

# Assessing the Value of the Next Generation Space Projects: State-of-the-art and new perspectives

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## Abstract

In the New Space Economy, the value exchanged for developing new infrastructure (e.g., a satellite constellation) cannot be fully captured by traditional models and methods. New stakeholders transferring technologies and knowledge from other industries are involved since the early stages of infrastructure development. The space infrastructure has to be valuable for new, often unknown, end-users in the long run. The value created exceeds the mere economic return and includes tangible and intangible dimensions, such as social and environmental benefits. Therefore, the project's sponsors need to assess a wide set of value dimensions to maximize the benefits for the stakeholders involved in the next-generation space projects.

While projects have traditionally been viewed as means to deliver specific outputs against a predefined scope, they are now increasingly conceptualized as agents of change for value creation. Notably, shifting the attention from product to value creation implies taking multiple dimensional perspectives of value, beyond the traditional short-term iron triangle, i.e. cost, time

and quality. Value is perceived differently among stakeholders and evolves throughout the entire project (and product) lifecycle.

Recent Project Management literature offers interesting insights to interpret the value mechanisms of space projects and programmes. Academics and practitioners developed models and methods to assess and manage value, covering a broad range of managerial decisions, from value planning to value engineering, and value analysis. The Project Management literature encompasses a set of approaches to enhance project value throughout the project or programme lifecycle. Value management can equip stakeholders to maximize project value creation and capture across a space project's concept, definition, implementation, and operation phases. Nevertheless, its adoption in the emerging New Space Economy context is still under-investigated and under-exploited.

Our research aims to investigate the state of the art of emerging models and methods to identify and assess the value of space projects in the New Space Economy. We performed a systematic literature review to identify the value mechanisms in space projects in the New Space Economy realm. Results are intended to set the background for new foundational research but may also support practitioners in implementing value-driven approaches for developing next-generation space projects.

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

## 1. Introduction

Interest in the New Space Economy, defined as "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 utilising space" [1], has grown rapidly during the past 10 years [2]. Either space and non-space organizations are attracted by new opportunities and challenges, such as the liberalisation of the space market, the cost reduction of space infrastructure deployment and management [3], the satellites' miniaturisation [4], the increasing accessibility to new space technologies and data [5] and the need to address planetary challenges including global warming and natural resource management. Governments and other public agencies are launching new projects and joint actions to foster a radical transformation of the space industry [6], which is estimated to be worth around \$ 1 trillion in 2040 [7].

Despite space organizations having decades of Project Management experience and deep knowledge on how to evaluate the success of a project in the short term, the long-term transformative value of space projects is still largely underestimated and seldom discussed [8]. Therefore, space organizations urge to assess the value of next-generation space projects for the entire ecosystem.

Recent Project Management literature offers interesting insights to interpret the value mechanisms of space projects or programmes. While projects have traditionally been viewed as tools to deliver specific outputs against a predefined scope, they are now increasingly conceptualised as agents of change for value creation [9]–[11]. Notably, shifting the attention from product creation to value creation [12] invites taking into consideration multiple dimensions of value [13] and its different perceptions among stakeholders [14], across the project lifecycle

[15]. Indeed, value in projects is jointly created by the participating stakeholders, including long-term societal benefits for the actors who are not actively participating in the project [16].

The research was designed to answer the following research questions:

*RQ1 "What is the state-of-the-art of project management literature dealing with value creation and capture?"*

*RQ2 "What is the state-of-the-art the New Space Economy and the related space project?"*

To this end, a systematic literature review was carried out aiming at mapping and systematising the literature on project value creation and capture, to proposing a conceptualisation of value in the New Space Economy domain.

## 2. Literature search

We performed two systematic literature search to investigate (i) the New Space Economy and (ii) Project value bodies of knowledge.

On the one hand, New Space Economy is a broad concept that includes the space industry and the space project [17]–[22]. These themes are closely related as the space project paradigm is changing in the context of the New Space Economy, influencing the traditional space industry and vice-versa [3], [23], [24]. Consequently, we initially explore the whole domain without focusing only on one of the dimensions above.

On the other hand, value creation and capture are very broad and multidisciplinary concepts and deeply studied in different fields, such as public administration [25], strategic management [26], [27], business model innovation [28] and marketing [29]. Recent studies claim "project value creation and capture" as an emerging theoretical lens in Project Management science [9], [30], [31] of which space projects may be considered a part.

Both literature searches followed a systematic protocol, resembling the Cochrane System [32]. The search protocol and appraisal criteria were designed to deliver unbiased, falsifiable, and reproducible processes and results to answer the research questions RQ1 and RQ2. A logical flow scheme is presented in Fig. 1.

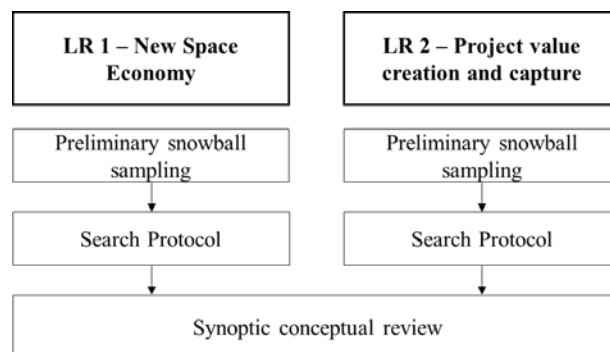


Fig. 1. Systematic literature review flow diagram

### *2.1 New Space Economy systematic search protocol*

The preliminary snowballing revealed that few publications adopt business and managerial perspectives in studying the New Space Economy. The entire body of research tends to adopt a technical perspective, and most results concerning the term "space" are grounded in distant disciplines (e.g., land management, urban planning...). The snowballing process laid the foundations for systematically deepening the "New Space Economy" or "New Space" phenomenon, which includes some useful domains strictly related to the Project Management discipline.

The search process began with defining a series of eligibility criteria, following the Cochrane method [32].

#### *2.1.1 Data sources*

We opted for the SciVerse-Scopus online scientific article database being the most appropriate source for scholarly articles in the space and management domains, as it is the most comprehensive in engineering, business and management, and social sciences in general. Other established databases, gathering contributions in business, management and social sciences (e.g., Web of Science), do not contribute additional sources to those already present in SciVerse-Scopus' pool.

#### *2.1.2 Inclusion and exclusion criteria*

The goal of the review is to clarify the boundaries and perspectives on the New Space Economy; therefore, it has to be explicitly mentioned in the papers, and it has to be the objective or one of the objectives of the intervention. We include the terms "space economy" and "new space" in the query, being the main words adopted in the literature and the most inclusive [17].

We did not include any criteria regarding the years of publication of the articles as a potential contribution of this review may include the evolution of the topic across the years. Journal articles were included, whereas conference papers, reports, and book chapters were excluded. Indeed, the multi-perspective nature and novelty of the theme require considering only high-quality articles accepted by the scientific community.

We included contributions in the Business, Management Accounting; Economics, Econometrics, Finance; Engineering; Social Sciences. Subareas are commonly adopted in this field [33], [34] and select only publications written in English.

We excluded all those articles that used the term "space" with a different meaning in the review, for example: "physical space", "living space", "political space", or "social-economic space", terms related to urban planning and political sciences. In the same way, the papers focused only on space policies and regulations, far from the management and business disciplines. We exclude the papers that present the space economy only from a technical and engineering perspective, without reporting managerial and business insights.

### *2.1.3 Search query*

We perform the search query presented in Table 1.

Table 1. The search query for the systematic search on the New Space Economy

Element	Translation into query
New Space Economy	TITLE-ABS-KEY ("space economy" OR "new space")
Business & Management, Social Sciences, Engineering and economics	AND (LIMIT-TO ("BUSI" OR "SOCI" OR "ENGI" OR "ECON"))
Articles	AND (LIMIT-TO (DOCTYPE, "ar"))
English content only	AND (LIMIT-TO (LANGUAGE, "English"))

The search was performed in April 2021 and returned 2245 articles. The sample undergone the title and abstract screening phase by applying the identified exclusion criteria. Most were excluded because they were out of scope, resulting in a reduced sample of 73 articles. In the end, 16 articles pertinent to the study's objective were included to constitute the body of literature on which the narrative review is based (Fig. 2).

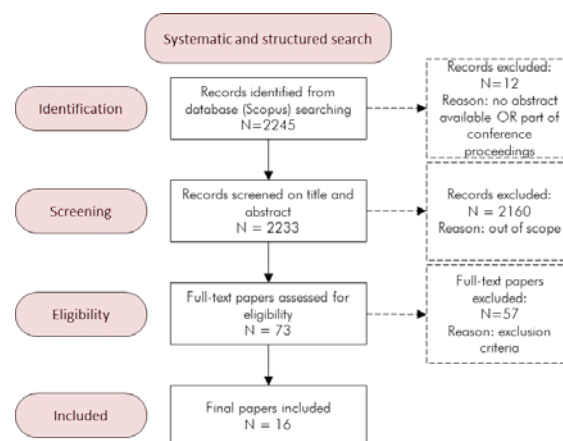


Fig. 2. The PRISMA flow diagram of the search



## 2.2 *Project value creation and capture systematic search protocol*

The concept of the project has been deepened, starting from the existing literature reviews on the subject [12], [30], [35]. The body of knowledge appears quite fragmented, there is not a commonly accepted lexicon, and often terms such as "project", "programme", and "megaproject" are used interchangeably, although they have different means [35]. In this paper, we include both "project", "programme" and "megaproject" as objects of interest.

The common definition of a programme is "a group of projects that contribute to a common, higher-order objective" [36], and they cannot be treated as scale-ups of projects [37]. Megaprojects are temporary endeavors characterized by large investment commitment, vast complexity (especially in organizational terms), and long-lasting impact on the economy, the environment, and society [38]. Various terms in literature such as complex projects, major projects [39], giant projects [40], and large projects [41] have been suggested to describe megaprojects and programmes.

The concept of "value creation" and "value capture" has been explored. There is confusion about these terms due to (i) the multidisciplinary by nature [42]; (ii) value creation refers to both content (what is value?) and process (how is the value generated?) [27]; (iii) the value creation process is confused with who creates value and who captures value [26]. Value and benefit are sometimes used interchangeably, and there appear to be many overlapping and ambiguous concepts such as value [43], benefit [44], [45], worth [46], and success [47]. Value creation may be defined as the process of co-producing offerings (i.e. products and services and information relationships) in a mutually beneficial seller/buyer relationship [48], while value capture has been defined as the process through which "*value is captured over time and across stakeholders over time*" [49]. In addition, value creation applies to various levels, such as micro-level (individual, group), meso-level (organization), and macro-level (networks, industries, society) [27], [42]. In

the field of value creation, a project might comprise a single project or a collection of projects in the sense of a temporary organisation [50] that enables value creation [51].

### *2.2.1 Inclusion criteria*

We selected the paper from 2006 to today. Indeed, the debate has resulted in a significant shift in emphasis within the project community from 'product creation' to 'value creation [52], and it is a well-recognised milestone in the Project Management scientific community.

Only Journal articles were included. We included contributions in the Business, Management Accounting; Economics, Econometrics, Finance; Engineering; Social Sciences. Subareas are commonly adopted in this field and select only publications written in English. As keywords We included "value creation", "value capture", and "benefits realization"

We excluded the term "value delivery" as it has become increasingly common to hear Project Management academics and practitioners talking about the choice of "delivery model" to create and capture value throughout the life cycle of the project from execution to operational handover [53]. However, in the context of Project Management, this term refers to the traditional process of delivering the desired outcomes according to the short-term project success criteria, such as staying within schedule, budget and scope, mainly revolving around single actors' economic value [9], [12]. Therefore, its selection may result in misinterpreting the emerging conceptualization of value mechanisms in projects.

We also exclude terms such as "project\* success", "outcome", and "output" as project management success is defined in terms of adhering to cost, time, and quality. It is strictly related to the short-term concepts of measurement, output and outcome [54], [55]. We include "project\*", "program\*" and "megaproject\*" as key dimensions of our review [30]. They are

usually close to adjectives that clarify their size. Therefore, we decided to use W/2 to be more inclusive (e.g., "large construction project") and choose the most used terms in the literature.

### *2.2.2 Exclusion criteria*

We excluded papers which lack infrastructure and large projects or programmes characteristics. The final aim of this study is to deepen the value creation and capture in space projects which are asset and technology-intensive. Therefore, records dealing with themes such as: "value creation in educational programmes" or "value capture in information systems" or programmes dealing with continuous improvement, innovation management, organisation, IT systems, and urban design are not considered. We exclude those papers that focus on the cost dimensions of value. This study focuses on the creation of value rather than the optimisation of value that often happens in value management and cost management and considers similarly earned value management and the traditional return of investment studies.

### *2.2.3 Search query*

The search query was designed to address all the adopted inclusion criteria. Table 2. illustrates its constituent elements.

Table 2. The search query for the systematic literature review on project value creation and capture

Element	Translation into query
Project	TITLE-ABS-KEY (("project*" OR "program*" OR "megaproject*" OR "megaproject*" OR ("project*" OR "program*") W/2 ("mega" OR "large" OR "infrastructure*" OR "complex" OR "major" OR "large scale" OR "global" )))
Value Creation and Capture	AND (("value") W/2 ("creation" OR "capture") OR ("benefit*" W/2 "realization"))
Business & Management, Social Sciences and Engineering	AND (LIMIT-TO ("BUSI" OR "SOCI" OR "ENGI" OR "ECON" OR "DECI"))
Articles	AND (LIMIT-TO (DOCTYPE, "ar"))
From the 2006	AND (LIMIT-TO (PUBYEAR > "2005"))
English content only	AND (LIMIT-TO (LANGUAGE, "English"))

The search query, performed in March 2021, returned 984 articles. The sample has then undergone the abstract screening phase, carried out by applying the exclusion criteria adopted

and reduced the sample to a total of 105 focal articles. In the end, 27 articles have been included pertinent to this study's objective and constitute the body of literature upon which the following narrative review is based. Fig. 3 illustrates the screening process.

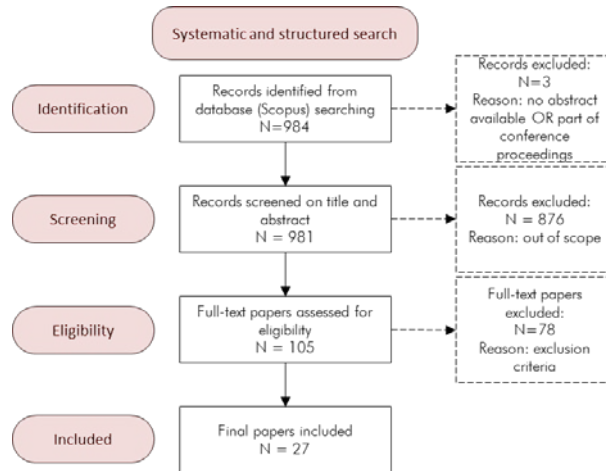


Fig. 3. The PRISMA flow diagram of the search

### 3. Literature review and discussion

#### 3.1 *The New Space Economy: a landscape of opportunities and threats for incumbents in the space industry*

Literature records few contributions regarding the complex phenomenon known as New Space Economy that, to date, lacks a unique and shared definition [56]. The articles identified present the New Space Economy according to theoretical perspectives, mostly focusing on peculiar aspects rather than providing a complete overview of the phenomenon. Indeed, most focus on the economic repercussions that space exploration will hypothetically bring into the future [56], [57] with few new insights compared to the past articles dealing with the same topic [58], [59]. Others focus on regulating space to foster the new space economy, trying to concur more to policy

debate than managerial debate [60], [61]. An emerging research stream focuses instead on venture capital and entrepreneurship in the "new space" [62]–[64]. A small group of authors deals with the economic assessment and benefits generated by space infrastructure and, more generally, space missions [65]–[67]. Finally, other researchers propose to look at the New Space Economy as an ecosystem, considering the overall complexity of the phenomenon [24], [68], [69]. This emergent stream has common traits with the project value creation and capture theories in project management, as presented in section 3.2.

Despite the different perspectives, most agree on the complexity and the frenetic evolution of the space-scape, being the traditional supply chain in a fast transition [70], [71], affected by high uncertainty [72] and in an "unstable state" [68]. Given the recent liberalization of the market, emerging models and approaches between space agencies and private entities are rising; with difficulties in identifying the merits and limits of such models of interaction and their applicability in the spectrum of space activities [17], [73], [74]. The New Space Economy is also characterized by a high technological heterogeneousness [24], [66], with the convergence of technologies traditionally belonging to different domains (e.g. space and digital) [3], [63]. In addition, space is a strategic asset for states and the prerogative of defense [75]. Therefore the national industrial capacity is strongly influenced by the dynamics of international politics [19], [76], [77].

The space industry is now characterised by cheap and more standardised upstream components, increased exploitation of space data for non-space downstream products and services, and a transition from technology-driven R&D to co-development of modular or easily configurable products for the end-users [78], [79]. Consequently, a shift in the value proposition of certain manufacturers and data providers of the space industry is observable. They seek to evolve from

providing infrastructure or data only to a more integrated solution approach [80] by extending down the value chain and providing added value services directly to the end-users [75], [81].

The theme lacks an exhaustive view in this new context focusing on space projects. The space industry is based on the development of capital-intensive space projects [82] with limited flexibility due to the relatively short life of space infrastructure (e.g., about 13 years for satellites) that, so far, cannot be extended [83]. It implies the need to understand ex-ante and quickly the value generated by the infrastructure to re-fund the investment and address the market's need [56]. There is an imminent need to understand and measure the value generated by a space infrastructure in the long run [8], [84], considering that the same infrastructure can have different purposes and enable the creation of many heterogeneous services and applications with a transformative impact on the territory with the creation of environmental and social value [85]. For example, the same satellite imagery can be used to monitor a field of wheat. The information can be used by farmers, to perform a more efficient and responsible agriculture, reducing food waste (social value) and the usage of pesticides (environmental value), insurers may use the information to assess the risk of the field, increasing profit and reducing the insurance costs for farmers (economic value). The sector is immature in this regard, and the formalization and development of instruments are therefore called for by several researchers and practitioners [68], [70], [86].

Most researchers address the New Space Economy phenomenon in a specific domain without providing any in-depth analysis of interfaces and dependencies between the stakeholders of the space ecosystem [84] along the space project lifecycle [87]. It emerges that the actors involved in the space project do have not a clear idea of what and how value is generated and for whom, how to measure it over time and which project architecture is most effective in these regards.

### *3.2 The value creation perspective is paving the way for a new conceptualisation of projects and programmes also in the New Space Economy*

Projects' actors create value by aligning single actors' goals and creating a clear strategic vision of the project's outcome [89]. Project actors may also destroy value by acting against each other's interests or violating the value of the whole system when pursuing their own interests only. Projects' actors negotiate who can capture value, and based on value propositions, actors assess whether it is worthwhile to participate in value-creating activities [16]. In this sense, several authors suggest developing new models and theories which recognize and shed light on the complexity of value in projects. Indeed, value is dynamic; not all project stakeholders' needs are revealed simultaneously but rather change along the project life cycle and reveal differently under the different project contexts [90]. For example, a growing number of downstream players (especially startups) are actively contributing to the Copernicus Programme, providing new services and creating value from the Copernicus data.

Value is composed not only of tangible benefits, such as increasing revenues or saving costs and time, but also of intangible benefits, such as improving quality, improving corporate competencies, cultivating personnel, improving the satisfaction of the stakeholders and protecting the environment among others [91]. Value creation in projects is a multidimensional and subjective issue by nature [10]. When trying to assess ex-ante, the social performance of a project [13], [95], stakeholders' expectations and satisfaction have to be prioritized [88].

Value creation in projects has been approached from outcome-based and system lifecycle-based perspectives. From the outcome-based perspective, a project creates value after the project's completion for the organizations participating in it when it achieves the desired outcomes set initially in the strategic front-end phase [96]. The desired outcomes revolve around single actors' economic value and short-term project success criteria, such as staying within schedule, budget



and scope. The outcome-based view emphasizes the sponsor's role with a notion that the project must create value for the project's sponsor [97]. The system lifecycle-based perspective [98] enables a multifaceted value conception by looking at the value and its creation not only during the project but also after it is completed, in the operations phase. Here, value is not limited to economic value for the participating actors, but it also includes other tangible and intangible values for other stakeholders [99].

Recent literature suggests moving from linear value creation processes, as in traditional value chains, toward developing value creation and value capture as a broader concept in project management, inferring short-term, longer-term, and emergent value [12]. Indeed, a project creates outcomes which have the capacity to continue operations and additional value-creating activities even decades after the project phase has ended [100]. Projects are multi-actor and multi-technology constellations that create value for multiple stakeholders over the system lifecycle [101]. The service-dominant conceptualization underlines that the purported (desired) value (to be) created by a project should be viewed not as an output of the project but rather as input to the customer's value creation process to achieve the customer's utilization goal [102]. In line with the above, other academics suggest delving into concepts that focus on social interaction among people and firms, illuminating the framing of projects within an array of social agendas, practices, stakeholder relations, politics and power [103].

Finally, there is a common motion in broadening the conceptualization of projects, overcoming the traditional "iron triangle" (schedule, budget, scope), fostering the development of new models and theories by applying frameworks of independent theory. For example, project value creation is highly linked to strategic management, and strategy could be seen as the art of creating value [48]; it may be enacted through portfolio management, programme management, and project management [104]. The strategic dimensions of value attract particular interest because their

creation is not limited to project execution but spans the project life cycle [97]. In this regard, a system thinking approach could also be useful to assess the value creation process within a project lifecycle, considering all the actors involved and their multifaceted relationships [105].

Figure 4 illustrates the conceptualization of project value creation and capture in the New Space Economy. It also presents the shifting paradigm from an outcome-based perspective toward a system lifecycle perspective in value creation and capture mechanisms of next generations space projects.

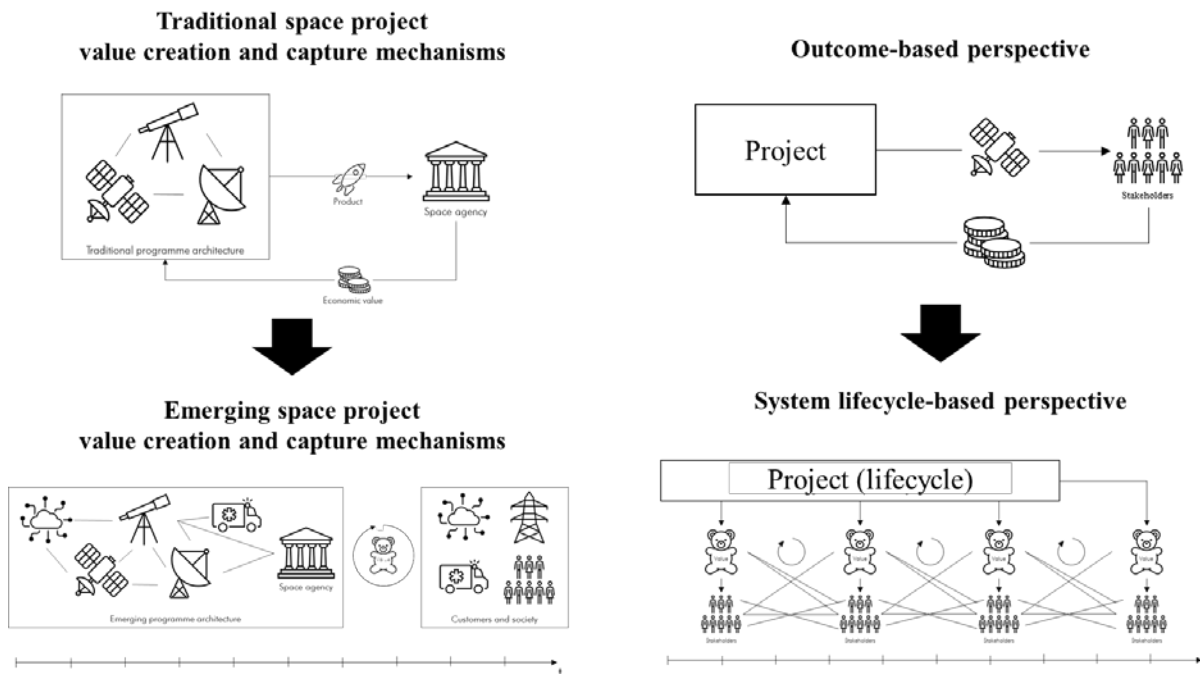


Fig. 4. The emerging space project value creation and capture mechanisms

## 4. Conclusions and research agenda

The historical growth model of the space sector, for which a project or programme is paid upfront by government and institutional funds [83], is increasingly complemented by a new model characterized by the liberalized and service-oriented market logic of the New Space Economy [34], [70]. The uncertain and extremely dynamic context makes it difficult for space industry actors to identify and develop value-added collaborations, especially with non-space actors [18]. Nowadays, value in projects is jointly created by the participating actors. Such value is not only limited to pecuniary value but also includes long-term societal benefits. Project value is a multidimensional concept [88] with subjective traits [13]. Notably, shifting the attention from product creation to value creation [51] invites taking into consideration multiple dimensions of value (beyond the traditional short-term iron triangle,) and different perceptions of value among project stakeholders [98]. Project stakeholders are interested in the social and environmental value of space infrastructure and data generated. The same data (e.g., satellite imagery) may have multiple purposes and applications (e.g., the same satellite imagery can be used by an energy company to monitor its own infrastructure and can be used by an insurance company to define the price for the infrastructure). Project actors have their objectives, expectations, interests, planning horizons, and motives that may be aligned or in conflict and thus, they can influence value creation [106]. However, less attention has been directed so far to the understanding of how multiple actors can coordinate together and jointly create value for many stakeholders; few exceptions are documented [16], [88] that focus on value-creating activities, but only in a single project phase at a time. Value may change over time and lasts even after the end of the project [100]. Nevertheless, value creation in a project unfolds as a process, which needs to be coordinated by an actor that integrates other actors, and their inputs, into the project [93].

Nowadays, space projects should be conceptualized as agents of change for value creation. The traditional outcome-based perspective is no more sufficient to interpret the value created and captured by the project stakeholders from the space infrastructure. According to our systematic literature review, we suggest adopting a system-lifecycle perspective; where the objective is maximizing project value creation and capture across the space project's concept, definition, implementation, and operation phases. A system-lifecycle approach guarantees to take into consideration the dynamicity, multidimensionality and subjectivity of value in space projects.

Our systematic literature review calls for methodological contributions in assessing the value created and captured by a space project in all its complexity [75]. Current knowledge on the concrete activities and mechanisms that constitute the value creation and capture processes in the New Space Economy is still very limited and further research is needed.

The New Space Economy body of knowledge may take advantage from the consolidated debate about project and programme success in Project Management [30], [36], [55] to investigate and assess the long term, social and environmental value [16] of space projects.

Academics and practitioners have to further investigate and develop new methodologies to assess the long-term value created and captured by project stakeholders in the next generation space projects.

Finally, while projects have traditionally been viewed as tools to deliver specific outputs against a predefined scope, they are now increasingly conceptualised as vehicles for value creation [9], [10], [12]. Few contributions present methodologies to measure the social, environmental and economic space project value, both tangible and intangible, throughout its lifecycle [19], [79]. Therefore, our study sets the background for new foundational research and support practitioners in implementing value-driven approaches for developing next-generation space projects.

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