Contributions to Management Science

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Space Tourism Value Chain

When East Meets West

Springer

Contributions to Management Science

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Preface

Chapter 120 of "Dream of Red Mansions" mentions in the book: "The great void is truly like a blessed land." Space travel used to be a myth for general people. However, we can experience traveling into space because of the advance of space technology and commercialization. Humans have been used to Earth travel from one to other destinations for various business purposes and enjoying various leisure activities at the destinations. The year of 2021 is the era of space tourism because three aerospace companies, Virgin Galactic, Blue Origin, and SpaceX, have completed successful space travels one after the other. In the last month of 2021, Japanese businessman Yusaku Maezawa even took on board the Russian Soyuz MS-20 spacecraft and flew to the International Space Station for space tourism. Virgin Galactic has begun the commercial operations of space travel every month since June 2023. Space has become a new destination for human travel. To be able to travel in space, travelers need to be wealthy and healthy. In the long run, space should be a destination for more people to be experienced. Space is a new destination that we have just developed. We need to devote more resources to foster the progress of space commercialization, which is one of the purposes of writing this monograph. Applications in fields such as medicine, materials science, and environmental science incurred following the development of space tourism. The space tourism industry is expected to grow significantly in the coming years, offering numerous opportunities for technological advancement, economic growth, scientific research, and collaboration.

This monograph presents the knowledge of space tourism from the perspective of general science education. The chapters outline the relevant space tourism stakeholders, from the upstream suppliers, intermediary institutions to downstream consumers and related industries of the space economy industry chain. Innovative point of view of applying space technology is introduced to develop space tourism for leisure purposes. The main industry chain of space tourism includes spaceports, spaceships, space travel agencies, space hotels, and even consumers are detailed in the chapters. Other related industries, such as space insurance, law, medical care, debris, etc., are also introduced. Finally, the dual-carbon economic model and sustainable development of space tourism are discussed. The economic development of space tourism and environmental protection summarizes green space tourism. When we

do everything possible to go into space tourism or even immigrate to Mars, Earth still needs to be sustained by sustainable space tourism, which matters to human long-term survival and development.

Space has become a tourist destination. We shall have a cognitive change to understand space tourism, which is not as usual as Earth tourism. The cognition of existence issue will become an ontological discussion in the space era, which is one of the purposes for us to travel space to understand survival and inheritance of human beings in the universe. Overall, the monograph seeks to provide a comprehensive understanding of space tourism, its industry dynamics, and its broader implications for human civilization.

Macau, China Kang-Lin Peng
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Chapter 1
An Overview of Space Tourism

The expansion of travel boundaries has been a significant aspect of human history (Cohen 2017). In recent times, the tourism industry has extended its reach to outer space (Bushnell 2021). This has been made possible by advancements in manned spaceflight technology and the commercialization of space (Teske and Adjekum 2021). As a result, individuals can now venture beyond the Kármán line and fulfill their desire for space exploration through space tourism (Mehran et al. 2023). This form of tourism offers a unique opportunity for individuals to explore the origins and limitations of human beings (Mesa-Arango et al. 2023). This chapter provides an overview of the current state of global space tourism development, including its characteristics, categories, and existing challenges. The successful implementation of space tourism projects by private enterprises in Europe and the United States offers valuable insights for China's space tourism endeavors (Ehrenfreund et al. 2010). Given China's leading position in global space technology, space tourism represents a promising commercial development field that can benefit both the country and its citizens (Kashevarova and Panova 2023). Following the completion of the long-term in-orbit space mission of China's Shenzhou-13 in 2022, the construction of additional space stations using the follow-up Shenzhou series has advanced China's manned spaceflight and space science and technology (Kashevarova and Panova 2023). The latest iteration of manned spacecraft has undergone significant enhancements in terms of its comprehensive capabilities (Uyanna and Najafi 2020). Commercial branches of the Chinese Academy of Sciences (CAS) have designed spaceships that can accommodate up to seven astronauts (Wu et al. 2021). The extended cabin of the Chinese-built space station offers improved conditions for astronauts' work and life, as well as further support for scientific experiments in orbit (Shan et al. 2023). However, this book primarily concerns the private and commercial development of national space science and technology. Following several successful flights in Western countries in 2021, space tourism is expected to boom (Peng et al. 2022).

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1.1 Background of Space Tourism

On April 30, 2001, space tourism was introduced when an American entrepreneur, Dennis Tito, embarked on a journey to the International Space Station via the Russian "Soyuz" TM32 spacecraft, departing from the Baikonur Cosmodrome in Kazakhstan (Tcharfas 2015). Tito's excursion lasted for a duration of eight days, during which he engaged in sightseeing activities (Cater 2019). This marked the inaugural instance of non-professional astronauts embarking on a space tour (Johnson 2020). To date, the count of individuals who have participated in space tourism initiatives is limited to slightly over ten (Toivonen 2022b). The disparity in the number of space tourism ventures, in comparison to the conventional terrestrial tourism, has been limited to the elevated technological and financial prerequisites, as well as the affluence and physical requirements of Space tourists Naturally, the development of a gratifying space tourism project necessitates meticulous preparation of the launch vehicle, which is how humans can traverse the vast expanse of the universe (Toivonen 2022a). The launch vehicle is responsible for transporting various space equipment, such as interstellar probes, space stations, and satellites, into space orbit (Van Allen 1986). Additionally, manned spacecraft can fulfill the desire of individuals to experience interstellar travel in space orbit (Ryzhenko and Halahan 2020). China's space science and technology are at the forefront globally, with the Shenzhou series manned spacecraft and space station construction contributing to its continued advancement (Lei et al. 2023). However, private commercial launch vehicles and manned projects are still nascent (Bitzinger 2021). Recently, private space companies in China, including Lingke Space, Blue Arrow Space, Star Glory, and Zero One Club, have emerged. The Chinese commercial space industry has initiated a series of exploratory ventures, with their substantive operations still in their nascent stages (Barwinski et al. 2020). The Beijing Institute of Future Aerospace Technology's "2020 China Commercial Aerospace Industry Investment Report" revealed that there were 313 registered commercial aerospace enterprises in China at the end of 2020, with nearly 50% of these established between 2017 and 2020 (Aerospace 2020). In recent years, China's commercial aerospace industry has experienced robust investment momentum, with the investment peak occurring in 2018 when accumulated financing exceeded 5 billion yuan for the first time (Zhang and Corrie 2018). Despite being impacted by the capital winter and the COVID-19 epidemic from 2019 to 2020, the domestic commercial aerospace industry has been revitalized (Rimmer 2020). In 2020, a significant number of domestic investment institutions, approximately 400, participated in the investment of the commercial aerospace industry (Denis et al. 2020). Among these institutions, more than 80 capital institutions invested in commercial aerospace enterprises (Teece 2022). During the same year, China's space industry accomplished 19 commercial launches, accounting for 49% of the total domestic annual launches (Harrison et al. 2020). Out of these launches, 16 were successfully put into orbit, resulting in an 84% success rate (Feng et al. 2019). Furthermore, the number of commercial rocket launches was 8, accounting for 42% of the total commercial launches. The year 2020 marked a significant milestone for

China's space industry, as it achieved breakthrough accomplishments in the commercial launch vehicle project (Pollpeter 2020). In 2021, China's space launches reached 55, which is the highest in the world (Miraux et al. 2022). The foundation of national space science and technology has instilled great confidence in the development of the domestic commercial space industry.

At present, the commercial global space industry is categorized into five distinct areas, including space stations, deep space exploration, manned space flight, artificial satellites, and launch vehicles (Kulu 2021). However, the technological advancement and industry scale of space stations, deep space exploration, and manned space flight are still in their nascent stages, with relatively basic overall technical development (Szocik and Wójtowicz 2019). Conversely, the research and development of artificial satellites and launch vehicles have emerged as the primary focus for the commercial space industry's growth and development (Denis et al. 2020). The development of space tourism holds significant implications not only for advancing aerospace technology commercialization, but also for promoting the development of related industries such as space medicine, space mining, space agriculture, space insurance, space manufacturing, satellite application, and space transportation (Zhang and Wang 2022). Furthermore, the revenue generated from space tourism projects and other commercial space ventures can be invested in researching and developing related technologies within the commercial space industry (Davidian 2020). By establishing a value chain and economies of scale, the cost of space tourism can be reduced, thereby expanding its accessibility beyond the realm of extravagant consumption for the affluent, and enabling more individuals to explore the vast universe, broaden their perspectives, and foster creativity and innovation for the betterment of society (Metzger 2016). Ultimately, the development of space tourism has the potential to enhance the quality of space-related industries, and their economic contributions could yield a positive and far-reaching impact on future social development (Alewine 2020).

Space tourism is a form of experience tourism that is highly coveted by individuals worldwide (Salem 2020). It involves using advanced technology to transport passengers on a brief excursion to space or space-related destinations (Cater, 2010). This firsthand experience allows visitors to gain a tangible and individualized comprehension of space-related phenomena, resulting in corresponding cognitive experiences (Ioannidis et al.). In contrast to terrestrial experience tourism, space tourism offers a distinct perspective on life and enlightenment (Roe 2023).

In contrast to conventional forms of tourism, space tourism exhibits four distinctive features. Firstly, it offers more precise and palpable service content, which is tailored and differentiated to provide an experiential tourism experience (Salem 2020). Space tourism encompasses fundamental amenities such as space travel, food, and lodging, while also emphasizing visitors' encounters with space, thereby enabling them to undergo a diverse range of emotional and cognitive transformations that arise from venturing beyond the earth's atmosphere (Munaro et al. 2020). Secondly, space tourism prioritizes the consumption process over the consumption outcome (Toivonen 2017). The concept of space tourism not only involves ensuring

the safety of tourists during takeoff and landing but also emphasizes the overall experience of their consumption, including the unique sensations of super-gravity during launch and weightlessness in space (Schneider and Vogt 2012). Furthermore, there are notable distinctions in the cost-effectiveness and performance of experiential tourism products, such as space tourism, compared to surface tourism (Mane 2023). It is imperative to offer customized service content that caters to the individual characteristics of tourists. For instance, a Japanese businessman named Yusaku Maezawa paid twice the standard fare for space travel, bringing along his secretary and broadcasting his space journey life, which garnered a significant following and created a pioneering and innovative image for both himself and his enterprise (Danov 2020). Additionally, SpaceX provided a tailored trip around the moon, albeit at a high cost (Chang 2020).

The marketing models utilized in traditional tourism differ from those employed in experience tourism, particularly in the case of space tourism (Crouch 2001). Traditional tourism typically employs service, commodity, and productive economies, while space tourism utilizes a production orientation (Chang 2017). This mode is dominated by suppliers with high demand due to their limited supply. The marketing process for space tourism involves close interaction between existing products and the specific needs of consumers (Crouch et al. 2009). The high price of space tourism products serves as a screening threshold for the target market, and the unique experiential consumer products are conveyed to tourists to facilitate consumption decisions (Sesliokuyucu et al. 2023). Unlike tourism products on earth, space tourism products have limited channels and do not require a multitude of intermediaries (Ceuterick and Johnson 2019).

The concept of space tourism encompasses four primary categories, namely orbital flight, suborbital flight, high-altitude flight close to space, and parabolic flight of aircraft (Crouch et al. 2009). Each type of flight has a distinct range of flying altitudes above the earth's surface. When an aircraft attains the first cosmic velocity,[1] which is equivalent to 7.8 km/s, it can maintain a constant speed while orbiting the earth. This speed is also referred to as the orbit (Maini and Agrawal 2011). Upon reaching the second cosmic speed of 11.2 km/s, the aircraft can overcome gravity and travel to other planets in the solar system (Macdonald and Stevens 2018). Orbital flight, which falls between the first and second cosmic speeds, is a crucial aspect of space flight, along with interplanetary and lunar flights (McCurdy 2011). Cosmic velocity denotes the four representative initial velocities at which an object departs from the earth and breaks free from the celestial gravity field (Kropff et al. 2015). Due to the dense atmosphere on the earth's surface, a spacecraft cannot move in a circle close to the earth's surface because of air resistance (Vallado and Finkleman 2014). It must

[1] The term "cosmic velocity" pertains to the four distinct initial velocities that an object assumes upon departing from the gravitational field of celestial bodies. The first cosmic velocity is determined by the presence of a dense atmosphere on the surface of the Earth, which impedes the spacecraft's ability to move in a circular trajectory in close proximity to the planet's surface due to air resistance. Consequently, the spacecraft must ascend to an altitude of approximately 150 kilometers before it can achieve a circular trajectory, where the impact of air resistance is negligible. At this altitude, the spacecraft attains a circling velocity of 7.8 km/s.

fly at an altitude of approximately 150 km before it can move in a circle, and the circling speed at this altitude is 7.8 km/s (Kessler et al. 1980).

Throughout human history, the majority of aerospace endeavors have been focused on orbital flight (Solomone 2013). During orbital flight, the primary force acting upon spacecraft is the gravitational pull of the Earth (Klinger and Mayer-Gürr 2016). The trajectory of the spacecraft follows an elliptical path, with the Earth situated at one of the focal points of the orbit (Nani & Nani, 2020). Short-term space tourism has been made possible through Earth orbit, including space shuttle and space station visits (Hobe 2007). For instance, on September 16th, 2021, the Space X "Dragon" spacecraft, launched by the Falcon 9 rocket, embarked on a space journey with the "Civilian Corps" from Launch Pad 39A of Kennedy Space Center in Florida (Kulu 2021). Four passengers traveled around the Earth for three days in an area of space 575 km above the ground, with a flight orbit 160 km higher than that of the International Space Station (Pardini and Anselmo 2023).

In the context of flight, the term "suborbital" pertains to the region situated between 20 and 100 km above the Earth's surface (van Fenema 2005). This particular altitude range occupies a position between the lowest orbit of a satellite and the highest attainable altitude of an aircraft, commonly referred to as the space transition zone or adjacent space zone (McDowell 2018b). The suborbital region encompasses various atmospheric zones, including the ionosphere, mesosphere, and stratosphere (McDowell 2018b). Notably, the altitude of suborbital flight closely approximates the "Kármán line," which is approximately 100 km above the Earth's surface (Sziroczak and Smith 2016). According to the United States, individuals who travel beyond 80 km above the Earth's surface are classified as "astronauts" (Beck 2009). Suborbital flight pertains to aviation activities conducted within the suborbital airspace, ranging from 80 to 100 km above the Earth's surface (Dempsey and Manoli 2017). Parabolic flight is typically utilized to achieve this altitude, and the duration of suborbital flight is significantly shorter than that of orbital flight (Jonsson 2015). At this stage, only two commercial space companies, Virgin Galactic and Blue Origin, have successfully implemented suborbital space tourism projects, with their aircraft reaching altitudes of 86 and 100 km, respectively (Yazici and Tİwarİ 2021). During these space travel experiences, passengers are afforded approximately four minutes of weightlessness in space and are able to observe the Earth's stunning vistas (Weibel 2020) (Fig. 1.1).

The act of engaging in high-altitude flight and parabolic flight of aircraft is often considered a form of simulated space tourism, albeit at a low altitude, as it does not involve entering sub-orbit (Anderson and Piven 2005). High-altitude flight, which utilizes spacecraft, enables passengers to reach a height of approximately 18 km from the ground, providing them with a close-up view of the boundless space overhead and the curvature of the earth's terrain (World View 2023). This experience also includes a brief period of weightlessness. The Russian MiG-25 and MiG-31 high-performance fighters are currently being developed to facilitate this type of spacecraft, with a flying distance of over 24 km and an expected ticket price of nearly 10,000 US dollars (Anderson and Piven 2005). On the other hand, the parabolic flight of aircraft involves using high-performance weightless aircraft to create a repeated

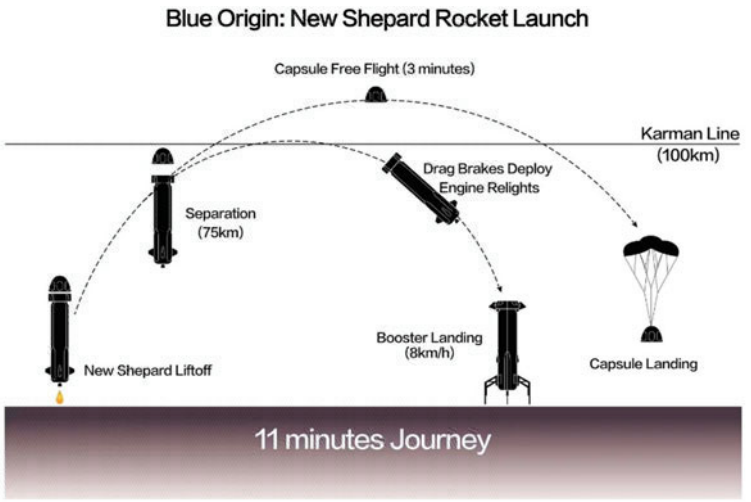

Fig. 1.1 Suborbital trajectory of blue origin

weightlessness environment, allowing passengers to experience weightlessness for approximately half a minute (Barratt 2016). The "IL-76" and other aircraft used for Russian astronaut training are currently being utilized for this type of space tourism, costing approximately US$5,800 (Reifert 2006). The advancement of human exploration into the vast expanse of the universe has led to an increase in space tourism, which has the potential to surpass the speed of the second universe (Clément 2011). This includes deep space tourism to destinations such as the lunar orbit, the moon, and Mars, which has generated great anticipation among humans (Huntress et al. 2006). Notably, successful cases of space tourism have been observed in companies such as Space X, Virgin Galactic, and Blue Origin, with Boeing's unmanned flight test also achieving success (Gudmundsson 2018). These developments have sparked interest in the commercial development of the aerospace industry on a global scale. The year 2021 has been dubbed the first year of space tourism, with three private enterprises in the western world achieving successful space tourism projects (Lee et al. 2021). This has encouraged more leading space industry companies to invest in space tourism development and gain valuable experience. The commercialization of space tourism is expected to accelerate the growth of the orbital and suborbital space tourism market, as well as the research and development of related technologies for circular round-trip transportation systems (Turek). Ultimately, reducing the cost of space tourism will pave the way for future space flights with longer distances from the ground (De Alwis et al. 2021).