Space Economy, Tourism and Logistics

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Abstract

The advancements in technology that developed with the Industrial Revolution provided people with the opportunity to explore their surroundings. Especially, the rocket technology developed during World War II paved the way for space exploration. The launching of the first satellites by Russia and the USA in 1957-58 marked the beginning of understanding the unknown and uncertainty of space. With the initiation of space research by Russia and the USA, the magnitude of the space industry has been increasing day by day. In recent times, the space economy is around $240 billion, while space tourism is around $1.5 billion. Space has attracted the interest of both states and private companies. Particularly, after the 2000s, space activities have been commercialized by private companies. In this study, the space economy has been evaluated within the scope of space tourism and space logistics. Qualitative in-depth analysis and quantitative VOSviewer methods have been used together in the study. In recent times, with SpaceX's reusable rocket technology, Falcon 9, a revolution has taken place in transportation and logistics in space. Also, SpaceX's low-cost approach providing access to space at more affordable costs is a significant advantage for future crewed or robotic space missions. The increase in space research and travel to space, the Moon, Mars, and deep space in the future will increase the volume of space tourism and, generally, the space economy, primarily boosting the importance of space logistics as it forms the basis of this process.

Keywords: Logistics, Space Logistics, Space, Space Economy, Supply Chain Management

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I. Introduction

Economy can be defined as the utilization of scarce resources. During the mercantilist era, countries engaged in commercial activities to increase their resources. To sustain these activities on a larger scale, they emphasized on naval fleets. Moreover, the discovery of new places accelerated commercial activities among international communities (Seyidoğlu, 1986).

In recent times, almost the entire surface of the earth has been explored. The limited resources on Earth are forcing governments and private companies to find resources outside the planet. Resource management activities in this context are discussed within the scope of the space economy. With the rocket technology developed by Germany and the USA during World War II, especially with the launch of the world's first artificial satellite Sputnik by the Soviets in 1957, new discoveries have become physically possible. Subsequently, the launch of the USA's first satellite, Vanguard, in 1958 accelerated the space exploration process (Cracknell and Varotsos, 2007).

The exploration of space has led to the development of the space industry and the emergence of new commercial opportunities. The space economy encompasses various activities such as satellites, tourism, space mining, manufacturing in space, space logistics, space transportation, space banking, space advertising and the Internet of Things (IoT) (Yost and Weston, 2024). In recent times, the size of the space economy has exceeded $400 billion, with more than 80% of the space economy consisting of commercial space activities (Space Foundation, 2020).

The most important discipline that enables the formation of the space economy is logistics. The supply, transportation, storage and return activities provided by logistical elements enable exploration, research, satellite projects and tourism activities in space. In this study, a qualitative study was conducted on the space economy, space tourism and space logistics. The research contributes to the literature and the industry due to the limited number of studies on Space Economy, Tourism and Logistics. It also discusses Türkiye's recent developments in the aviation and space sectors (TUA, 2022).

II. Space Economy, Tourism and Logistics

Space has been a subject of curiosity for centuries. Humanity still has a curiosity about unexplored areas around it, similar to geographical explorations. Explorations bring various costs. Initially, explorations are approached scientifically. However, these explorations have created a commercial area for humanity in the later process. With the beginning of the exploration of space, commercial activities have increased day by day. Ultimately, in the 2020s, the size of the space economy reached $423 billion (Space Foundation, 2020). The space economy examines the economic dimension of activities carried out by people in and beyond the atmosphere. The space economy encompasses activities such as satellites, the space industry, space tourism and space logistics. With the advancing technology, space activities are also gaining momentum. Especially after 2015, investments in the space industry have increased and the space economy has reached a significant size. The advancing technology will continue to increase the volume of the space economy in the future (Eugeni et. al., 2022; Kulu, 2023).

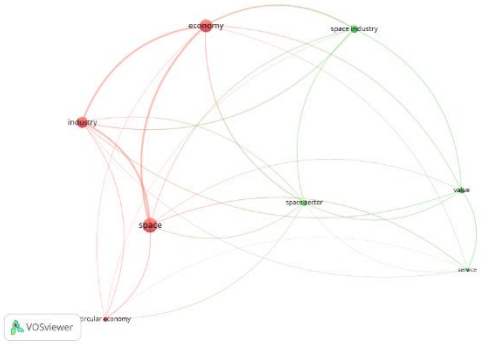

Figure 1. VOSviewer Network of Studies on Space Economy

Concerning the literature research conducted in the field of space economy, the most mentioned concepts are space, industry, economy and circular economy, as well as space sector, space industry, value and service as shown in Figure 1. The space industry is particularly supportive of concepts such as Industry 4.0 and super smart society. Therefore, it is likely that the volume of the space industry will increase in the future. In terms of economic size, the largest shares in the space industry belong to the USA, China, the European Space Agency (ESA) and European countries, Japan, Russia, India and Italy. In recent years, interest in space activities has increased. There are more than 70 space agencies worldwide (Space Foundation, 2020; Kulu, 2023).

Space tourism, one of the main components of the space economy, was first realized in 2001 through the Russian space tourism company Space Adventures, with Dennis Tito paying $20 million to stay at the International Space Station (ISS) from April 28 to May 6 (Cater, 2010; Zhang and Wang, 2022). This event is considered as the beginning of space tourism (Crouch, 2001). Today, companies like Axiom Space, SpaceX and Space Adventures conduct long-duration commercial flights to the ISS. Virgin Galactic and Blue Origin, on the other hand, conduct short-duration suborbital space tourism with their own spacecraft. The market share of suborbital space tourism is expected to be $1.5 billion before 2030, with a total commercial space tourism size of $1.7 billion (Florom-Smith et. al., 2022). As shown in Figure 2, the most mentioned concepts concerning the literature research in the field of space tourism are tourism, space tourism, tourism space and dark tourism.

Figure 2. VOSviewer Network of Studies on Space Tourism

Although space tourism currently has a small share in the space economy, it is considered highly important given the expectation of its future commercial growth. Space tourism is also influenced by space logistics activities. The evolution of rockets and spacecraft used for space travel in the future will expand the boundaries of space tourism (Florom-Smith et. al., 2022). Recently, the Turkish astronaut Alper Gezeravcı, sent to the ISS for a scientific mission with Axiom Space, has been a significant start for space tourism and Turkish space research.

Space logistics activities are crucial for the realization of space tourism. Currently, companies providing services in space tourism use Axiom Space and SpaceX Dragon spacecraft, Space Adventures Soyuz rocket, Virgin Galactic SpaceShipTwo and Blue Origin's New Shepard spacecraft for tourism activities. Space Perspective and Zero2Infinity companies, on the other hand, conduct space tourism using balloons.

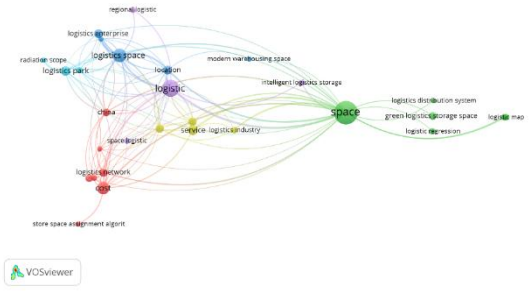

Figure 3. VOSviewer Network of Studies on Space Logistics

Space logistics is not only crucial in space tourism but also in space research, satellite launches, Moon, Mars and deep space exploration. It plays a significant role not only in transportation processes but also in supply, production, storage, return to Earth, maintenance and repair processes (Shull et. al., 2006; Baraniecka, 2019). Space logistics refers to the processes of supply, production, storage, distribution, handling, and service provision with specialized vehicles and equipment both in and beyond the atmosphere to complete space missions. It is crucial for the success of space missions, research and tourism activities (Bowersox et. al., 2020). As shown in Figure 3, the most mentioned concepts in the literature research on space logistics are Space Logistics, Service Logistics Industry, Logistics, Logistics Space, Cost, Logistics Park, Space, Logistics Distribution System and Green Logistics Storage Space. Space logistics will become an even more important area in the future with the increase of commercial activities.

III. Methodology

The research examining space economy, tourism and logistics used both qualitative and quantitative research methods. In the study, the impact of tourism and logistics elements on space economy was investigated. While qualitative methods incorporate personal thoughts, quantitative methods reach conclusions by statistically analyzing the data obtained. In the current study, data obtained from the Web of Science database on space economy, space tourism and space logistics were analyzed using the VOSviewer package program (Yıldırım and Simsek, 1999; Patton, 2005; Toraman, 2024; Alnıpak and Toraman, 2023). Additionally, qualitative methods were used in the study. Secondary sources such as research, studies, reports and articles on space economy, space tourism, and space logistics were examined. The study, conducted using both qualitative and quantitative methods, examined the current state and future of space economy in the literature.

IV. Discussion and Conclusion

The exploration of space has always been a subject of fascination. After World War II, the military technology developed during the war was intended for use in space exploration and was tested for this purpose. In this context, space activities can be said to have yielded positive results with the satellites sent into space between 1957-58.

The space industry has brought a new breath to many sectors. National Aeronautics and Space Administration (NASA) and ROSCOSMOS have led the way in space activities. They have made significant contributions to the development of the sector through their scientific activities. The space industry has enabled the development of engines, rockets, spacecraft, technical equipment, vehicles and tools.

In 2001, Dennis Tito's 8-day tourist visit to the ISS sparked the idea that tourism activities could be carried out in space. The 2000s were a period when the space economy was revitalized and its volume increased. During this period, both governments and private companies accelerated their space activities. Governments invested in communication, navigation and military activities, while private companies pursued activities based on new business models. Especially Germany's Industry 4.0 concept, which it presented as automation in production and Japan's Super Smart Society concept, which later popularized automation processes, will enter the field of space economy. Additionally, connecting to the Internet of Things (IoT) applications via satellite is crucial (Space Foundation, 2020; Yost and Weston, 2024).

Recently, the activities of Virgin Galactic, Blue Origin, Axiom Space, SpaceX, Space Adventures, Space Perspective and Zero2Infinity in space tourism are crucial for the development of the space economy. Although current space tourism prices are high due to the high initial investment costs of space vehicles, technological advancements will reduce costs in the future. Especially, the reusability of New Shepard is likely to enable space

tourism to reach a wider audience in the future (Florom-Smith et. al., 2022). The Falcon 9 rocket, which reduces launch costs with the possibility of reuse, has contributed most to the development of space activities. SpaceX, which is important in space logistics, is a private and commercial space and rocket company with ambitions in space. SpaceX has provided low-cost access to space with the Falcon 9 rocket. SpaceX operates in space research, Moon missions, Mars missions, deep space missions, space tourism, cargo transportation, satellite launch activities with Falcon 9, Falcon Heavy, Dragon and Starship spacecraft. SpaceX is a significant stakeholder in space logistics with its rockets and spacecraft. Space logistics involves the planning, implementation, control and necessary intervention in the event of any issues of space missions, research, cargo delivery, or travel, as well as the planning of crew returns at the end of missions, using rockets, spacecraft, vehicles and equipment (Reddy, 2018; SpaceX, 2021).

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