What is value in the New Space Economy? The end-users perspective

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Abstract

New industrial dynamics are disrupting the space sector. New stakeholders bringing in capital, technologies, and knowledge from other industries are developing next-generation space infrastructures and services. Both commercial and institutional space projects have to be valuable for a wider set of end-users, asking not only for economic returns but also social and environmental benefits. Space organizations urge understanding and fostering value in the New Space Economy ecosystem. Indeed, end-users are still struggling to enact the expected value of satellite data and solutions for their business.

This paper aims to investigate the expected value and the level of adoption (enacted value) of satellite data and satellite-based solutions in the New Space Economy ecosystem from the perspective of end-users. We interviewed 21 managers from end-user organizations in different sectors (i.e., Insurance & Finance, Energy & Utility, Transportation & Logistics). Value is deeply discussed in general management literature, and we identify Value Theory as the theoretical lens with the most explanatory power for the phenomenon under examination. From the end-users perspective, we frame the expected value and the level of adoption of satellite data in taking strategic and tactical decisions regarding their activities, services and products, laying the foundations for further studies of value mechanisms in the New Space ecosystem. Our research set a theoretical and conceptual foundation on value in the New Space ecosystem. It also delineates the blurred boundaries of the New Space ecosystem, the main stakeholders involved, and their perception of value. Insights and implications for strategic and innovation management are also provided. Practitioners may exploit our research findings and leverage the end-users-oriented framework to develop next-generation space projects in the New Space ecosystem.

Keywords: Value Management; Economic value; Social value; Environmental value; SDGs

1. Introduction

New industrial dynamics are disrupting the space sector. New stakeholders bringing in capital, technologies, and knowledge from other industries are now involved in developing next-generation space infrastructures and services. Space projects have to be valuable for a wider set of end-users, asking not only for economic returns but also social and environmental benefits in the long term.

In a traditional space economy, space organizations (i.e., upstream and downstream) build a satellite constellation and develop a satellite-based solution commissioned and paid upfront by the client, usually a space agency. Thus, the scope, the end-users and the expected value of a satellite infrastructure are clearly identified since the beginning of the project/programme.

In the New Space Economy, the liberalization of the market and the ever-easier and cheaper access to satellite data have changed the value proposition of space organizations toward end-users. For example, the free access to space infrastructure, such as GNSS, has stimulated the emergence of new products, services, businesses and industries. Without satellite navigation data, end-users such as Uber, Ofo and Deliveroo would not be the worldwide giants we all know that have revolutionized mobility and the lives of consumers. End-users can capture the value of satellite data and generate new businesses. However, the complexity and deep uncertainties affecting the medium-long term development of this business may limit the expected value enactment. Indeed, the heterogeneity of the applications complicates the identification of end-users, their needs and engagement strategies. End-users may enact the expected value from satellite data but have to be engaged by space organizations in different ways and with different purposes. Different end-users can access data in different countries, and the same satellite data can be valuable for different industries and purposes. Understanding what value end-users expect from satellite data is thus the most urgent issue to be addressed.

End-users can collect quasi-real-time and precise data from many sources, including satellite data. Although data per se are worthless, they should become useful information to stakeholders and thus respond to their needs. On the one hand, space organizations (i.e., upstream and downstream) building satellite infrastructures and sensors, and producing the data, cannot envisage all the possible applications of their data as they are not end-users experts. On the other end, end-users (including organizations from other sectors such as Insurance & Finance, Energy & Utility, and Transportation & Logistics) are not aware of the kind of data that satellites might generate and how to enact the expected value, as they are not space experts. This lack of awareness and alignment of respective value propositions between space organizations and end-users stakeholders leads to missed opportunities for exchange value. From the end-users perspective, the difference between the expected value and the current level of adoption of satellite data (enacted value) in decision-making is the second issue to be addressed. Therefore, we investigate the following research questions:

RQ1) *What value do end-users expect from satellite data in the New Space Economy ecosystem?*

RQ2) *What is the level of adoption of satellite data in end-users decision-making?*

2. Background

2.1 The New Space Economy value chain

We subscribe to the OECD definition of the New Space Economy: "*the full range of activities and the use of resources that create value and benefits to human beings in the course of exploring, researching, understanding, managing, and utilizing space*" [1]. This definition hinges on the concept of value which is the main purpose of space data and infrastructures [2].

This paper deals with the value captured by end-users in the New Space Economy ecosystem. In our research, we will investigate the value captured by end-users by adopting satellite data generated by space projects developed by upstream and downstream stakeholders (for simplicity, we will refer to them as "space organizations"). We subscribe to the three macro segments of stakeholders usually considered in this context according to the Space Economy Observatory [3]

- Upstream stakeholders; space Industry companies and institutions engaged in research, development, construction and management of enabling space infrastructures and technologies.
- Downstream stakeholders; companies offering digital innovation solutions and services (e.g., IT provider, system integrator, consulting firm) and specialized research centres that deal with research, development and implementation of the most advanced digital technologies leveraging space technologies and data.
- End-users; companies, and institutions in demand, interested in new applications and services deriving from the combined use of space and digital technologies.

Four main value streams conventionally represent the New Space Economy realm and create value for end-users [4]. They are:

- Space Access; enabling the exploration of outer space (e.g., rockets, telescopes, unmanned and manned space vehicles, such as the International Space Station, Virgin Galactic for space tourism, or Mars rovers) [5].
- Earth Observation; monitor the Earth and its land, water, and atmosphere through satellite imagery [6].
- Satellite Navigation; allows users (equipped with compatible devices) to determine their position, velocity, and time by processing signals from satellites [6].
- Satellite Communication; data transmission in telecommunications, TV broadcasting, telephone, radio, and recently, the internet [7].

In our research, we investigate the value captured by end-users in adopting Earth Observation, Navigation and Communication satellite data. Figure 1 summarises the value streams and segments in the New Space Economy ecosystem in a comprehensive value chain. In grey is depicted our level of analysis.

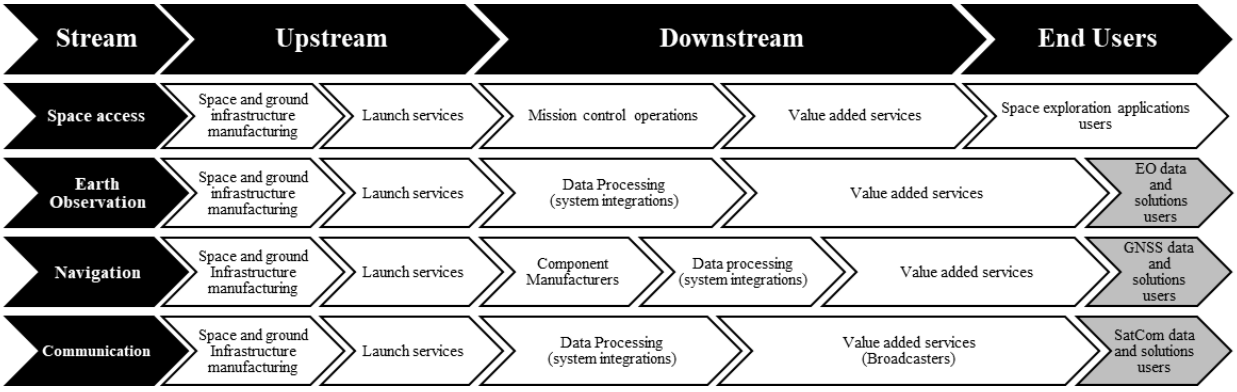

Fig. 1. The New Space Economy value chain [3]

2.2 Key industrial dynamics underpinning the emergence of the New Space Economy

Several industrial dynamics underpin the emergence of the New Space Economy and transform the value mechanisms in the space ecosystem, including how end-users enact expected value. We briefly present the most relevant ones in the context of our research.

- Macro-economic and socio-political changes; recent years have seen the emergence of a considerable number of new space-faring nations (i.e., countries that have developed access to space capabilities) and the establishment of several new Space Agencies [8].
- New regulations and policies; For example, the space market is being liberalized. New rules are encouraging cross-fertilization between the space and non-space industries (e.g., ICT, energy, healthcare) [9], [10].
- New funding and financing dynamics; Outsourcing is increasingly being used by space agencies, and new kinds of collaboration are being accelerated (e.g., Public-Private-Partnership). The public sector has diversified and transformed its processes to invest money and encourage the growth of new private players [11]. The expanding market and lower entry barriers (e.g., program development costs) are attracting an increasing number of private investors, fostering private-to-private funding mechanisms, and shifting funding away from traditional public sources and toward angel investors, venture capital firms, and private equity [12], [13].
- New technologies; Non-space sector innovations are adopted by the space sector, which necessitates the transfer and integration of human resources and know-how from other fields (e.g., 3D printing) [14]. Technological downsizing and cost reduction decreases the risks of participation in space missions. The introduction of new digital technologies (e.g., the Internet of Things, data analytics, machine learning algorithms, artificial intelligence, cloud, and edge

computing) and their inexpensive availability are transforming the space sector into a cross-technological realm [2], [15].

These industrial dynamics attract new stakeholders who capture value from space data and solutions. They are new space organizations that use public and private funds to run their business, address existing and growing space industries with innovative ideas, or strive to establish unique footholds in emerging space markets (e.g., SpaceX). Non-space organizations, mainly in information and communication technology (ICT), integrate space and digital technologies to bring innovative products and services to a wide range of sectors and end-users (e.g., Google). New end-users, the focus of our research, governmental or private organizations, and people utilizing space technology for commercial purposes (e.g., Red Cross, Uber, society).

The disruption of the space sector and the growth of huge end-users markets lies in the availability, reusability and analytical reproducibility [16] of satellite data. The same data can be processed, with relatively small costs, to create valuable products and services for many end-users. The applications domains of satellite data span from, e.g., land use and cover mapping [10], carbon biomass assessment [17], disaster and risk management [18], air and water quality monitoring, and resources: Earth Observation imageries are used to monitor ecosystems and biodiversity [19]. In dealing with our investigation, it is, therefore, necessary to clarify what value is and what value mechanisms are.

2.3 Conceptualisation of value

In general management literature, value is vastly discussed. Researchers often simultaneously discuss both contents (what is value?) and process (how is value created?) as these two aspects are strictly intertwined [20]. We will take both perspectives in our paper. In line with Gil and Fu (2019)

[21], we define value as *"the sum of the economic benefits and wider social gains to be accrued from a new large-scale technology development minus the capital costs to be incurred"*.

Value is multi-dimensional. It includes tangible (e.g., revenues) and intangible (e.g., knowledge) dimensions. Triple-bottom-line accounting [22] is a popular paradigm to describe sustainability that integrates economic, social, and environmental (ecological) considerations and is extensively used for public planning and decision-making [23], [24].

Value changes over time. A project generates short-term and long-term value. An infrastructure may generate benefits even decades after its completion [31]. Thus considering the long-term value created in the project design is fundamental to grasping the enacted value of its outcome [32].

Value is subjective. Different stakeholders have different value perceptions and expectations. Value is conceptualized in terms of the recipient stakeholder [33]. Individuals (or organizations) will evaluate something as valuable if it fulfils their implicit or explicit needs [34]. Therefore, a business model's value is a result that fits stakeholders' requirements and expectations. If stakeholders expect environmental and social value, the business model must reflect it [35]. The subjectivity of value is a fundamental assumption for understanding the value mechanisms at the organizational level (further explained in section 2.4).

Scholars distinguish between value in exchange and value in use [20], [36]. Value in exchange is the monetary value or the amount paid by the user to the seller, gained by the seller when the exchange of the new activity, product or service takes place. Value in use is the user's subjective perception of the qualities or utility of a seller's activities, products and services. According to these definitions, value is determined by the quantity of value subjectively experienced by a target user (or customer). The subjective value perception results in the user's willingness to pay for the activities, products and services. Recently, researchers have studied the antecedents of value in use, introducing the concept of expected value, the value a stakeholder expects to receive, and enacted

value, the value a stakeholder receives (but does not necessarily experience or capture) [25]. In our paper, we will leverage these two key concepts, further explained in section 3.2.

2.4 Value mechanisms

Value mechanisms are the processes that explain how value is created, distributed and captured at several levels, including the micro (person, group), meso (organization), and macro (networks, industries, society) [20], [38], [39]. In our research, we will investigate the meso-level.

Management scholars distinguish between value creation, distribution and capture mechanisms [20], [36], [39], [40]. Value creation is the process of co-producing offerings (i.e. products and services and information relationships) in a mutually beneficial seller/buyer relationship [41]. Value distribution refers to the process of transferring the value from the seller to the user [42]. Value capture is the process of securing profits from value creation and the distribution of those profits among participating actors such as providers, end-users, and partners [20]. Value capture necessitates proper governance structure design to ensure that the value created exceeds the cost of achieving that [43]. Value capture extends beyond monetary value and legal agreements. Value capture involves actions that allow providers and end-users to decide how the additional value created should be allocated between them [20].

We subscribe to the existing body of knowledge regarding the transformation of decision-making processes to enact the expected value by adopting data and digital technologies [46], [47] regarding the organizations' activities, services and products.

3. Methodology

3.1 Research design

We investigate our research questions using a qualitative and abductive research approach. The unit of analysis of this study is the value captured by end-user organizations by exploiting satellite-based applications. The level of analysis is the end-user organization adopting satellite data or satellite-based solutions in its business. The empirical context of our research is the European New Space Economy ecosystem.

3.2 Theoretical Lens

We identified Value Theory [46] as the theory with the most explanatory power for the phenomenon under examination. In our paper, we leverage two key elements of Value Theory: i) "expected value" and ii) "enacted value" [36].

Expected value is the value a subject expects to gain from an object and is interested in exchanging money. Value cannot be treated as a mere quality of an object nor as the mere mental quality of a subject [47] but emerges in a relation between the object (e.g., satellite data) and the expected value taking subject (e.g., expected value regarding the adoption of satellite data in taking tactical and strategic decisions) [46]. End-users interested in adopting satellite data in their decision-making manifest expected value.

Enacted value is the value a subject may (or may not) capture in using the object [36]. Value is multi-dimensional, subjective and changes over time [27], [48]. End-users who, for example, improve their services by adopting satellite data in their decision-making exploit the enacted value provided by satellite data.

3.3 Data Collection

Our research is based on two sets of data. First, we conducted open interviews. Second, we gathered internal documents, publicly available data and ongoing involvement for triangulation. These two data collection methods are conventional and appropriate for qualitative research and ensure the richness of the findings and the purpose of triangulation [49].

Interviews were chosen as a suitable method to explore end-users value mechanisms in the exploratory part of our research. Interviews can bring essential experts' ideas closer to practice while identifying various problem-solving methods [50], and the interviewer is given the opportunity to ask clarifying questions [51].

We use two sequential sampling strategies: one for organization sampling (i.e., the organization) and one for managers sampling (i.e., those who work in such organizations). Organizations were chosen using a theoretical sampling method to assure the sample's representativeness; commercial end-users organizations across Europe were included.

#	**Industry**	**Job Role**	**Experience**
Int 1	Insurance & Finance	Data Scientist	12 years
Int 2	Insurance & Finance	Head of Portfolio Management	14 years
Int 3	Energy & Utilities	Head of Assets Coordination	18 years
Int 4	Energy & Utilities	Innovation and Partnerships Manager	22 years
Int 5	Transportation & Logistics	Head of Technical Dept.	10 years
Int 6	Insurance & Finance	Head of Space	25 years
Int 7	Energy & Utilities	Head of Venture Building and Scouting	12 years
Int 8	Transportation & Logistics	Head of Marketing, Communication and Strategic Business	28 years
Int 9	Energy & Utilities	Geodynamics dept. Engineer	11 years
Int 10	Insurance & Finance	Leading Expert Space Insurance Underwriting	24 years
Int 11	Energy & Utilities	Head of Innovation	18 years
Int 12	Energy & Utilities	Head of Open Innovation	14 years
Int 13	Insurance & Finance	Head of Innovation	13 years
Int 14	Energy & Utilities	Head of Innovation	14 years
Int 15	Insurance & Finance	Head of business development	13 years
Int 16	Insurance & Finance	President	31 years
Int 17	Insurance & Finance	Senior Project Manager	11 years

Int 18	Transportation & Logistics	Account Manager	12 years
Int 19	Energy & Utilities	Senior Manager	14 years
Int 20	Energy & Utilities	Head of Digital Services	19 years
Int 21	Insurance & Finance	Data Scientist	13 years

Tab. 1. Profiles of the interviewees

Interviewing end-user stakeholders offer the opportunity to investigate their perception of value and investigate how they capture this value. Managers were selected with a purposive sampling based on job content and the direct connection of managers with space organizations [52], [53]. We interviewed 21 managers with an average of 16 years of experience. The interviews lasted, on average, 44 minutes. All the discussions were conducted online, and all interviewees and organizations were given anonymity [54]. The sampling stopped when we reached theoretical saturation [51]. Table 1 summarises the profiles of the managers interviewed.

We leveraged the deep knowledge of two of the three authors with the empirical context, conducting open interviews initiated by the question, "*How do you capture value from the adoption of satellite-based data and/or solutions in your business?*". The discussion was an open interview to access the respondent's point of view [55]. Thanks to the permission for recording (from 20 out of 21 interviews), the lead author transcribed the interviews. We also took extensive notes during the interviews.

We sought additional primary and secondary data to triangulate the data [49]. For example, if an interviewee referenced a specific project, we gathered pertinent information about such project. Secondary data consists of information from public and non-public organizations (e.g., project reports, presentations, website news, company reports, detailed plans, and newspaper articles) that deal with completed or ongoing projects based on the adoption of satellite-based solutions in the end-users business. A combination of quantitative and qualitative data was gathered [56].

3.4 Data Analysis

We abductively coded our data. We performed a content analysis using Atlas.ti software, and following the guidelines provided by Hsieh et al. [57]. We built a framework (Figure 2) derived from the existing body of knowledge and populated with data regarding the i) expected value and ii) enacted value regarding the adoption of satellite data in decision-making reported by the interviewees. Discussion among authors supported the finalization of the coding. As a result, the transcribed information was thoroughly examined based on its content and summarised in a framework (Figures 3 and 4) [58]–[60]. Finally, we leverage the Value Theory [46].

Strategic decisions			
Tactical decisions			
	Activities	**Services**	**Products**

Fig. 2. Framework of analysis

In our framework, we distinguish between strategic and tactical decisions.

Strategic decisions have a medium-long time horizon (i.e., 3+ years), imply a huge investment of resources (both monetary and non-monetary), have a cross-functional impact on the organization and the business, and are often non-reversible. They usually bring a radical transformation of the organization and business. For example, acquiring a firm to gain new internal competencies is a strategic decision to improve the organization's value proposition in the long term; it requires a huge investment of resources and impacts the entire organization (e.g., organization structure redesign). This decision is difficult to reverse, especially in the short to medium term.

Tactical decisions, on the other hand, have a short time horizon (i.e., less than 3 years), require a limited investment of resources, have a vertical impact on the organization or business, and are

often reversible. For example, launching a new product is a tactical decision with a relatively short-term horizon (depending on the product, with a short return of investment time), requires limited resources and impacts the organization's single business line. It is often reversible, withdrawing the product from the market.

End-users take strategic and tactical decisions in three main domains: activities, services and products.

Activities consist of internal processes and actions the end-users take to develop, deliver and improve their services and products. Activities are necessary conditions for the exploitation of their value proposition. For example, energy companies have the main value proposition to deliver electricity on time to their clients (both companies and citizens). To do so, they need to monitor and maintain their electricity distribution lines. Monitoring and maintaining the energy distribution infrastructure are two necessary activities for energy companies to realize their value proposition.

Services are the application of one party's competencies (such as knowledge and skills) to benefit another [61]. Services do not necessarily depend on a tangible good. Services are strictly connected with the value, as the experience and perception are essential to the determination of the value of the service [62]. For example, remote sensing companies offer satellite-based monitoring services to their energy clients, providing them with knowledge and expertise.

Products consist of tangible goods (or bundles of tangible and intangible goods) sold to end-users to satisfy their needs [63]. In our research, products necessarily depend on tangible goods. Products are the result of industrial processes. For example, a GPS sensor is a product sold by space firms to mobility end-users. It results from the generation, distribution and storage processes.

To interpret our data, we qualitatively assess the expected value (Figure 3) and level of adoption (Figure 4) by populating the framework of analysis with a three dimensions scale [64] ranging from "low expected value/adoption" (i.e., three white dots) to "high expected value/adoption" (i.e., three

black dots). Besides, in Figure 4, we qualitatively compare the expected value and the enacted value deriving from the adoption of satellite data. We represent in italic those sectors in which the enacted value is more or equal to the expected one, and vice-versa in bold.

4. Findings

Regarding the expected value of adopting satellite data in decision making, our data shows that Energy & Utilities, Insurance & Finance and Transportation & Logistics end-users have different value expectations, as summarized in Figure 3. Overall, end-users declare high expected value from satellite data for improving their activities, services and products. Energy & Utilities end-users have great value expectations regarding adopting satellite data in strategic decisions regarding their activities. Insurance & Finance strongly expect value for decision making, both strategic and tactical, regarding their services and products. Transportation and Logistics declare high expected value in tactical decisions regarding their activities.

As for the enacted value of satellite data in decision making, our data shows that end-users take strategic and tactical decisions thanks to adopting satellite data in their business to improve activities, services and products. However, our data highlights different levels of adoption of satellite data for Energy & Utilities, Insurance & Finance and Transportation & Logistics end-users. We summarise our findings in Figure 4. End-users mostly adopt satellite data to take tactical decisions rather than strategic ones. Furthermore, end-users leverage satellite data to improve their activities rather than their products or services. The enacted value of satellite data in taking tactical decisions regarding the activities is more or equal to the expected value for all the end-users (in *italic*). Energy & Utilities and Insurance & Finance have received less value than they expected (in **bold**), especially in taking strategic decisions regarding services and products.

In the next pages, we further present our findings comparing the expected value (Figure 3) and the enacted value (Figure 4) regarding adopting satellite data in decision-making.

Strategic decisions	Energy & Utilities ●●● Transport & Logistics ●○○ Insurance & Finance ●●○	Energy & Utilities ●●○ Transport & Logistics ●○○ Insurance & Finance ●●●	Energy & Utilities ●●○ Transport & Logistics ●○○ Insurance & Finance ●●●
Tactical decisions	Energy & Utilities ●●○ Transport & Logistics ●●● Insurance & Finance ●●○	Energy & Utilities ●●○ Transport & Logistics ●○○ Insurance & Finance ●●○	Energy & Utilities ●●● Transport & Logistics ●○○ Insurance & Finance ●●●
	Activities	**Services**	**Products**

○○○ = low expected value | ●●● = high expected value

Fig. 3. Expected value from the adoption of satellite data in decision-making from the end-users perspective

Strategic decisions	**Energy & Utilities** ●●○ *Transport & Logistics* ●●○ **Insurance & Finance** ●○○	**Energy & Utilities** ●○○ *Transport & Logistics* ●●○ **Insurance & Finance** ●○○	**Energy & Utilities** ○○○ *Transport & Logistics* ●○○ **Insurance & Finance** ○○○
Tactical decisions	*Energy & Utilities* ●●● *Transport & Logistics* ●●● *Insurance & Finance* ●●○	*Energy & Utilities* ●●○ *Transport & Logistics* ●●○ **Insurance & Finance** ●○○	**Energy & Utilities** ●○○ *Transport & Logistics* ●●○ **Insurance & Finance** ●○○
	Activities	**Services**	**Products**

○○○ = low adoption | ●●● = high adoption
Italic if Enacted value ≥ Expected value
Bold if Enacted value < Expected value

Fig. 4. Level of adoption of satellite data in decision-making from the end-users perspective

4.1 Adoption of satellite data in taking tactical decisions

Overall, end-users prefer to adopt satellite data in tactical decisions, and the enacted value is more than the expected value. End-users adopt satellite data to decide on low-risk and short-term investments. They know how to properly assess the expected value and exploit the enacted value in decision-making. Managers favour the adoption of satellite data to improve the efficiency of business activities rather than the quality of services and products delivered.

"Space is very far from our daily base. We start to explore the value of satellite data for our activities, looking for efficiency improvement that requires small and low-risk investments" [Int19 - Energy]

4.1.1 Activities

End-users adopt satellite data to take tactical decisions to improve their activities. It is the more frequent and consolidated adoption because the value of satellite data is easily assessable in the short term.

"We use Earth Observation imagery to monitor our infrastructure. You can monitor vast territories more frequently than helicopter flights with the same amount of money. The cost-saving is easy to calculate" [Int11 - Energy]

Managers appreciate the relatively frequent and continuous update of satellite data (both positioning and imagery) that meet their expectations in tactical decisions.

"Satellite positioning data offer you quasi-real time information about your fleet; this information is fundamental in managing and programming the logistics on a minute-basis. Satellite data improve efficiency" [Int5 - Transportation]

The satellite data and applications' novelty fosters end-users managers to explore their adoption in a "safe environment" that does not directly impact their end-users.

"We prefer to first experience and learn the benefits of satellites internally. The easy way is to experiment with the adoption of satellite imagery to efficient our internal processes before selling a new satellite-based service or product" [Int1 - Insurance]

4.1.2 Services

End-users adopt satellite data to make tactical decisions regarding their services. Indeed, satellite data are appropriate to guarantee a relatively high return on investment in the short term as they add value to existing services. Satellite imagery provides new insights about the market (e.g., urbanization, climate) that are fundamental for managers to take tactical decisions regarding their services, and for Energy & Utilities and Transportation & Logistics end-users, the enacted value is more than the expected value.

> *"We use satellite data to assess the market's status and evolution. It really improves the quality of our services, and previsions regarding our insurance services"* [Int7 - Energy].

Besides, our data shows that end-user managers use satellite data as a marketing tool to bundle the existing services with attractive value-added content to attract new end-users and justify a higher price for the existing service.

> *"Space is fascinating. Going to clients saying you are providing this service by leveraging satellite data makes you very innovative and smart"* [Int8 - Transportation].

Still, our data show limitations in exploiting satellite data to take tactical decisions, mainly because technology does not meet the expected value, and because of a low-risk appetite of managers when it comes to enriching services with satellite data.

> *"You can use data to provide a new service. However, if you are not a satellite expert, you can't totally trust them. We use very simple imagery in our decision-making, but we don't want to risk so much in selling a satellite-based service"* [Int13 - Insurance]

4.1.3 Products

Despite a huge value expectation regarding adopting satellite data to make tactical decisions regarding products, Energy & Utilities and Insurance & Finance end-users do not see the enacted

value. Satellite data are marginally adopted as add-ons for their products to make a bundle product whose value is increased by the "space technology".

> *"We offer our clients the possibility to include satellite-based information in our infrastructure monitoring dashboard. It adds the value of our product but does not disrupt it"* [Int4 - Energy]

Nevertheless, satellite data are rarely used to take tactical decisions in product development and delivery. Indeed, interpreting satellite data for product development requires strong competencies to interpret the information deriving from data and integrate them with the product.

> *"I think we lack the competencies to leverage satellite data to develop our product and meet the expected value. If we build new infrastructure, I will ask experts for information about the territory, no more. We are not able to design the infrastructure based on satellite data"* [Int12 - Energy]

End-users managers also underlined the lack of solutions able to properly answer their expectations and needs regarding product development.

> *"Earth Observation offers many smart solutions for whom we are unwilling to pay. Why do I have to invest in satellite information when they do not answer my needs, or can I use other sources that provide less expensive solutions?"* [Int10 - Insurance]

4.2 Adoption of satellite data in taking strategic decisions

Despite the expected huge value, few managers adopt satellite data in strategic decisions. End-users mostly adopt satellite data in strategic decisions for their activities rather than their services or products. Overall, managers feel uncomfortable with the reliability of satellite data, they understand and expect high value in the long term, but they do not experience enacted value right

now. They consider investing in satellite data too risky for strategic decisions, especially since the benefit/cost ratio appears unclear.

"Satellite will revolutionize our decision making, but nowadays, I can't build my business on information that I don't understand where they come from. Besides, satellite data requires huge resources and competencies, do the benefits really repay the cost?" [Int11 - Energy]

4.2.1 Activities

End-users adopt satellite data in taking strategic decisions about their activities. In detail, managers highlight the strategic role and the expected value of satellite data for planning infrastructure development and mitigating climate change risks.

"Satellite imageries are very effective in improving our planning process. They offer useful information to understand if and where to build the energy power infrastructure. Modelling and predicting climate evolution are very important, especially for renewable energy plants. Here, satellite data are good allies" [Int 9 - Energy]

Satellite data are considered a unique source of information with low costs compared to in-situ inspections. End-users use satellite imageries to predict the environment and climate's evolution and have started to invest hugely in this information. However, the expected value is still far from being enacted, especially in the insurance sector.

"We are investing in new competencies and technologies because we understand satellite data may disrupt the insurance sector, and we have to be ready. Right now, we are not" [Int 2 - Insurance]

Managers integrate satellite data and complement it with other sources of data. Satellite data plays a marginal role in taking strategic decisions regarding the activities of their firms as they are

complex decisions that require a huge amount of different data that need to be integrated, and end-users now lack these capabilities.

> *"Satellite data play a marginal role in our strategic decision processes. They are often used as a complementary data source to other more consolidated information"* [Int5 - Transportation]

4.2.2 Services

End-users leverage satellite data to take strategic decisions regarding their services. According to our data, the expected value is very high, especially in the insurance sector, where intangible goods are the core of their value proposition. Insurers are starting to use satellite data to improve their services and decide whether to invest or not in specific markets.

> *"We increasingly leverage satellite data to understand if and how to provide insurance services in given markets (e.g., ensuring the agriculture sector in developing countries). Insights about the evolution of the environment are, in this case, very strategic for us"* [Int17 - Insurance]

Still, the long-term value of satellite data appears unclear to end-users who cannot enact the value of satellite data. They regret huge investments in satellite data to take strategic decisions as they lack understanding of the potential value of satellite data in their business.

> *"Satellite data, and space in general, are fascinating. However, we don't really grasp the value of their adoption that justify huge investments to take strategic decisions regarding our services"* [Int14 - Energy]

4.2.3 Products

The managers interviewed greatly expect the value of satellite data adoption. However, managers stated they are not using satellite data in strategic decisions regarding their products as they do not meet their expectations. They declare the main reason is that satellite data do not offer the proper solution for their needs. Indeed, satellite data providers offer useful services that managers can exploit poorly to make thoughtful strategic decisions regarding their products.

> *"Providers offer very interesting tools that lack in answering our real needs. We look for precise and reliable information regarding our asset, that nowadays appears fragmented"* [Int3 - Energy]

Relying on new sources of information for strategic decisions requires long approval processes within the end-users organization. It slows down adoption or often does not start because the effort required does not seem to repay the value that can be drawn.

> *"Before using satellite data, you must trust them, and its reliability must be approved internally. Very often, we don't start this process because we don't understand the value in it"* [Int8 - Transportation]

Strategic decisions are risky, and their implementation generally requires huge resources. The managers interviewed declare themselves as risk averse. They are waiting for a higher maturity of the satellite data and their applications that justify the adoption of satellite data in strategic decisions regarding their products.

> *"We can't bet in our business, we see the potential value of satellite data in our business, but nowadays it is still too risky and not mature enough"* [Int 15 - Insurance]

5. Discussion

Our findings show a huge difference between the expected value and the enacted one (i.e., level of adoption) resulting from adopting satellite data in taking tactical and strategic decisions. Satellite data meets end-users expected value in making tactical decisions. Transportation & Logistics manifest an enacted value that is in line with expectations. However, the expected value is still not enacted for what concerns strategic decisions about services and products, especially for Insurance & Finance and Energy & Utilities end-users.

Value Theory [46] (Section 3.2) offers several insights to interpret why this difference occurs. We will discuss them in the following sections.

5.1 Assessing the expected value

End-users adopt satellite data for tactical decisions rather than strategic ones, requiring fewer resources and risks. It implicates a better assessment of the expected value before the adoption of satellite data, and, requiring fewer resources, the enacted value in tactical decision-making is relatively easy to be achieved.

End-users tend not to adopt satellite data in strategic decisions for three main reasons. First, they still see very promising satellite data or general space technologies but are far from their business. Therefore, end-users tend to focus on existing key resources and competencies for their decision-making processes [43], [65]. The expected value is high, but the resources to fill the gap between the expected value and the enacted value appear too high [66]. Second, managers see the opportunity to adopt satellite data in their decision-making but still do believe it requires radical organization transformation rather incremental. End-users are already dependent on existing resources and data, making difficult the transition toward the adoption of satellite data in their

decision-making [67]. Third, to assess the expected value of satellite data and satellite-based solutions, end-users need specialized knowledge of the satellite solution and what alternatives exist at a given time [68]. The lack of competencies in assessing the expected value makes end-users overoptimistic [48]. Transportation & Logistics, which traditionally have more experience regarding satellite data, especially in navigation satellite, have acquired the competencies to assess the expected value over time properly.

Synthetizing, end-users lack the competencies and instruments to assess the expected value in the long-term and prefer to adopt satellite data in tactical decision-making as they generally require fewer resources and reversible choices.

5.2 Enacting the expected value

End-users expect value from satellite data because they recognize the novelty and appropriateness [69] of satellite data in taking tactical and strategic decisions about their activities, services and products. However, achieving the expected value (or experiencing the value enacted) appears difficult for several reasons.

First, the adoption of satellite data in decision-making processes depends on organizational formation [70] and transaction costs between the data providers and the end-users [71]. Our data shows that end-users see high transaction costs in adopting satellite data and, therefore, a huge gap between the expected value and the enacted value [72]. Therefore, data providers may engage end-users and negotiate solutions to reduce transaction costs and foster the adoption of satellite data in strategic decisions regarding services and products. Second, our data show that end-users regret spreading the adoption of satellite data due to a lack of resources and competencies. Data providers should focus on building and providing these resources and competencies to end-users [73] rather than offering only the solution to their problem. It may foster the enactment of the expected value.

Third, end-users recognize the expected value of satellite data in decision-making but have a vague understanding of how to achieve the enacted value in the long term. Satellite data and solutions providers do not properly answer their needs, reducing end-users willingness to adopt satellite data in decision-making [74], [75]. By directly engaging with stakeholders, satellite data and solutions providers should become more aware of the value for the end-users and offer them data and solutions to properly answer their needs and enact the expected value.

6. Conclusions

Our work explains, from the end-users perspective, the expected value and the enacted value [36] regarding the adoption of satellite data in decision making in the New Space Economy ecosystem, and why there is a gap between the expected value and the enacted value occurs. End-users have great expectations of the value deriving from adopting satellite data in decision-making. However, the enacted value is less than the expected value for Insurance & Finance and Energy & Utilities end-users.

Our research demonstrates that satellite data are mostly adopted to take tactical decisions rather than strategic ones. End-users mostly adopt satellite data in making decisions about their activities. They slightly adopt satellite data to make decisions about their services, but they poorly adopt satellite data in taking decisions regarding their products, especially since they do not adopt satellite data in taking strategic decisions about their products.

End-users see satellite data as a complementary resource for decision-making that requires new competencies and still appears far from their business and too risky compared to existing solutions [70], [76]. End-users understand and appreciate the expected value of satellite data in the short term

but are still not able to fully enact the expected value in the long term [72] due to a lack of literacy [69]. Satellite data do not fully answer the end-users needs and need to be engaged since the satellite-based solution development began.

We show how Value Theory [46] has the explanatory power of the phenomenon and offers useful insights to academics and practitioners to foster the transition in the adoption of satellite data in the decision-making processes of end-users. Our research offers practitioners a framework to assess the expected value (Figure 3) and level of adoption (or enacted value) of satellite data in decision-making processes (Figure 4). Furthermore, we offer practical suggestions to foster the adoption of satellite data in taking strategic decisions from the end-users perspective. For the first time in Space Economy studies, we take the end-users perspective to investigate and explain the value mechanisms in the New Space Economy ecosystem. We extend the Value Theory by testing it in the new space economy ecosystem. Space scholars may benefit from this management fresh perspective in building new research.

We are conscious that our research has three limitations. First, we interviewed managers belonging to European organizations. Further research should explore the phenomenon in other regions. Second, we interviewed managers of Energy & Utilities, Insurance & Finance and Transportation & Logistics. Further research should be done in other sectors such as health, agriculture, and tourism. We performed an exploratory qualitative study laying the foundation for further research, possibly through quantitative studies. Finally, we only interview managers of private organizations; further research should expand the spectrum of satellite data end-users, including institutional and military end-users value perceptions.

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