How Firms Utilize the Data Provided by Space Firms

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1 Introduction

Space firms can be described as firms that are associated with at least one of the space sectors. There are two major space sectors—upstream and downstream. Upstream can be further divided into manufacturers and launchers, while downstream includes communications providers, satellite data providers, and platforms and mapmakers (Weinzierl, 2018). The broader space economy may also include sectors such as space exploration, space infrastructure, and space governance. The shifting focus of space firms toward nanosats has greatly influenced the increased production of satellite products to gather significant amounts of data from the lower earth orbit. There are over 2080 nanosats scheduled to launch from 2022 to 2027 (Nanosats, 2023). This will result in an enormous supply of satellite data including remote sensing, earth observation, and geospatial data, which may enable companies to use the data products to improve the existing business sectors and enter the next chapter in their evolutionary journey.

The existing literature has provided applications of space data in various business sectors including, agriculture to improve water management

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by mapping the field in addition to monitoring crop health and forecast yield (Vuran et al., 2018), allowing insurance firms to evaluate the risk of natural disasters as well as quantify the losses (Ardila et al., 2022; Kuntla, 2021). The infrastructure development and shipping routes trackers benefit from satellite data to improve the performance of transportation (Perboli et al., 2021). Satellite data are also used to monitor mining operations, assess the environmental impacts, and understand land management (Maus et al., 2020). Oil and gas firms can greatly benefit from using satellite data to identify leaks (Guanter et al., 2021). However, the focus of these studies corresponds to application specific and inapplicable on a general level. The most important challenges of integrating satellite data into existing businesses include:

- Value proposition
- Lack of understanding about satellite products
- Lack of innovative solutions

Firms may also require significant government grants and funding to optimize the fundamental economic structure to incorporate satellite data (Weinzierl et al., 2022). Firms compel the designer to focus on customer-centric product development in the new space under the uncertainty of market conditions (Golkar & Salado, 2021; Ojala, 2016). To address these gaps, the aim is to gather insight about space data to integrate with opportunity creation/development theory (Alvarez et al., 2013; Overholm, 2015; Schneider, 2019). In the space data economy, product innovation by means of using space data has not been conceptualized widely in the literature. Therefore, an analysis of how companies have used space data in business activities to improve business performance bring forth insights for space data economy and business literature is needed. The main contribution of this study is to present a theoretical and practical explanation of some of the fundamental questions in space economy. These questions include:

1. How does space data create value for business activities that is unmatched by any other technologies?

2. What types of space data products are available in the market that can be integrated in new product development?
3. How do firms decide whether to use space data or not?

The aim of these research questions is to enable space data practitioners with guiding literature as well as contributing to the continuously evolving literature of space data business. The chapter is organized as follows: the next section lays the foundation of opportunity creation/development theory followed with space data economy. Research methods and findings are presented in the following section. The chapter closes with discussion and conclusions.

2 Literature Review

It is generally agreed among opportunity theorists that opportunity comes from imperfection of a competitive market that can potentially be realized with monetary value (Alvarez et al., 2013; Overholm, 2015; Schneider, 2019). This means that there won't be any opportunities in perfect market conditions. Therefore, opportunities are generated in an economic system when there is room for improvement. Firms tend to focus on product innovation during a certain market condition (Schneider, 2019). Previous studies have broadly debated the role of discovery, which can be caused by an external force that brings forth opportunities (Alvarez & Barney, 2007). This could lead to the creation of new products and services solving existential problems and meet the demand of the market (Korsgaard, 2011; Ojala, 2016). However, Filser et al. (2020) argued recognizing an opportunity requires a few aspects from an entrepreneur or a venture including (1) Personal factor (Education, Knowledge), (2) Organizational factor (Funding potential, Decision-making process), and (3) Environmental factor (Network, Market conditions).

Authors have argued that entrepreneurial education is associated with the performance in creation (Hmieleski et al., 2015). The environmental conditions of a firm play a big role in how the opportunities are recognized (Edelman & Yli-Renko, 2010). Closing the gap between opportunity recognition and action depends on the firm's belief and perception (Barreto, 2012; Shepherd et al., 2014). Karami et al. (2022) emphasized seizing the opportunity with an example case study where firms anticipate change in advance instead of waiting for change to occur in the market, while taking a tolerable risk on product development as

well as engaging with business platforms, expanding the value network, and participating in conferences. In this context, firms should proactively recognize opportunities by anticipating the changes in the space data economy. The opportunity theory has widely been established in the literature with respect to the implications on space product innovation. However, there is a gap in integrating opportunity theory with new space to explain how firms can utilize the opportunity from space data in existing businesses.

Space data refers to the data generated by satellites using synthetic aperture radar (SAR), multispectral image, and geolocation information. The context of space data is specifically mentioning these sources of information that can be used by existing firms on the globe. Space data economy can be divided into two major building blocks, which are upstream and downstream shown in Fig. 1. The upstream consists of manufacturers of satellites and ground stations as well as launch activation and operations (OECD, 2022; PWC, 2020). The manufacturers provide hardware equipment, assembly and network capabilities. The launchers bring rockets and services that are necessary to launch satellites into the orbital system. The operations block allocates the capacity of the system and provides system's maintenance in the ground station. Operations are connected to both upstream and downstream blocks to ensure connectivity and downlinking the data (raw data) and enable for further processing (Black et al., 2022; Deloitte, 2019). The downstream segment consists of operations and space data products. The space data products consist of various data products and packages. These products include agriculture, climate, insurance, geo-intelligence, security, maritime, and finance. These packages also include communication, surveillance, RF spectrum monitoring, and emission monitoring. The industry is governed with regulations as a whole.

The space economy in the US and India has been growing in the last decade (Highfill & MacDonald, 2022; Mani et al., 2023). However, the impact on the economy of this expansion is yet to be quantified. The downstream space activities have been expanding in Europe over the last few years compelling enterprises to innovate and capture value from the opportunities presented by the new space paradigm shift (Bousedra, 2023). China aims to explore the possible access for materials and energy resources to fulfill its economic and energy needs by building a solar power station (Goswami, 2018). These activities inspire new power dynamics in the space sector considering that government

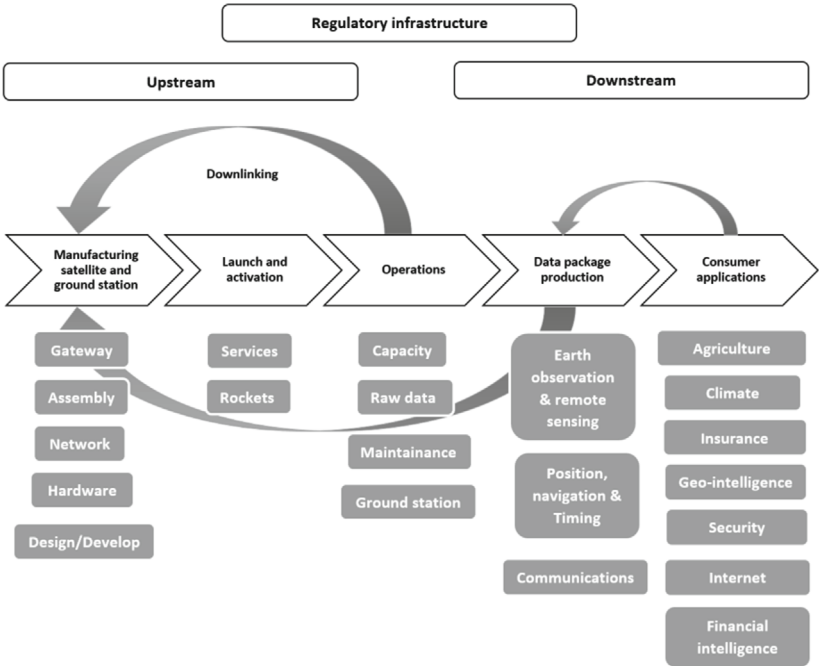

Fig. 1 Representation of space data economy

is not the only agency participating in the development of the space industry (Rementeria, 2022). Nevertheless, democratization of the space sector brings a new structural aspect to the governance of this industry. The uncertainty of space economy and openness also present challenges that may lead to a culture of innovation (Clormann, 2021). The biggest challenge the space sector currently faces is the space debris (Béal et al., 2020). However, the infrastructure for taxation is unclear. The role of policy intervention can be effective when the timing and selection are appropriate to reflect the targeted components of the system in the evolving ecosystem (Carter & Pezeshkan, 2023). The growing numbers of satellites in the orbit system eventually leads to expansion of the space surveillance system to identify illegal objects and understand the nature of space pollution (Wang et al., 2022). Furthermore, secure communication from satellites to devices should be considered in the evolution of

the space sector (Bradbury et al., 2020). Space security and surveillance give rise to the construction of space policies that support research and development of new space (Castaño, 2021).

There is a variety of space data products available in the market at various bandwidths with different hardware adding complexity to choosing the right product for a firm's need. Prol et al. (2022) discussed the opportunities and challenges of communication satellites in low earth orbit. The most common commercial application is flood monitoring produced with SAR and multispectral images (Kuntla, 2021). The quantification of disaster caused by flooding has proven to be an important application for insurance providers (Ardila et al., 2022). Remote sensing also allows precision agriculture and mapping greenhouse gas to improve climate change response (Guanter et al., 2021; Vuran et al., 2018). The mining industry has been benefited greatly by remote sensing data (Maus et al., 2020). Moreover, logistics has improved performance by space data adoption (Perboli et al., 2021). Many specific industrial applications have adopted space data to improve the performance of businesses. However, there is still a huge gap among various business sectors using space data in business activities. This study addresses how businesses can identify the opportunity to use space data in product development.

3 Research Method

The study considers gathering valuable insights from an emerging business sector that can be complemented with the literary knowledge provided by previous research studies and facilitate business models toward product development using space data. These tasks were achieved by extracting information from two case studies (Darke et al., 1998; Yin, 2013). The information helped generalize and unfold conclusions that reflect on the research questions and provide a deeper understanding of the research field (Eisenhardt, 1989). The knowledge derived from the case studies help integrate and examine the business model evolution (Hedman & Kalling, 2003).

The case studies selected in this project are all participating in the space sector. The firms also meet the theoretical requirements as prescribed by (Eisenhardt, 1989). These firms met the following criteria: (1) firms involved in the innovation and opportunity creation/development activities in new space, (2) progress of the firms directly related to space data-based services, and (3) firms provided solutions to the observable

problems in non-space related businesses. Table 1 shows the materials and various data sources used in the study. There were four interviews and one questionnaire conducted by the author for the purpose of data collection for this study during the year 2023. The first interview was related to the development and progress in the upstream sector conducted through virtual meetings. The intentions were to gather information about space data-based services or products in the industry. It was found that the upstream sector provides the hardware and services to the satellite companies to launch into the respective orbits. The second interview dealt with the downstream activities over virtual meeting. This firm provides space data-based services to conventional businesses. There was only one questionnaire designed for Firm C due to the unavailability of time. Firm C provides weather related services to customers. The third interview was a face-to-face meeting. The interviewee has a lifelong experience in both industry and academic organizations. The topic of the interview was remote sensing and earth observation. The fourth interview was also a face-to-face meeting. The interviewee has a wide range of experience in both industry and academia. The topic of the meeting was global navigation space systems.

The length of the interviews varied between 20–120 min. All interviewees have an in-depth knowledge of the subject area. They talked in-detail about the role of their organizations and the progress of the space industry. They were asked the research questions in many ways, to which interviewees provided detailed answers. The author took notes of the information provided by the interviewees. The qualitative approach

Table 1 Empirical data used in the study

Data source	*Main activity*	*Year*	*Headquarter location*
Interview with the CEO of Firm A	Upstream	2023	Espoo, Finland
Interview with the CEO of Firm B	Downstream	2023	Espoo, Finland
Questionnaire with a senior member of Firm C	Weather related services	2023	Helsinki, Finland
Interview with academic/industry expert	Remote sensing	2023	Vaasa, Finland
Interview with academic/industry expert	Global navigation space system	2023	Vaasa, Finland

taken in this study provided the author with the tools to extract data and knowledge in the space industry that are conformed to the research questions (Eisenhardt, 1989).

The data collection also includes visiting websites of space firms and gathering information on products and services shown in Table 2. There are six types of CubeSat constellations identified in the space sector providing services to the existing businesses. These constellations generally provide seven types of products and services that are observable from a satellite. Each of these general products and services may include various solutions addressing specific identifiable problems. There were over twenty-five company web pages found from the internet search. The data collected from companies web pages included different products and services offered to the business to understand how companies have used space data in solving problems. The database used for gathering information on satellite companies is nanosats.eu

This study implements a comprehensive data analysis method, which consisted of three parts (Casterlé et al., 2012; Lester et al., 2020), (1) Data summarization, (2) Data visualization, and (3) Conclusions. In the first part of data analysis, the notes taken from the interviews were organized based on the research questions. The contents were then simplified to adhere with the flow of the study including the business model and opportunity creation/development. The written sources were also used to explain products and services of space businesses recommended by the mixed method research (Leko et al., 2023; Liu, 2022). This process

Table 2 Other written sources

CubeSat constellations	*Number of sources*	*Products and services*
Multispectral and hyperspectral	9	Earth observation and remote sensing
Communication	5	Infrastructure
AIS/ADS-B	3	Surveillance
Weather data	3	Weather forecast
RF spectrum monitoring & geolocation	3	Security, position, navigation and timing
Emissions & greenhouse gas monitoring	2	Monitoring and observation
Quantum key distribution	3	Secure communication and clock synchronization

allows creating summaries reflecting on both qualitative and quantitative data for each research question in chronological order and allowing synchronous links to the subject of this study.

The second part of data analysis includes visualization or representation of the data that are relevant to the subject of this study and answer the research questions. The visualization is accomplished by creating tables to represent a clear understanding of the topic studied. It was noted that the interviewees brought different points of view for the topic at hand. Although, these points are valid in practical aspects of business processes. The most relevant answers are favored and presented in the study. The Tables provided a visualized outcome of the study including the characteristics of space data firms, progress of the industry, and possibility of value creation.

The third part of the data analysis includes conclusions drawn from the various aspects of the industry. The identified key aspects of the case study are elaborated. The key benefits and challenges of the study are highlighted as well as identified patterns are discussed. The outcome of the study is further related with the literature to form a solid understanding of the topic (Leko et al., 2023), and presents knowledge on how firms can benefit from the opportunities in the emerging space data sector.

4 Findings

This section presents the finding of all research questions mentioned in the introduction. Each subsection provides examples from the interviews in tables. The subsections also reflect on the information extracted from the interviews.

4.1 How Does Space Data Create Value for Business Activities that is Unmatched by any Other Technologies?

Space data provides an opportunity to look at the planet in its entirety, which makes it very valuable for various business activities. Any problems occurring on the planet can be detected and seen, giving businesses the opportunity to make better decisions through monitoring natural disasters, detecting environmental change, and providing data regarding the past, present, and likely future. There are separate satellite constellations to provide position, navigation, and timing data. The positioning data is important for the manufacturers because the devices used for positioning

send information of its status. A great challenge to this industry is easy access to space due to high cost. Therefore, special considerations have been given to the development of low cost hardware. The life cycle of the satellite is also short, which also contributes to the high cost factor.

There are various business cases of space data implementation. For example, a local company in Finland conducted an analysis of tree height that may disturb electricity distribution lines. In this case, space data is not directly being used for energy distribution but indirectly, for solving a problem. This type of innovative solution is difficult to come by for most firms. Space data have been used in the solar and wind industries to help understand the climate better and predict the weather. Space agencies around the world share data to study various problems including estimation of clouds' effect on solar radiation on long or short timescales as well as price fluctuations. While there is much interesting research related to space industry, commercial applications have a lot of room to fill other than estimating the prices of space data packages. Examples of product development opportunities from the interviews are presented in Table 3.

Table 3 Highlighting product development opportunities for research question 1

Examples from interviews	*Identified opportunities*
"Building forest inventory for Nordic customers requires intensive satellite data usage to create a product of high accuracy to investigate and detect bark beetle attack using data fusion. Remote sensing and artificial intelligence were used to create the product"	Data fusion (remote sensing and artificial intelligence)
"Positioning data is needed for many business sectors. Firms did not use to have information of the devices employed. However, new positioning devices send information of its health as well. This generate interest from various firms to utilize these devices"	Generated interest is value creation
"Sentinel 1 and ICEYE satellites are similar but different in its resolution because Sentinel 1 was designed to view big problems on the planet and ICEYE was not"	Education and skills

Space firms deal with managing big data, which brings its own complexity so they cannot always focus on what can be done with it. For example, Sentinel 2 data packages are images from a camera. How these images can be used to solve problems of social services and inequality through observation is another challenge. Data analysis and problem domain variables determine whether it works for the customers. The goal of the satellite firms also determines the solution it will provide. The firms understand the problems on the planet and the space industry has a better chance to provide relevant solutions. Knowledge gaps have to be closed in space data usage in industries that could solve problems on a large scale. There is value in having platforms that could address the problems on the planet relevant to the space data products. For example, the hardware of satellite and electricity distribution are technically very disparate. Satellite images may be a bridge to the gap between "cutting trees with chainsaws" and space data. The gap is currently wide, as "chainsaw managers" are not looking to incorporate space data in their businesses so a middle entity or a platform would help address the needs of the market and educate about the problem. If there is a common objective between firms on the ground and space firms and a clear value proposition, the solution can become a reality. There are also other tangible limiting factors including resolution, data engineering, downloading and scaling. Not all satellites have the power to produce and expand at the same time.

4.2 What Type of Space Data Products are Available in the Market that Can be Integrated in Product Development?

There are many types of space data products available in the market. Speaking strictly of CubeSat constellations, there are seven categories of space data products (see Table 2). This study categorizes space data products and services into three categories. (1) Earth observation and remote sensing, (2) Position, navigation, timing, and (3) Communication. The first category's products and services include all multispectral, hyperspectral, and SAR data packages. The second type is related to global position and navigation as well as time synchronization. The third group of products and services includes communication. These three categories cover all the space data products available to customers (see Fig. 1). Examples of product development opportunities are shown in Table 4.

Table 4 Highlighting product development opportunities for research question 2

Examples from interviews	*Identified opportunities*
"Leveraging AI and robotics along with space data in the same platform will enable businesses to utilize this industry at maximum extent. A new commercial sector takes time to grow due to the slow technological adoption. Space data is dependent on the hardware that require access to space. This is a supply chain issue. Once this issue is resolved, the suppliers and the contractors will have a better chance to address majority of the problems"	Resolving supply chain through networks
"There are many ways space data can be used to identify and solve problems. Activities related to piracy and oil leaks are responsibility of governments but private contractors can identify these problems as well. As soon as cost and benefits are analyzed, the problem can be resolved"	Funding and value creation
"Firms that serve society and identify climate change problems, they are likely to use space data for study and research. Space data is most suitable for large-scale problems. For example, ICEYE focuses on flood detection problem and not any others"	Problem solving through skills

In the space data economy, object detection plays a key role with optical and SAR data at high resolution. These data can be used to estimate temperatures, number of trees in a region, and for city planning. Space data make an impact when designers leverage robotics and artificial intelligence in the same platform. Incorporating space data can benefit businesses for solving an identifiable problem. The largest users of space data are governments. They assign tasks to various agencies to solve a problem by space data. Firms on the ground are trying to close the gaps between using space data and problem solutions. The technical infrastructure is in place but the lack of skill for using space data is a hurdle for many firms. There are risks associated with adopting space data, however the rewards for incorporating space data for solving problems can be high

for firms. If space data is publicly available, firms do not need to manufacture the satellite from scratch and then fill the market demand cost efficiently. Thus, firms that are willing to use space data are already one step ahead in dealing with the complexity of manufacturing the satellite and launching it.

Firms that are tackling climate change problems, biodiversity loss, and pollution are likely to use space data. Space data would benefit the study of this problem, as these are multidimensional problems. For example, a main product of ICEYE is flood detection. The frequency of data production may be a key for solving some problems. It depends on the nature of application and the system's ability to generate data packages. For military applications, high frequency is critical. Forestry and agriculture may not need high frequency. Furthermore, speed is important for pest detection in forestry, natural disaster assessment, and electricity distribution. A local electricity distribution firm used helicopters for inspection of distribution lines. However, the manual inspection can be replaced by space data since "helicopters cannot fly in storms," they explained. The frequency of space data should be determined based on application and the system's capability for producing it. Some applications derive value from high frequency of space data. Space data firms provide simple to use products to firms that implement the data in business activities. Firms pay different prices for different applications. The cost of space data products and services can be determined by the production cost and understanding the customer needs. The cost of space data can be understood better by separating the space data from data analytics and data intelligence. The market will determine the cost by application specific solutions. It also depends on whether a firm is selling space data or analysis of space data, which is an important distinction.

4.3 How Do Firms Decide Whether to Use Space Data or Not?

One of the challenges that firms face when adopting space data is the unknown criteria of which the firm can benefit from. There are efforts made by satellite communities to provide examples for various applications. The value of knowing the problem that can be addressed by space data is existential. However, the solutions remain abstract. There is a need to break down the inquiry from a broader problem to sector level analysis and dispel any abstract solutions. The criteria for a firm to use space

data broadly is the replacement of manual inspection outdoors. Furthermore, a business owner would also take into account the cost and benefits as well as timely advantages of space data adoption. These criteria can be evaluated by feasibility study. For example, a local company can hire ten employees for expansion but global expansion may require space data adoption. In this case, geographical scaling is another criterion. Examples of product development opportunities are shown in Table 5.

The firms looking to adopt space data in their business activities can expect particular outcomes from its value chain. These expectations may include (1) better decision-making capabilities, (2) increased revenue, (3) cost reduction, and (4) risk mitigation. There are various investment firms and financial institutions already using space data in investment models and financial models. The decision-making for these firms rely on space data to monitor the performance of a company. Start-ups should be critical in their feasibility analysis. Inaccurate understanding of customer needs can bankrupt a space company. The amount and abilities of space start-ups should justify the demand of space data products.

The infrastructure for space firms is available to support product development. There are many firms providing small platforms using space data. Conventionally, the big firms provide platforms for small firms in communications. Communication satellites provide a platform for companies and remote sensing satellites provide earth observation. The concept of platform is also disturbing to some companies due to the lack of trust. For example, there are four major global navigation systems including GPS,

Table 5 Highlighting product development opportunities for research question 3

Examples from interviews	*Identified opportunities*
"It is important to determine the size of the market for space data solutions. Are there enough customers and what the state of competition in that area is"	Problem solving
"Investment firms use space data for investment and financial modeling"	Problem solving and skills
"Big firms provide platforms for small companies that can be used to create products and services for customers"	Value creation and problem solving

GNSS, GLONASS, and BDS. The existence of different global navigation is proof of distrust among nations. Similarly, firms compete to make a better product than others do, using their own platforms due to distrust and geopolitical reasons. The development of the space data economy is progressing slowly. The reason is that the gap closes in some business activities and not in others. Recently, solving problems with space data can be seen. However, not all areas of business will see the integration of space data. Despite the existence of motor vehicles, between 1890 and 1920, mobility relied mainly on horses before suddenly changing. Similar trends were seen for the adoption of the internet in the 90's. It generally takes one generation for technological adoption.

4.4 What are Space Data Opportunities for Product Development?

This section briefly summarizes the outcome of product development opportunities shown in Table 6. The essence of opportunity development related to space data knowledge gathered from the interviews are highlighted in Table 3–5. There are five important aspects of opportunity development presented in Table 6, which include value creation (Alvarez et al., 2013; Schneider, 2019), network (Filser et al., 2020), problem solving (Korsgaard, 2011; Ojala, 2016), skills (Filser et al., 2020), and funding (Filser et al., 2020). There are six key parameters selected from the research questions to justify integration of space data in business activities. These parameters include technological advantage, space data integration, space data platform, space data infrastructure, space data frequency, and space data expected outcome. It was found that funding and networks for space data products and services are available. There were many observable problems being solved by using space data products in various business sectors. Furthermore, there is an enormous gap in many industries that can be bridged by space data products and services leading to value creation. However, there is a mismatch of skills needed to implement space data in business activities. The major reason for this mismatch was the required knowledge needed for various business sectors and identification of problems that could be observed by satellites. In addition, a separate set of skills were required to implement space data in business activities.

Table 6 Available opportunities of space data for product development

Parameters	*Value creation*	*Network*	*Problem solving*	*Skills*	*Funding*
Technological advantage	A	A	A	PA	A
Space data integration	A	A	A	PA	A
Space data Platform	A	A	PA	PA	A
Space data infrastructure	A	A	A	A	A
Space data frequency	PA	A	A	PA	A
Space data expected outcome	A	A	A	PA	A

1. A is for available
2. PA is for partially available

5 Discussion and Conclusions

This study aimed to highlight important questions lingering in the new space. The current research work in this domain is application specific. The biggest challenges hindering the space data economy were found to be unclear value propositions, lack of skills, and need for education. Firms involved in new space require government grants and funding to optimize the business model. To address these challenges, the study investigated three major questions corresponding to value proposition, space data products and services in the market, and the criteria used to adopt space data. It implemented opportunity development theory to identify the key parameters of space data adoption that can benefit a firm. Further, the study found that space data primarily deals with the problems on a large scale that are observable by satellites. These problems may relate to remote sensing, navigation, or communications. Remote sensing provides data from various sensors including multispectral, hyperspectral, and synthetic aperture radar. Navigation data mainly includes positioning information while communications satellite data provide infrastructure. The study also found that the frequency of space data generation is application specific. Some applications can benefit from near real time space data production. The frequency of space data production is also dependent upon the hardware capability and budget, thus frequency data generation would increase the cost significantly.

5.1 Theoretical Implications

This study contributes to business research by combining insights from the new space sector into opportunity development theory. Firstly, opportunity development theory was used as a foundation for the development in the new space. The questions for the interviews were developed using the essence of opportunity development literature. The questions were specifically developed to collect data on value proposition and product development (Alvarez et al., 2013; Schneider, 2019). While space data utilization has always been for defense purposes till now, many new businesses have been taking the opportunity to incorporate the publicly available space data in their business activities to create value. The research questions also reflect on the nature of problem solving in the market (Korsgaard, 2011; Ojala, 2016). Currently, the most successful applications of space data are insurance claims for natural disasters and agricultural monitoring. Space data provides solutions to large-scale problems. Furthermore, the study refers to the skills and resource exploitation of space data (Filser et al., 2020). The applications of space data requires various sets of skills and multidisciplinary approaches.

Secondly, the study provides a theoretical aspect on the progress of space data applications by demonstrating the benefits in the agriculture sector (Vuran et al., 2018). Crop health detection and water management have been the top products in agriculture. However, the cost of incorporating high tech products could be unaffordable for farmers. Insurance and transportation has been at the forefront in the adoption of space data (Ardila et al., 2022; Kuntla, 2021; Perboli et al., 2021). Furthermore, mining and environmental impact assessment are benefitting from space data (Maus et al., 2020), in addition to oil and gas leak detection. Although, space data provides asset monitoring on mining sites and oil leakage in the ocean as added value to the business performance. However, these applications are useful for government law enforcement. The study also emphasized on the importance of space surveillance and avoiding space pollution (Béal et al., 2020; Wang et al., 2022). The future of new space depends on the infrastructure and management of space activities that are highlighted in the study for a sustainable space data adoption.

Finally, the study implements the essence of opportunity development theory to gather key insights of space data availability for product

development. The study focused on five essential parameters from opportunity development theory including value creation (Alvarez et al., 2013; Overholm, 2015), funding (Filser et al., 2020), solution to a problem (Korsgaard, 2011), and skills and network (Filser et al., 2020). These parameters were considered to be the foundation of space data integration in business activities. Furthermore, the study provides key indicators of space data availability for adoption in businesses including technological advantage, space data integration, platform, infrastructure, frequency, and expected outcome. The findings of the study enhance our understanding regarding opportunity development by emphasizing the importance of large-scale planetary problems. Problem scale (large or small) is an important factor to be considered in opportunity development when leveraging space data.

5.2 Practical Implications

This study provides a guide for small to medium firms on the opportunities available in the domain of space data utilization for various business activities. The practical aspects of integrating space data can be decoded in three ways. Firstly, firms should focus on how space data create value in their business activities (Schneider, 2019). Value creation does not strictly refer to monetary value. However, a sustainable business proposition requires a monetary aspect. Space data provides technological advantages and eliminates manual inspections from observable problems on the planet (Korsgaard, 2011). Firms should look into the possibility of solving a problem using space data that may not be solved by other technologies. The use of space data also requires skills and knowledge in various disciplines. Firms should be ready for skill development that is necessary to be successful in space data adoption (Filser et al., 2020). There are various funding and growing networks available in Europe for space data related activities. Firms should not try to reinvent the wheel by focusing on the development of satellites from scratch to match their application specific needs, instead they should identify appropriate platforms and infrastructures already available. Firms should try to follow the market development and conduct feasibility studies to facilitate their decision-making for adoption of space data.

Secondly, there are various space data products and services already available in the market for businesses. For example, the Copernicus project provides SAR data, multispectral data, and climate data freely to

create data products and services. Firms that are looking for global expansion may consider these products and services to benefit their business performance and practice business model innovation. The space sector can make a great impact on all existing businesses. The ramifications for avoiding space data integration may be higher than one can anticipate. Nonetheless, it is important to make sure the applicability of space data is feasible. The cost of space data plays an important role in its adoption but the risk to reward justify the investment. Firms should also consider the frequency and resolution of space data products and services. Both frequency and resolution depend on scale of application as small-scale applications may require high frequency and vice versa. The best emerging space data practices include:

- Investment firms use space data to create financial models and investment strategies including oil prices and energy prices;
- Space data can be used to track livestock and manage crops;
- Space data is used to monitor tree growth around electrical power lines;
- Firms use space data to detect flooding and calculate insurance claims;
- Agricultural and forest health monitoring has been done using space data.

Finally, firms should consider all the necessary criteria before incorporating space data in business activities. Conventionally, firms jump on the opportunity of available funding without considering the feasibility of space data adoption for their businesses. If a customer is unwilling to pay for a solution based on space data, it is unwise to develop that product or service even when the funding is available. Without a usable product or service, funding will only prolong the failure. So how should firms avoid making this mistake? Firms should consider the key essence of opportunity development theory. The first is value creation, which means customer-centric product development. A customer should be willing to pay for a product made by using space data. The second is problem solving, which means a space data product or service should provide a solution to an existing problem that may have not been solved otherwise. The third is skill and network. Space data products require skills in various disciplines and examples from hands on experience. Firms should consider their own ability to navigate through multiple layers of education and skills before applying for space funding.

5.3 *Limitations*

This study provides insights into the use of space data in business activities by gathering information through interviews similar to any empirical study. However, the quantity of interviews could be expanded by including more data from other experts in the field. The first shortcoming has to do with information gathering from diverse business sectors to have a concrete understanding before generalization of the subject. The second factor that limits this study is the integration of two separate fields of study including business research and space research. Most of the literature available on the space sector is technologically driven. However, it was challenging to relate these two fields of research. The third limiting factor is that the study provides few parameters to consider before the adoption of space data. However, these criteria could be expanded depending on the nature of the business sector.

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