovations"* is placed on the Futures Map´s mapping horizon, as it currently connects to both acceptable futures and visions. One current megatrend is to embed technology in future activities (Dufva, 2020), and virtual space tourism could become an alternative choice through which to experience "destination space" in the future. Indeed, people have found the subject of space travel fascinating ever since the beginning of the space exploration era, as demonstrated by the popularity of space-themed television series such as *Star Trek*, and science fiction films, such as *Star Wars,* which have produced science fiction-based stories and visions about space travel for many different generations (Toivonen, 2020). The first space tourism products may thus be based on such science fiction-related image curiosity factors (Damjanov & Crouch, 2019), where space tourism is an escape from social monotony (Cohen & Taylor, 1992; Feifer, 1985).

There are weak signals suggesting that various digital interactions will be enhanced by adding more virtuality, with artificial intelligence and robotisation, for example, imaginaries familiar from science fiction movies, supporting this change (SITRA, 2020). Virtual reality technologies can change the way humans interact in the future, and provide a practical solution allowing many without the necessary funds or the necessary physical or age requirements to have an authentic experience (Yeoman, 2008; Damjanov & Crouch, 2019), as supported by the findings. A politician suggested that (Article B, p.67): *"Virtual travel will be 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."

There are currently some virtual reality innovations in the terrestrial space tourism segment; for example, public virtual reality tours at the Kennedy Space Visitor Centre (USA) in conjunction with the authentic launch site, presenting realistic 3D simulations of the soil of Mars (Kennedy Space, 2019). The findings indicate that such virtual tourism experience facilities would be desirable in locations that already support terrestrial space activities, such as stargazing or viewing the northern lights in Finland, as quoted from a Delphi panellist (Article C, p.11): *"I especially wish Lapland would use stargazing and virtual space travel opportunities more and not only promote the Northern Lights. Finland has great potential for such development, as a large number of people already want to watch the sky in Lapland."*

Space tourism may be considered the ultimate luxury tourism experience, but at the same time the concept of luxury has moved from the physical to having a more emotive appeal, and space tourism is also a metaphor for understanding that change (Yeoman, 2008). Despite the space environment being extremely hostile to the human body, the chance to experience the Earth from beyond, where the world is shown as one united place, may be an attractive enough motive for some people to decide to expose their bodies to space in search of a new version of leisure (Toivonen, 2020). Virtual reality, however, enables one to gain an experience of the outer space environment without leaving the Earth, providing a more sustainable alternative to space travel that is environmentally friendly, safer, cheaper and accessible to those with existing medical conditions (Chhanivara, 2019; Damjanov & Crouch, 2019). Even the virtual kind of space tourism could foster an understanding of how the world is connected to the universe, and, in terms of cultural sustainability, create a sense of protectiveness towards the Earth (Wilson, 2018). According to Rudd et al. (2012), experiencing moments of awe has been scientifically verified to produce a tendency towards altruism, and is thus more supportive of the cause of sustainability.

The start of commercial New Space services also holds promise for education in fields related to space (Collins & Autino, 2010), enhanced by a trend in space-related virtual video games and products (Ceuterick & Johnson, 2019). Virtual reality technology could, for example, be used as a practical tool to train future spacecraft pilots and to educate students about space travel and its effects on the environment, and as a Delphi panellist (Article C, p.11) noted: "*I do not see virtual travel to space as a new form of travelling, but instead it provides a new method to learn or become a new encyclopaedia*".

There are already a number of major consumer electronic companies on the market offering consumers virtual reality headsets, advanced image processing, and sensing and robotic technologies (Ceuterick & Johnson, 2019). My findings indicate that this development is desirable, as a Delphi panellist (Article C, p.11)

suggested: virtual travel as a good option for: "*those with medical issues, as the health risks associated with space travel are quite high, or those who cannot afford the ticket*". In future it might be possible to provide an opportunity to join a friend's space journey via a social media platform through virtual reality, without the need for individual physical travel, as envisioned by a space entrepreneur (Article B, p.62): *"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."* Such enjoyment of an experience without leaving home fits with Feifer's (1985) classic features of a postmodern tourist.

It needs to be noted, however, that virtual technology is still in the early stages, and existing virtual reality gadgets are not yet able to completely replace a real-life experience, as there are still obstacles to the fluid transmission of content (Toivonen, 2020). The findings also highlighted favouring a "real" space experience, such as expressed by a Delphi panellist (Article C, p.11): *"I doubt anybody set on doing an actual space journey and having the means to do it would be satisfied with the virtuality experience alone. People are unfortunately too egoistic to just keep that experience as their single option: it is relatively well known how polluting current-day air travel is, and still journeys are sold, and people fly for leisure purposes"*. When space tourism develops, as witnessed in certain destinations that have taken advantage of virtual opportunities (D'Urso et al., 2016), tourists seeing places on a virtual screen may not feel that they have replaced the physical experience, but may have increased their desire for a real experience. Virtual travel could, however, offer an antidote to destination overcrowding, by providing virtual access to the masses (Guttentag, 2021).

My findings suggest that the high cost of space tourism and environmentally-conscious travel megatrends mean that it is highly likely that virtual experiences will replace physical space tourism in volume in the early development stage of the New Space tourism industry, if sufficiently realistic and interactive enough. This could even facilitate the development of synergies or by-products, including adventure tourism products and services that as yet only exist in visioneering minds, to improve the potential for a multiplier effect (Khan et al., 1990). As noted by space tourism entrepreneur (article B, p. 62)*: "Indeed, space tourism could pioneer the creation of such services, which may be provided by other industries in the future."*

One contemporary global concern, reflecting the sustainability megatrend, is the increasing consumption of the Earth's resources required to sustain, especially, Western society's way of life (Yeoman, 2012). According to Boston (2017), rapid technological advances, together with a massive increase in the global population and resource utilisation, mean that humanity has an over-expanding capacity to cause harm to the environment, such as the effects of the industrial revolution causing the current climate change crises. As more nations have made the change

from agricultural to industrial societies, their standard of life has improved, resulting in more people competing for the same resources (Spector & Higham, 2019; Collins & Autino, 2010). Humanity is technologically close to the point where colonies can be built on the surface of the Moon and Mars, however, by utilising materials from these locations (NASA, 2020b). Space tourism companies Blue Origin and SpaceX are currently involved with NASA in developing technology for future human colonies in such locations (Blue Origin, 2020; SpaceX, 2020).

The success of future space colonies will depend in a large part on the availability of low space travel costs, which appear to be achievable only through the development of a vigorous space tourism industry (Collins, 1994; Toivonen, 2020). As the destination development timescale for building new space colonies is currently seen as anything from the most optimistic vision of 20 years (Elon Musk) up to100 years (Stephen Hawking), the findings suggest that there needs to be predictive long term planning via global government initiatives, with corporations providing sufficient funding to support the development of a space destination infrastructure, such as that described by a space scientist (Article B, p.66): *"The developments are likely to commence with the erection of greenhouses to ensure food production and to test survival-related technologies."*

A Delphi panellist (Article C, p.12) predicted that, because the technical innovations for the New Space industry currently seem to be progressing rapidly, the human element will also soon be embedded: *"As social human beings, there will soon be a push towards having companionship in space and being the first human to establish a colony will be very attractive to people who can afford it".* The first colony could thus even be counted as Earth's first act of self-replication, enabling space manufacturing and allowing a further increase in colonies, while eliminating costs and dependence on Earth (McKnight, 2003). This is supported from a futurist perspective in the findings (Article B, p.67): "*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 copy real-life structures."*

The fact that humanity is currently limited to one planet and its resources creates a problem, in spite of inventions and technology, requiring a more prudent use of the Earth's resources (Collins & Autino, 2010; Cole, 2015). In the most utopistic of visions, using natural resources from space could be a new alternative to ensure more equal standards of living for everyone on Earth, and pioneering space colonists could initially build and maintain solar panels that would be used to provide power on Earth (Johnston, 2017; Toivonen, 2020). The findings indicated that such visions raise further discussion about the justifications for replenishing Earth´s resources with those from another planet in order to advance technological developments with an end-goal of greater equality on Earth – if the division is somehow managed fairly- as suggested by a Delphi panellist (Article C, p.12): "*We have one Earth, with tremendous opportunities, but we are gradually eroding this away in our pursuit for the*

next big thing, the next growth, the next something – whilst simultaneously making the Earth that exists in front of our eyes less and less liveable".

My findings suggest that in the light of current climate crises and reflecting sustainability practises in the tourism industry, some of the effort and resources now being used for space tourism technology developments should also be targeted for Earth-bound purposes of environmental protection, rather than just developing space technology, including for touristic purposes, with the motive of replacing Earth-bound resources with those obtained in space. Even though there is no known life in space, meaning no indigenous habitat would suffer from human colonisation, the findings emphasise, similarly to Johnston (2017), that decisions should be made and legislated globally about whether it is even ethically and legally right for the material used to manufacture a settlement to be taken from, for example, the Moon, despite Collins and Autino's (2010) suggestion that Earth's environment could be spared by moving some industry and also human inhabitants to space colonies.

My findings also suggest, similarly to approaches by Spector et al. (2017, 2019) and Scott (2020), that justifications for future colonisation include the ultimate survival of *Homo sapiens* as a species if Earth becomes uninhabitable. There has been much speculation over the years about how the world could end for humankind, including through global pandemics, the impacts of asteroids, and climate change. The benefits of human expansion into space have therefore also been increasingly noted over the past decades by scientists; Collins (1994, 2010) being one of the first space tourism academics to connect the involvement and development of commercial space tourism to reducing the danger of human extinction on Earth as a result of disasters, and continued by Spector et al. (2017, 2019). The findings connect human survival to new technological innovations, as explained by a space tourism entrepreneur (Article B, p. 66): *"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."* However, such "human only" concentration dismisses the importance of human's connection to other species on Earth.

The findings also highlighted the importance of new technological innovations to offer businesses an increasing opportunity to extend their activities in space, as quoted from a space scientist (Article B, p.61): *"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 is more abundant in space."* Colonies on the Moon, Mars, or asteroids could extract local materials, such as iron and titanium, as launching materials from Earth would be costly (Perlman, 2009). The solar system alone has enough natural resources and energy to support anywhere from several thousand to over a billion times the current population of Earth, providing opportunities for both resource mining and the building of a workforce colony,

leading to new economic opportunities (Lewis, 1997). If the only motivation for this is an attempt to achieve monopolistic control and profit, however, companies may actually hinder development in space (Collins & Autino, 2010).

Daily communication on Earth has also become more dependent on space technology, such as the satellites which provide reliable and fast internet access, as especially experienced during the global Covid-19 pandemic which transformed different virtual forms into a "new normal" (Ateljevic, 2020). Space has therefore become increasingly important economically and politically for many formerly non-active countries, providing more tools for scientific research and economic investment opportunities, and for countries, such as Finland, which are building their own space programmes (Business Finland, 2020). The findings emphasise that in such a future development trend, as quoted from a space scientist (Article B, p.61): *"the cost of the space inside a rocket is shared; and thus even academic institutions with relatively small budgets have been able to test small measuring satellites in a real space environment"*. Recent technological innovations for the potential re-use of space rockets and miniaturising of satellites enables more to be packed inside one rocket (Praaks, 2018). This creates better cost-efficiency and less need for multiple rocket launches.

Lastly, the creation of space debris is an environmental problem connected with New Space satellite activities (Viikari, 2007). The findings indicate that this type of threat to safety could harm the New Space tourism industry, as a small particle of debris from a former satellite or similar object may prevent a safe voyage or landing on Earth (Palmroth, 2018). The growth in the amount of space debris has created more awareness of the seriousness of the problem, however, and both the governmental sector and industry have made efforts to mitigate further hazards by developing procedures and standards for the operation and design of space missions (Janhunen, 2004; Palmroth, 2018; Viikari, 2007). New technical solutions are essential to ensure that the situation does not accelerate to become unsustainable, and to guarantee the safety and functional ability of both future satellites and future space tourism vehicles. A Finnish New Space technology innovation, the electric wind sail, for example, could be used in such processes, as suggested by a space scientist (Article B, p.63): *"An electric sail 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"*.

6. Conclusions

Future prediction is linked to the past, and connects the past to the future (Yeoman & Mars, 2012). This linearity was disrupted by the global Covid-19 pandemic, emphasising the need for "science fiction" to be included in futures scenario planning to predict implications for society. Space has for the first time in history become a new operative environment for private businesses, including the new adventure tourism sector which has emerged through the developments of the New Space Industry. This thesis explored the development of this futuristic travel phenomena, interpreted weak signals to reflect future tourism sustainability, and created frameworks to assist in planning more sustainable development paths for the New Space tourism industry.

Space tourism is part of new postmodern phenomenon of the space environment being transformed into a New Space industry business platform. For generations space exploration was a wishful utopia until it became reality in the 1950s "Space Race" between the United States and the former Soviet Union. The successful NASA missions also began to generate interest in the creation of non-professional space exploration. Space tourism is a logical development of the ever-increasing distances that postmodern tourists travel, and the exploration of the space environment by robotic or crewed missions is a natural extension of humankind's desire to explore our own planet (Williamson, 2003).

As previous trends in adventure travel have already blurred the boundaries between adventurous activities and tourism (Beedie & Hudson, 2003), the emergence of the New Space tourism industry means that a postmodern tourist is no longer expected to train as an astronaut in order to experience life away from Earth. Virgin Galactic, Blue Origin and SpaceX, all owned by globally influential and wealthy visionaries, accomplished their first space tourism flights in 2021. Despite it´s relatively short existence, the New Space tourism industry has already presented operational level sustainability in a way that has not been seen in the traditional governmental-led "old space" industry. For example, in 2018, SpaceX achieved the world's first repeat flight of an orbital class rocket, presenting a historic milestone for full rocket reusability. The emergence of the New Space industry also made it possible for smaller countries such as Finland to become active in the space environment, and start contributing to global New Space industry developments.

There has been criticism especially regarding the environmental impact of the New Space tourism industry, and the ethical synthesis of influential private sector commerce and publicly funded infrastructure, especially relating to the

concentration of power (Tett, 2018). There is similar concern about the backgrounds of the pioneering space tourists; the handful of tourists paying over $20 million for their trips to the International Space Station come from already-privileged segments of society, and low orbital "space jumps" will also only be affordable for the wealthy elite: will the understanding of an authentic space environment be a new separating power of knowledge, increasing the gap between the wealthy and everyone else even further?

Outer space and "early reflections on sustainability" became visible to the wider public when the Apollo 17 photograph of the Earth from beyond the biosphere was taken in 1972, and this photographic image became a symbolic icon of environmentalism, presenting the Earth as a fragile object upon which human actions have a great impact. The importance of sustainable development has been commonly recognised for decades, however the IPCC (2018) report still managed to raise global concern with its pessimistic forecast for the Earth's future. The increased concerns about emission levels contributing to further climate change demonstrate that there is obvious apprehension about environmental issues (new emissions and space debris) at the start of the New Space tourism industry.

Space tourism has been classified according to various levels of sustainable development in previous academic research (Fawkes, 2007), however, there has also been opposition to such as classifications. For example, Peeters (2018) argues that nothing leads us to believe that space tourism could ever be part of sustainable development on Earth, because proposing outer space migration as a serious option may distract policymakers from taking the necessary mitigation measures. Webber (2019), however, claims that the key to understanding the whole field of the New Space tourism industry is operational reusability, as the price elasticity of demand for human payload is high, thus requiring reusable rockets and lower-cost space access.

Increased educational awareness and feelings of awe regarding Earth, such as those already described by astronauts, may also have positive consequences in terms of protection for Earth's future wellbeing, creating economic prosperity from money donated by New Space industry actors to different charity schemes on Earth, replicating the current aviation industry. Satellites that assist in daily activities on Earth, improved by technological progress in reusable innovations for New Space industry, could speed the response to natural disasters, with accurate data supporting rescue operations, and could monitor the impact of climate change more accurately. For the most optimistic or imaginative, New Space tourism could even become a distant form of eco-tourism, as seeing the Earth from afar might increase people's desire to protect the only planet that can offer suitable living conditions for humans.

Looking through the lens of utopian scenarios, one could speculate that New Space tourism could contribute to Earth's sustainable development by creating new innovations for all virtual reality environments, generating employment for those living near spaceports or terrestrial space tourism sites, enhancing the development

of reusable technology required for low-cost access to space, and thus enabling the use of solar system resources such as solar power, and allowing humans to create space colonies as an insurance policy for the ultimate survival of humans. Through a dystopian lens, a future scenario may be that New Space could contain a few private corporations gaining benefits in outer space, and thus dictating a new ownership and rules of ethics for the space environment, where only the affluent will be empowered enough to escape the effects of climate change, leaving both rest of the humans and other species on the Earth to suffer the consequences, which are partly contributed to by the development of the New Space industry. As demonstrated in this thesis, however, there are alternative future scenarios for the New Space tourism industry, where it starts improving elements of sustainability, by supporting the creation of global space legislation, supporting aspects related to communal fairness, and continuing to develop space tourism technology that as a side product also assists in the prevention of climate change on Earth.

The New Space tourism industry is in the pioneering stage, and there is currently good momentum with which to include practises of sustainability as an ordinary approach to industry actions. Early adapted and regulated sustainable development practises are especially important if the New Space tourism industry expands to mass space tourism in the future. From scientific perspective, this thesis contributed to creating and extending new knowledge on elements of sustainability related to New Space tourism, and validated the predictive power of grounded theory in discovering concepts of sustainability related to tourism in the context of New Space industry. Different concepts and dimensions in relation to elements of sustainability and New Space tourism industry were visualised in Figures 3-5 to assist other researchers in conducting similar studies in their countries in the future.

Futures Map was introduced as a suitable method to demonstrate futures scenarios in the context of New Space tourism. Based on the empirical findings, three future scenarios were determined for themes through which elements of sustainability can be predicted and/or actioned in the New Space tourism industry, and placed on current or future time horizons, to predict the future direction of a scenario. Pragmatic reflections on the scenarios were outlined using some of the Futures Map´s quality criterion; for example, I chose to interpret causally relevant facts with effective explanations through only a few scenarios (Kuusi et al., 2015, p. 22), and therefore the contexts of virtuality and technological innovations are combined as one future scenario. Some of the empirically rich insights also resulted in proposals and new knowledge for industry action, presented in this thesis as direct quotes from the respondents.

From a practical perspective, this thesis contributed to a change of a mindset in regards to virtual space tourism. Virtually experienced space tourism was seen in the findings as the most sustainable form of space tourism, with positive or negative implications that could emerge through a tourism multiplier effect (Khan et al., 1990).

Investments and innovations in virtual tourism in the context of space travel could in the future benefit the entire tourism industry and assist in addressing sustainability issues in the tourism industry more comprehensively: for example, to develop more authentic "non-flying" tourism experiences. These may be in demand in the future if natural disasters and pandemics continue to prevent travelling and people still desire tourism related experiences to escape their daily routines. Virtual space tourism may be experienced in various physical locations, from one´s own couch, to a terrestrial space tourism site and even in the authentic physical environment of space. Hence creating challenges for future policy regulations and tourism planning strategies to cover all environments. In Finland, experiencing the aurora borealis so that it feels authentic through a virtual gadget (D'Urso et al., 2016; Feifer, 1985) in a purpose-built space tourism attraction, could increase both local employment and Finland´s technological know-how and competence regarding operations related to space sustainability, and thus increasing the credibility of the objectives set by the Ministry of Economic Affairs and Employment of Finland (2020) space strategy.

This thesis also contributed practically by producing new framework tools, such the New Space Model for Finland (Article C, p. 6), which conceptualises sustainable interrelationships in New Space tourism, and can be used to guide tourism planners and policymakers to create a national New Space tourism strategy - something currently lacking in many countries. The Sustainable Future Planning Framework (Article A, p.27) may also be furtherly used to guide content creation for New Space tourism within higher education, the importance of which is already highlighted by Kawashima et al. (2015) and Messina et al. (2018).

In writing this thesis I became aware of some limitations that should be addressed. Firstly, it needs to be acknowledged that the topic of this thesis has been researched very little, and that there is a lack of empirical research in particular with which to compare my findings. The futuristic scope of this thesis also did not appeal to external parties as regards financial support for writing my thesis, which partly influenced the selection of Finland as the case study country; which enabled me to conduct most of the face-to-face interviews in my home region without the need for extensive travel expenses (as otherwise needed in the pre-Covid-19 world). Secondly, especially at the beginning of my writing process (during 2015-2016), I faced major obstacles in finding contextually suitable academic articles, or even any media coverage of the contextual areas at all, as many simply did not yet exist. In 2018, however, there was a notable shift in both media coverage and academic writing, mainly because of two global incidents: firstly, SpaceX managed to successfully launch a re-usable rocket, resulting in much media attention; and secondly the IPCC report on the effects of global warming was published, resulting in a strong global demand for sustainable actions. After these two separate events, both supporting the context of this thesis, there was more media coverage, and published academic research on space tourism became available.

Thirdly, even though in my opinion grounded theory suited this thesis focus quite well as a methodology (to gain enough new knowledge to answer the research questions), concentrating purely on futures methods, such the Delphi method as well as the full utilisation of the Futures Map (Kuusi et al., 2015) could have resulted even in more detailed and in-depth scenario building. The Futures Map in particular ended up being used at a relatively basic level, and parts of the Map, including the full utilisation of all quality criterion, were left untouched, despite the pragmatic potential it might have offered. Finally, it needs to be noted that the empirical findings of this thesis are subject to only one region's understanding of space tourism and sustainability, within both the professional field as well as with the general public. Conducting similar interviews and surveys elsewhere in the world could have resulted in different results and analysis. People under 30 years old were also much more willing to participate in the public survey than people over 50 years old. This may be because Finland has never been an operational space nation, whereas in the USA or Russia, where the older generation in question was more widely exposed to the idea of space exploration in their youth, the topic might have been familiar enough to result in more enthusiastic participation.

For future research recommendations, the current weak signals indicate that space exploration is already showing signs of assuaging the desire for permanent human colonisation through the formation of the US space military and the Mars visions provided by two of the world's financially influential corporate leaders, Elon Musk (SpaceX) and Jeff Bezos (Blue Origin). The desire to utilise and exploit the natural resources of space by countries with existing space technology (for example China), and also some global corporations, creates ethical questions regarding not only the environmental impact on the space environment (other than Earth orbit), but also around general global equality.

Co-operation between governments and the private sector has tended to be economy-based, with environmental issues addressed voluntarily (Duval & Hall, 2015). As previous tourism studies have indicated, despite decades of concentrated effort to achieve sustainable development, there is still social inequality between the developed and undeveloped countries, as well as within the different socio-economic groups in Western societies. There is thus a need for more critical consideration and further research into different aspects of fairness in relation to accessing and the further commercial use of the space environment, in order to avoid uncontrolled parallel development where the most powerful dictate to the rest of the world, in both the economic and social elite dynamics of concentrated power and action. I therefore suggest that the relationship of New Space tourism industry to aspects of global fairness and equality could be investigated in greater depth, the results possibly advocating the future practises of New Space tourism companies.

More attention is also required in order to develop a long-term conceptualisation of modern mobility for sustainability (Spector et al., 2017). I therefore also suggest

a further research focus on exploring the combined contexts of virtual space tourism and the tools of modern technology, such as artificial intelligence and robotics, and by, for example, using science fiction as a methodological approach, to investigate what this will mean for a future New Space tourism industry. Such study could even lead to the formation of a New Space philosophy, reinserted through new human-driven technologies, in relation to the context of space.

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