



THE ROLE OF SPACE ENTREPRENEURSHIP IN ACHIEVING SUSTAINABLE DEVELOPMENT GOALS

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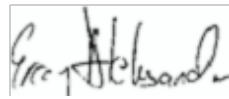
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Dedication

To my wife, Neli, whose love has been my compass, my strength, and my constant source of support throughout this journey.

And to my daughter, Eleonora, whose presence inspires me to take new steps, pursue greater dreams, and build a future worthy of her light.

This dissertation is dedicated to them, with all my love and gratitude.

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Abstract

THE ROLE OF SPACE ENTREPRENEURSHIP IN ACHIEVING SUSTAINABLE DEVELOPMENT GOALS

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This study examines the intersection between space entrepreneurship and the Sustainable Development Goals (SDGs), with a particular focus on how emerging private-sector initiatives within the space industry contribute to broader sustainable development outcomes. It critically analyses the extent to which technological, institutional, and market-driven developments in the launch and satellite sectors enable or constrain progress toward SDG targets.

The research develops a conceptual framework designed to serve as a practical and analytical blueprint for emerging space ecosystems. The framework identifies key enabling and inhibiting factors shaping the evolution of space entrepreneurship, while aligning industry practices with sustainability-oriented objectives across technological, socioeconomic, and institutional dimensions.

The study adopts a multi-level analytical structure, encompassing global, European, and Western Balkan contexts. The global level provides insight into established industry models, best practices, and dominant actors within the space economy. The European level offers a relevant

institutional and regulatory environment, within which the Western Balkan space ecosystem is developing. The Western Balkans are examined as a primary focus due to their emerging position, characterized by untapped potential, structural constraints, and increasing relevance within the broader European innovation landscape.

The research employs a primarily qualitative approach supported by secondary quantitative data, combining written semi-structured interviews with key stakeholders across the space sector with evidence derived from academic literature, policy documents, and industry reports. These data sources enable the identification of patterns related to access to space infrastructure, innovation capacity, gender inclusion, and ecosystem development. Case-based insights further contribute to contextual depth and analytical robustness.

The findings contribute both theoretically and practically by providing a structured understanding of how space entrepreneurship can support sustainable development, particularly in underrepresented and emerging regions. The study offers actionable insights for policymakers, entrepreneurs, and institutional actors seeking to leverage space technologies for inclusive and sustainable growth, while also informing the development of scalable models for participation in the global space economy.

Keywords: SDG, Space, Launch, Rocket, Satellite, Europe, Balkans

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Chapter 1: Introduction

1.1 Background and Context

1.1.1. The background

The 21st century presents humanity with a complex and unprecedented set of global challenges that threaten the fundamental pillars of sustainable development—societal stability, economic equity, and environmental sustainability. Climate change alone has resulted in annual economic losses exceeding \$252 billion due to extreme weather events, while global greenhouse gas emissions reached approximately 36.8 gigatons of CO₂ in 2022, indicating a continued divergence from climate targets (Calvin *et al.*, 2023). At the same time, persistent poverty, gender inequalities, technological divides leaving approximately 2.9 billion people without internet access, and ongoing environmental degradation continue to undermine global development efforts (Iannone, 2017; Schneegans, Lewis and Straza, 2021). These interconnected crises require urgent, scalable, and cross-sectoral solutions that transcend national boundaries and traditional policy frameworks.

In response to these global challenges, the United Nations General Assembly (UNGA) adopted the 2030 Agenda for Sustainable Development in September 2015, introducing 17 Sustainable Development Goals (SDGs) and 169 targets designed to provide a universal and integrated framework for sustainable development across all countries. Despite this ambitious global commitment, progress remains uneven and insufficient. According to recent United Nations reports, approximately 37% of SDG targets are currently stalled, while an additional 36% are

regressing, highlighting systemic implementation challenges, particularly in developing regions such as the Balkans (Sachs *et al.*, 2019; UN DESA, 2023).

Within this context, the global space sector has emerged as a potentially transformative enabler of sustainable development. Over the past two decades, the sector has undergone a significant structural transformation, shifting from traditionally state-dominated, high-cost programmes toward a more dynamic, commercially driven ecosystem. This transition, commonly referred to as the “New Space” paradigm, is characterized by increased private sector participation, rapid technological innovation, and cost-efficient approaches to space access and utilization (Peeters, 2018; European Space Agency, 2021).

The global space economy has expanded significantly, growing from approximately \$200 billion in 2010 to \$448 billion in 2020, with projections suggesting it could exceed \$1 trillion by 2040 (Brukart, 2024, Morgan Stanley, 2020). This growth is largely driven by entrepreneurial ventures such as SpaceX, Rocket Lab, Planet Labs, and European startups including PLD Space, which have introduced disruptive innovations across the value chain. Central to this transformation are advancements in rocket programmes and associated launch technologies, which have reduced launch costs by up to 90%, from approximately \$20,000 per kilogram to around \$2,000 per kilogram, while increasing global launch frequency to over 1,000 launches annually (Vidmar, 2020; SpaceX, 2025).

These developments have enabled the deployment of thousands of satellites and the emergence of new applications directly linked to SDG implementation. For instance, satellite constellations such as SpaceX’s Starlink, deployed through over 130 Falcon 9 launches in 2024 alone, provide broadband connectivity to approximately 1 million users globally, including schools and healthcare facilities in underserved regions, contributing to SDG 10 (Reduced Inequalities)

(Iannone, 2017; SpaceX, 2025; World Bank, 2023). Similarly, Earth observation satellites operated by companies such as Planet Labs, which manages a constellation of over 200 imaging satellites, provide high-resolution data for agricultural monitoring, supporting approximately 10 million farmers and contributing to SDG 2 (Zero Hunger) through yield improvements of 10–20%.

Beyond agriculture and connectivity, space-based technologies also contribute to climate monitoring and disaster risk reduction. Satellite systems enable the tracking of environmental changes and support mitigation of climate-related economic losses estimated at over \$252 billion annually (Calvin *et al.*, 2023, IPCC, 2023). In parallel, space-enabled telecommunication infrastructure supports telemedicine applications, improving healthcare accessibility in remote areas and contributing to SDG 3 (Good Health and Well-Being). Educational initiatives, particularly those based on CubeSat platforms, have engaged over 100,000 students globally in STEM disciplines, contributing to SDG 4 (Quality Education) (Rocket Lab, 2025).

The increasing integration of private actors into the space sector is further reflected in the rise of public-private partnerships (PPPs), which have become a cornerstone of New Space development. Programmes such as NASA’s \$8 billion Commercial Crew Program and ESA’s co-funding initiatives, including the €1.3 million “Boost!” contract supporting PLD Space, demonstrate how collaboration between public institutions and private enterprises reduces financial risks, accelerates innovation, and enables scalable solutions aligned with SDG objectives (National Aeronautics and Space Administration, 2025; European Space Agency, 2024).

At the international level, organizations such as the United Nations Office for Outer Space Affairs (UNOOSA) have explicitly recognized the role of space technologies in sustainable

development through initiatives such as Space4SDGs, Space4Women, Space4Climate, and Space4Agriculture. These programmes highlight the growing institutional acknowledgment of the link between space activities and SDG achievement, particularly in areas such as gender inclusion, environmental monitoring, and capacity building (United Nations Office for Outer Space Affairs, 2005; United Nations Office for Outer Space Affairs, 2020; United Nations Office for Outer Space Affairs/DESA, 2021).

As the space sector continues to evolve, it has become increasingly segmented into key subdomains, including Earth Observation (EO), satellite communications (SATCOM), and emerging areas such as space sustainability and debris mitigation. However, all of these applications fundamentally depend on access to space, which is enabled by the launching industry. Rocket programmes and associated satellite launch systems therefore represent the foundational infrastructure of the New Space ecosystem, determining the accessibility, affordability, and scalability of space-based solutions.

Technological advancements in launch systems—particularly reusable rockets, lightweight small satellite launchers, and emerging green propulsion technologies—have significantly lowered barriers to entry. Reusable launch vehicles, such as SpaceX’s Falcon 9, which has achieved over 250 reuses, and Rocket Lab’s Electron, priced at approximately \$7 million per launch, enable cost-efficient deployment of satellites and support a rapidly expanding small satellite market projected to exceed 10,000 launches by 2030 (Brukart, 2024; Rajagopalan and Stroikos, 2024; Rocket Lab, 2025, Rocket Lab, 2025; Indian Space Research Organization, 2025; Morgan Stanley, 2020). At the same time, green propulsion technologies, including methane-based engines such as SpaceX’s Starship and ESA’s Prometheus engine, aim to reduce the environmental impact of launches, which currently produce approximately 400 tons of CO₂

equivalent per launch, aligning space activities with climate-related sustainability goals (Dallas *et al.*, 2020; European Space Agency, 2021, European Space Agency, 2024; Malinowskaa *et al.*, 2023).

These technological and structural transformations have significantly democratized access to space, enabling not only established spacefaring nations but also startups, universities, and developing regions to participate in the global space economy. This has important implications for industrial development, job creation, and technological capacity building, particularly in emerging ecosystems.

However, the distribution of these benefits remains uneven. The global space sector is still largely dominated by major powers such as the United States and China, which account for approximately 80% of global launches and investments. Developing regions, including the Balkans, face significant barriers, including limited funding, low levels of research and development investment (typically between 0.1% and 0.5% of GDP), expertise shortages driven by brain drain, and reliance on foreign launch providers at costs ranging between \$50,000 and \$100,000 per CubeSat mission (Fedajev, Panić and Živković, 2025, Eurostat, 2023).

Despite these constraints, emerging initiatives such as Montenegro's *Luča* satellite, developed with an approximate budget of €200,000 and successfully launched in 2025, and Croatia's CroCube, launched in 2024, demonstrate the region's potential to participate in the global space ecosystem. These projects highlight how access to launch capabilities can serve as a strategic entry point for developing countries, enabling participation in space-based innovation and contributing to multiple SDGs, particularly those related to industry, innovation, education, and partnerships.

Overall, the convergence of technological innovation, entrepreneurial activity, and increasing global demand positions space entrepreneurship—and particularly rocket programmes and associated satellite launches—as a critical enabler of sustainable development. At the same time, significant gaps remain in understanding the full extent of their socioeconomic and environmental impacts, particularly in underrepresented regions such as the Balkans. Addressing these gaps requires a comprehensive and empirically informed analysis of the enabling and inhibiting factors shaping the New Space ecosystem, which this study aims to provide.

1.1.2. The European Context

In recent years, the European launch and spaceflight sector has undergone significant transformation, driven by increasing global competition and a growing strategic ambition to position Europe as a leading space power. However, Europe’s limited autonomous launch capacity has been identified as a key constraint, potentially affecting its freedom of action and ability to independently plan and deploy space missions (European Space Policy Institute, 2023). At the same time, geopolitical disruptions in the early 2020s—most notably the loss of access to Russian Soyuz launch services and increased reliance on U.S.-based providers such as SpaceX—have reinforced the importance of achieving independent access to space. In response, the European Space Agency has intensified investments in next-generation launch systems, including Ariane 6, Vega-C, and future reusable launcher concepts, with the objective of ensuring long-term competitiveness and strategic autonomy in the global space economy (European Space Agency, 2021; European Space Agency, 2024, Forbes).

- Ariane 6, completed six missions by March 2025, deploying 25 satellites, including for environmental monitoring, contributing to Climate Action related SDG by providing

critical climate data that mitigates billions in annual economic losses from extreme weather events (European Space Agency, 2021; Calvin *et al.*, 2023; European Space Agency, 2024; IPCC, 2023).

- European startups, such as PLD Space, have secured public and private funding to develop new launch systems, including the Miura 5 rocket. These initiatives reflect a broader European effort to strengthen the commercial space sector, foster innovation, and support industrial development in line with sustainability objectives related to industry, innovation, and economic growth (SDG 9 and SDG 8). While such projects are expected to contribute to job creation and economic activity, publicly available data on their precise economic impact remains limited (European Space Agency, 2021; European Space Agency, 2024).

Despite these advancements, Europe still faces significant challenges, such as:

- The Ariane 6's launch cost is much higher than SpaceX's Falcon 9 affecting availability of options to choose launch operators and providers, and therefore limiting inclusive and equal access to the European space industry;
- Regulatory hurdles in Europe delay launch programmes and cost startups significant additional expenses creating entry barriers;
- Rocket launches are associated with greenhouse gas emissions and other environmental impacts, which have raised increasing attention within the context of sustainable space activities and climate-related policy discussions. In response, there is a growing emphasis on the development and adoption of more environmentally sustainable propulsion technologies, including liquid oxygen–methane systems such as ESA's Prometheus engine, which aim to improve efficiency and reduce certain types of emissions compared

to traditional propellants. Achieving broader alignment with climate-related objectives (SDG 13) may therefore depend on coordinated efforts across national and institutional actors to advance and implement such technologies (Dallas *et al.*, 2020; European Space Agency, 2021; Chebukhanova and Zimakov, 2022; Calvin *et al.*, 2023; European Space Agency, 2024; IPCC, 2023; Malinowskaa *et al.*, 2023; Chebukhanova & Zimakov, 2022).

1.1.3. The Balkan space ecosystem development

The Balkan region, historically underrepresented in the global space sector, is increasingly witnessing the emergence of early-stage space initiatives that indicate its potential to contribute to the achievement of the Sustainable Development Goals (SDGs). While still limited in scale, these developments reflect a gradual shift toward participation in the global space economy.

Montenegro has recently positioned itself as a notable emerging actor through the successful launch of its first satellite, *Luča*, in 2025, developed by Montenegro Space Research. In parallel, ongoing efforts in rocket propulsion research, led by a small team of engineers, aim to explore lightweight launch capabilities for small satellites. These initiatives represent foundational steps toward building national technological capacity and fostering innovation ecosystems, aligning with broader objectives related to SDG 9 (Industry, Innovation and Infrastructure). The *Luča* mission, supported through a combination of national and European Union funding, serves both educational and research purposes, with potential long-term implications for capacity building, international collaboration, and future economic development, particularly if supported through structured partnerships and scaling mechanisms inspired by models such as the Indian Space Research Organization (ISRO).

In Croatia, the CroCube project represents a significant milestone as the country's first satellite initiative. Led by Daniela Jović and supported by a multidisciplinary team, the project

emphasizes educational outreach, engaging students across universities and schools in STEM-related activities. As such, it contributes primarily to SDG 4 (Quality Education), while also demonstrating the potential for broader industrial and innovation-related spillovers. Although currently focused on education, initiatives such as CroCube could support the gradual development of national space capabilities if complemented by institutional support and long-term strategic planning.

Other countries in the region are also developing relevant, though still limited, initiatives. In North Macedonia, STEM programmes supported by national and European funding mechanisms promote science and technology education, including space-related topics, with indications of relatively balanced gender participation. In Serbia, satellite data applications—particularly through platforms such as AgroSense—demonstrate the integration of space-based technologies into sectors such as agriculture, supporting productivity and decision-making processes. In Bosnia and Herzegovina, STEM initiatives remain largely project-based and constrained by limited resources, with insufficient publicly available data on scale and long-term impact.

Despite these promising developments, the Balkan region faces several structural constraints that limit the scalability and sustainability of its space activities. Investment in research and development remains significantly below the European Union average, while expertise shortages are exacerbated by the emigration of STEM graduates. Additionally, reliance on foreign launch providers, such as SpaceX and Rocket Lab, increases costs and limits the frequency of regional space missions.

These conditions highlight the critical role of the launching industry as an enabling mechanism for participation in the global space economy. Access to launch capabilities allows emerging actors to deploy satellites, generate data, and engage in space-related innovation, thereby

contributing to multiple SDGs, including those related to industry development, education, employment, and international cooperation.

However, scaling these initiatives requires coordinated efforts to address key barriers, including limited funding, regulatory gaps, and the absence of comprehensive national and regional space strategies. Furthermore, sustainability considerations—such as environmental impacts of launches and the need for responsible space operations—must be integrated into future development pathways.

In this context, enhanced regional cooperation, stronger institutional frameworks, and increased access to European and international funding mechanisms could play a decisive role. Initiatives such as coordinated regional programmes or a potential Balkan Space Consortium could support the development of infrastructure, facilitate knowledge transfer, and strengthen human capital retention.

Overall, current developments suggest that, although still in an early stage, the Balkan space ecosystem holds meaningful potential to evolve into a more structured and impactful contributor to both the European and global space landscape.

1.2. The significance and contribution of the Study

The significance of this thesis lies in its multifaceted contribution to advancing both academic understanding and practical applications of space entrepreneurship in the context of the 2030 Agenda for Sustainable Development.

Theoretical Significance:

This study contributes to the interdisciplinary literature by examining the role of space entrepreneurship through the lens of the innovation ecosystem framework, with a particular

focus on underexplored areas such as the socioeconomic and environmental implications of rocket programmes and associated satellite launch activities in emerging regions.

It addresses key gaps identified in the Literature Review, particularly the limited attention given to the role of launch systems as enablers of SDG-aligned applications. By integrating technical, social, and environmental perspectives—rather than focusing solely on economic indicators—the study provides a more holistic understanding of how space technologies contribute to sustainable development.

In addition, the research contributes to the relatively limited body of knowledge on emerging space ecosystems in the Western Balkans, offering a novel regional perspective within the broader global space economy.

Practical Significance:

The thesis provides evidence-based insights and policy-relevant recommendations for policymakers, space agencies, and entrepreneurs seeking to scale SDG-aligned space activities. These include strategies related to improving access to space through cost-efficient launch solutions, strengthening gender inclusion through STEM engagement and education initiatives, and promoting more sustainable space practices through the adoption of emerging technologies and mitigation approaches.

Furthermore, the study highlights the importance of public-private partnerships, technology transfer mechanisms, and institutional support frameworks in enabling broader participation in the space sector, particularly for developing regions. By drawing on international best practices, the research offers practical guidance for fostering innovation ecosystems that are both economically viable and socially inclusive.

Regional Significance:

The study places particular emphasis on the Western Balkans as an emerging space ecosystem, highlighting its potential for future development. Initiatives such as Montenegro's Luča CubeSat mission and Croatia's CroCube project are considered as early indicators of regional capability and engagement, particularly in the domains of education, innovation, and capacity building.

The research further explores how coordinated regional efforts, supported by international partnerships and institutional development, could strengthen the position of Balkan countries within the European and global space economy. In this context, the concept of a regional cooperation framework—such as a Balkan Space Consortium—is examined as a potential mechanism for pooling resources, fostering collaboration, and accelerating the development of space-related capabilities.

Ethical and Sustainability Significance:

The thesis also addresses critical ethical and sustainability challenges associated with the rapid expansion of space activities. These include issues related to space debris and orbital congestion, environmental impacts of rocket launches, and unequal access to space-sector opportunities and benefits.

The growing accumulation of orbital debris poses risks to long-term space sustainability and the continued availability of satellite-based services, while increasing launch activity raises concerns regarding environmental impacts. At the same time, structural barriers to entry—particularly in the launch segment—contribute to unequal participation in the global space economy, with capabilities concentrated in a limited number of countries.

In response, the study emphasizes the importance of strengthening governance frameworks, promoting responsible and sustainable space practices, and enabling more inclusive access to space technologies. This includes the development of national and regional policy frameworks,

improved regulatory alignment, and the adoption of best practices in sustainability and cooperation.

Overall, the thesis contributes by linking global developments in space entrepreneurship with regional dynamics in the Western Balkans, offering both theoretical insights and practical pathways for the development of a more inclusive, sustainable, and innovation-driven space ecosystem. In doing so, it supports the broader objectives of the 2030 Agenda, particularly the principle of ensuring that no region is left behind in the transition toward a more technologically advanced and sustainable future.

1.3 Research Objectives and Questions

This study builds on the foundations established in the Concept Paper (CP), Literature Review (LR), and Research Proposal (RP), highlighting the transformative potential of rocket programmes as a critical entry point for developing countries to participate in the global space economy. It does so by examining Europe’s strategic pursuit of launch independence and the emerging potential of the Balkan space ecosystem.

The primary objective of this thesis is to explore how the New Space ecosystem and space entrepreneurship—particularly through rocket programmes and associated satellite projects—contribute to the achievement of the Sustainable Development Goals (SDGs), with a specific emphasis on SDG 5 (Gender Equality) and SDG 9 (Industry, Innovation and Infrastructure), across global, European, and Balkan contexts.

The thesis also considers Montenegro as a potential regional leader, particularly in light of the successful 2025 Luča satellite mission, while recognizing Croatia’s contributions through the CroCube project launched in 2024 and its impact on STEM education.

The study aims to provide a comprehensive analysis of the technical, socioeconomic, and ethical dimensions of space entrepreneurship, while addressing key gaps identified in academic literature. The specific objectives are as follows:

- To analyze the role of rocket programmes and technologies—including reusable launch systems, lightweight launchers, and green propulsion—in enabling cost-effective and sustainable access to space, and supporting SDG-aligned applications in agriculture, health, education, connectivity, and climate action, particularly in the context of developing countries.
- To evaluate Europe’s pursuit of launch independence, examining both opportunities and challenges, including cost competitiveness, regulatory frameworks, delays, and environmental considerations, and their implications for innovation, industrial development, job creation, and international cooperation.
- To investigate the development of the emerging Balkan space ecosystem, with a focus on Montenegro’s Luča satellite and Croatia’s CroCube project, alongside broader STEM and space-related initiatives in North Macedonia, Serbia, and Bosnia and Herzegovina, identifying both opportunities and structural barriers related to funding, expertise, and infrastructure.
- To examine how space entrepreneurship can promote gender equality through STEM engagement, leadership opportunities, and policy interventions, particularly within European and Balkan contexts, addressing the underrepresentation of women in the space sector.
- To propose evidence-based policy recommendations aimed at strengthening and scaling the contributions of space entrepreneurship to the SDGs, particularly in Europe and the

Balkans, by addressing challenges such as financing gaps, regulatory barriers, environmental impacts, and unequal access to space-sector opportunities.

The research questions guiding this study are designed to align with these objectives:

- How do rocket programmes and associated technologies—through cost reductions, increased launch frequency, and advancements in propulsion systems—enable space entrepreneurship to contribute to the SDGs, particularly SDG 5 and SDG 9, and what opportunities do they create for developing countries?
- What are the key opportunities and challenges associated with Europe’s pursuit of launch independence, and how do these dynamics affect space startups and emerging regions such as the Balkans?
- How can the emerging Balkan space ecosystem contribute to SDG achievement, particularly in relation to education, gender equality, innovation, and partnerships, and what are the key barriers limiting its development?
- In what ways can space entrepreneurship promote gender equality, and what strategies can be implemented to address the underrepresentation of women in the space sector?
- What policy frameworks and strategic approaches can enhance the scalability, inclusivity, and sustainability of space entrepreneurship’s contributions to the SDGs, particularly in developing regions such as the Balkans?

These objectives and research questions provide a structured foundation for the thesis, enabling a systematic analysis of space entrepreneurship’s role in advancing the SDGs, with a particular focus on rocket programmes, satellite systems, and the emerging potential of the Balkan region within the global space economy.

1.4 Scope and Delimitations

1.4.1 Scope

This thesis examines the contributions of space entrepreneurship to the Sustainable Development Goals (SDGs), with particular emphasis on rocket programmes, associated satellite programmes, and their role in enabling more accessible, cost-efficient, and sustainable access to space for a wide range of SDG-aligned applications.

From a sustainability perspective, the study gives priority to those segments of the space sector that function as core enablers of broader downstream benefits. In this context, the launching industry, satellite industry, and associated research and development (R&D) initiatives are considered foundational. The logic underpinning this approach is that research precedes development, development precedes manufacturing and testing, and launch capabilities are necessary to deploy satellites that can subsequently support educational experiments, Earth observation, communications, and other socially relevant applications. Similarly, STEM activities related to space R&D are treated as a necessary precondition for the development of future space capabilities and ecosystems.

The study prioritizes **SDG 5 (Gender Equality)** and **SDG 9 (Industry, Innovation and Infrastructure)** due to their particular relevance to social inclusion and industrial development within the space sector. At the same time, the thesis gives due consideration to other SDGs where relevant, particularly **SDG 2 (Zero Hunger)**, **SDG 3 (Good Health and Well-Being)**, **SDG 4 (Quality Education)**, **SDG 10 (Reduced Inequalities)**, **SDG 13 (Climate Action)**, **SDG 16 (Peace, Justice and Strong Institutions)**, and **SDG 17 (Partnerships for the Goals)**, in order

to provide a more holistic understanding of the role of space entrepreneurship in sustainable development.

The analysis covers both the **technical** and **socioeconomic** dimensions of space entrepreneurship. On the technical side, particular attention is given to reusable launch systems, lightweight launchers, and green propulsion technologies. On the socioeconomic side, the study considers issues such as industrial development, job creation, STEM engagement, innovation ecosystems, and gender inclusion, as reflected in academic literature, policy reports, and industry analyses.

Geographically, the thesis adopts a **global and comparative perspective**, allowing for the identification of best practices that may be relevant to the Balkans. In this respect, the research examines developments in major and emerging spacefaring nations, including the United States, India, and selected European actors. A particular regional focus is placed on **Europe**, especially on the role of the European Space Agency (ESA), European launch programmes, and associated initiatives that support New Space ventures, technological demonstration, and broader access to the space sector.

Within this European context, the **Western Balkans** constitute the primary regional focus of the study. Special attention is given to Montenegro's **Luča** CubeSat mission, Croatia's **CroCube** project, and emerging STEM-, satellite-, and space-related initiatives in North Macedonia, Serbia, and Bosnia and Herzegovina. Although these activities remain at an early stage, they are treated as important indicators of regional potential, talent, and capability, and as illustrative examples of how emerging space ecosystems may develop through coordinated support, partnerships, and institutional strengthening.

At the same time, some actors and initiatives are considered only selectively. For example, although Bulgaria's EnduroSat is acknowledged as an important regional actor, it is referenced only where relevant to strengthen broader arguments regarding space entrepreneurship and SDG contributions. This is because the principal focus of the thesis remains on launch-related capabilities, enabling systems, and emerging ecosystems in less-developed or nascent space sectors. Similarly, companies such as Rocket Factory Augsburg are considered only illustratively where they provide useful comparative insight, but not as central case studies, given the limited availability of longitudinal evidence relevant to the thesis objectives.

The study is structured through an **innovation ecosystem framework**, which examines the interplay between actors, resources, and institutions across global, European, and Balkan contexts (Lamine *et al.*, 2021, Lamine et al., 2021). This framework is particularly suitable because the space sector is inherently multistakeholder, multidisciplinary, and shaped by complex interdependencies between public institutions, private companies, academic actors, and regulatory systems.

Accordingly, actors, resources, institutions, and their related outputs—such as projects, programmes, initiatives, policies, and regulatory frameworks—are considered only to the extent that they provide insight into the development of rocket programmes, associated satellite launch activities, European launch independence, and the development and integration of emerging Balkan space sectors.

The thesis also gives due consideration to important **ethical and sustainability-related challenges**, including space debris, rocket emissions, and unequal access to space-sector opportunities and benefits, insofar as these affect alignment with **SDGs 13, 16, and 10**.

In addition, the study incorporates **qualitative interview data** to complement the literature and provide grounded perspectives on gender dynamics, innovation ecosystems, and regional development challenges. Interviewees are considered only insofar as their views support the analytical objectives of the study and are not treated as central narrative actors. The interviews involve approximately **7–12 participants**, including representatives of Balkan STEM and space initiatives, members of the Montenegro Space Research engineering team, female leaders from European space startups, and ESA representatives. These interviews are intended to enrich the analysis by providing complementary qualitative insights alongside secondary data.

The principal interviewees considered in this study include:

- Daniela Jović, Project Lead of Croatia’s CroCube initiative and CEO of Orbitalyx
- A Montenegro Space Research engineer involved in the development and launch preparation of the Luča satellite
- Martina Dimoska, Program Human Systems Integrator at the NASA Johnson Space Center, North Macedonian space entrepreneur, founder of the International Space Alliance, STEM advocate, and analog astronaut
- Tamara Blagojević, SpaceWatch.Global Field Reporter and Business Development Manager, Serbian space professional and consultant in business development, capacity building, and professional development
- Valeriya Barashkova, Co-Founder and Sales and Marketing Director at Aerospace Capital
- Vladimir Gašić, research associate professor and astronomer
- Vuk Maksić, student and member of Argo Robotics
- ESA representatives, whose identities are not disclosed for privacy and security reasons

By synthesizing these perspectives, the thesis seeks to extract good practices and enrich the theoretical understanding of the relationship between space entrepreneurship and sustainable development.

1.4.2 Delimitations

Several delimitations are established in order to ensure a focused and manageable scope.

Technological delimitation:

The research does not provide an in-depth analysis of non-launch space technologies such as space robotics, in-orbit servicing, in-orbit manufacturing, or space mining. Instead, it focuses primarily on launch systems and enabling technologies such as reusable rockets, lightweight launchers, and green propulsion.

Organizational delimitation:

The study focuses primarily on New Space startups, entrepreneurial ventures, and public-private partnerships. Traditional space agency activities that are not meaningfully connected to entrepreneurial or commercialization dynamics are not treated as central objects of analysis.

SDG delimitation:

The thesis prioritizes SDG 5 and SDG 9, while treating other relevant SDGs as secondary but still important contextual dimensions. This prioritization is intended to ensure analytical depth without diluting the main focus.

Geographical delimitation:

The Balkans serve as the primary developing-region case, due to their strategic relevance, emerging initiatives, and comparative proximity to Europe. International examples from the United States, India, Brazil, New Zealand, and selected European states are included for contextual and comparative purposes.

Temporal delimitation:

The study avoids speculative projections beyond 2040 and remains broadly aligned with the SDG timeline and currently available evidence.

Stakeholder delimitation:

Interview data are used to provide qualitative insight into prioritized themes such as gender dynamics, innovation ecosystems, and regional development challenges, but interviewees themselves are not treated as the main objects of study.

These delimitations ensure a focused and rigorous study, while allowing the thesis to address significant gaps in the literature regarding the role of rocket programmes, satellite initiatives, and emerging regional ecosystems in advancing sustainable development.

1.5 Theoretical Framework

The thesis adopts an **innovation ecosystem framework** to analyze space entrepreneurship's contributions to the SDGs, conceptualizing it as a dynamic, interdependent network of actors, resources, and institutions that drive technological, socioeconomic, and environmental outcomes (Lamine et al., 2021). This framework is particularly well-suited to the study's interdisciplinary nature, integrating insights from entrepreneurship, space technology, sustainable development, and policy studies to provide a holistic understanding of how rocket programmes, technologies and associated satellite launches enable SDG-aligned solutions.

The framework's components—actors, resources, and institutions—are applied across three analytical levels: global, European, and Balkan, ensuring a comprehensive exploration of the study's objectives.

- The global level is primarily taken into consideration due to the collaborative and transboundary nature of the space sector, as outer space itself represents Global

Commons, concerning humanity as a whole. Additionally, it is considered due to the current nature of international geopolitical relations, where corporations increasingly take on roles previously monopolized by states, and where their businesses and activities are also of transboundary nature, therefore having different examples of best practices by different actors from various parts of the globe. Therefore, best practices are extracted at the global scale.

- The European level is considered due to the fact that the Balkan region falls within the European Region, specifically falling under Southeastern Europe. Therefore, the dynamics of regional relations will largely depend on whether this region develops in a synchronised and peaceful manner, which can be enabled through the cooperative and harmonized development of the Balkan space ecosystem, therefore not only contributing to achieving the SDG targets, but also to catalyse current European dynamics.
- The third and the final level, as the last, but most important piece of the puzzle is the Balkans, providing that necessary ingredient to connect all the dots, and mirrored in: resources, talent and opportunities. As such, Balkan can support Europe in its effort to become one of the global space powers.

1.5.1 Actors

Actors within the innovation ecosystem represent the key entities that drive space entrepreneurship and shape its contributions to the Sustainable Development Goals (SDGs). These actors are characterized by their roles, capabilities, and interactions, and can be broadly categorized into private sector actors, governmental institutions, academic and scientific organizations, investors, and international bodies.

Private Sector – New Space Companies and Startups:

Private actors play a central role in advancing New Space entrepreneurship by developing technologies, commercializing services, and enabling SDG-aligned applications. A distinction can be made between established companies and emerging startups.

Established actors, including SpaceX, Rocket Lab, PLD Space, and Planet Labs, function as key enablers of the ecosystem. Through advancements in reusable launch systems, small satellite deployment, and Earth observation technologies, these companies have significantly reduced barriers to accessing space and enabled applications in connectivity, climate monitoring, and agriculture.

In parallel, startups and emerging initiatives contribute through innovative and often niche solutions. Companies such as SatSure, SpaceD, and SpacePharma demonstrate how space-based data and technologies can be applied to agriculture, disaster management, and health research, supporting multiple SDGs.

In the Western Balkans, early-stage initiatives reflect growing participation in the space sector. Projects such as Croatia's CroCube and Montenegro's Luča CubeSat, as well as emerging propulsion research efforts led by Montenegro Space Research, illustrate the region's entry into New Space activities, primarily through educational and capacity-building initiatives.

Governmental Sector – Space Agencies and National Programmes:

Governmental actors provide the institutional backbone of the space ecosystem through funding, infrastructure, and regulatory support. Key actors include the European Space Agency, National Aeronautics and Space Administration and Indian Space Research Organisation, which support space activities through launch programmes, public-private partnerships, and policy frameworks.

These institutions enable technological development and facilitate collaboration with private actors, contributing to the advancement of SDG 9 (Industry, Innovation and Infrastructure) and SDG 17 (Partnerships for the Goals). In emerging regions, including the Balkans, national governments primarily support space-related activities through STEM initiatives and research funding, although institutional frameworks remain underdeveloped.

Scientific and Academic Sector – Universities and Research Institutions:

Universities and research institutions play a crucial role in developing human capital and advancing scientific knowledge within the space ecosystem. Through educational programmes, research collaborations, and participation in CubeSat projects, academic actors contribute to workforce development and innovation.

In the Balkan region, universities and educational initiatives support projects such as CroCube and broader STEM engagement programmes, fostering interest in space technologies and contributing to SDG 4 (Quality Education) and SDG 5 (Gender Equality).

Funding Sources – Investors and Private Sector Partners:

Financial actors, including venture capital firms, institutional investors, and private partners, provide the capital necessary for scaling space ventures. Public-private partnerships between agencies and private companies play a particularly important role in reducing financial risks and accelerating innovation.

While global investment in the space sector has grown significantly, access to capital remains uneven. In the Western Balkans, space initiatives rely primarily on national funding and European Union support mechanisms, limiting scalability and long-term sustainability.

International Organizations and Governance Bodies:

International organizations, such as the United Nations Office for Outer Space Affairs and the

Committee on the Peaceful Uses of Outer Space, play a key role in shaping global space governance. Through international treaties, guidelines, and capacity-building initiatives, these institutions promote the peaceful and sustainable use of outer space and support international cooperation.

Their activities contribute directly to SDG 16 (Peace, Justice and Strong Institutions) and SDG 17 (Partnerships for the Goals), particularly by establishing regulatory frameworks and facilitating collaboration between developed and emerging space actors.

Ecosystem Interactions and Challenges:

These actors operate within a highly interconnected ecosystem, characterized by collaboration across public, private, and academic domains. However, the literature highlights several challenges, including regulatory gaps, unequal access to funding and infrastructure, and disparities in technological capabilities between established and emerging space regions.

In the Western Balkans context, these challenges are particularly pronounced, limiting the ability of local actors to scale initiatives and fully participate in the global space economy. Addressing these constraints requires stronger institutional frameworks, increased investment, and enhanced international cooperation to support more inclusive and sustainable development of the sector.

1.5.2 Resources

Resources represent the tangible and intangible assets that underpin the innovation ecosystem, enabling space entrepreneurship to contribute to the achievement of the Sustainable Development Goals (SDGs). These include technological capabilities, financial capital, human expertise, and data and knowledge resources.

Technological Resources:

Technological advancements have significantly transformed access to space. Reusable launch

systems developed by companies such as SpaceX and small satellite launch solutions from Rocket Lab have contributed to reducing costs and increasing launch frequency.

The emergence of CubeSats and miniaturized satellite technologies has enabled more affordable participation in space activities, particularly for educational and research purposes. Projects such as Croatia's CroCube illustrate how such technologies can support STEM engagement (SDG 4), while satellite-based applications in agriculture and environmental monitoring demonstrate their broader relevance for SDG 2 and SDG 13.

In addition, large satellite constellations and Earth observation systems, operated by companies such as Planet Labs, support data-driven applications in connectivity, climate monitoring, and disaster response. At the same time, ongoing research into sustainable propulsion systems reflects efforts to reduce the environmental impact of space activities and align with SDG 13 (Climate Action). (European Space Agency, 2021; European Space Agency, 2024).

Financial Resources:

The global space economy has experienced significant growth, driven by increasing levels of private investment and public funding. Venture capital and institutional investments have supported the expansion of launch services, satellite systems, and downstream applications (Seraphim Capital, 2022; Brukart, 2024; Morgan Stanley, 2020; Seraphim Capital, 2022).

Public funding mechanisms remain essential, particularly through organizations such as NASA and the European Space Agency, which provide support through large-scale programmes, grants, and innovation initiatives.

In contrast, space-related activities in the Western Balkans are typically funded through comparatively modest project-based budgets, often in the range of several hundred thousand euros. Projects such as Montenegro's Luča CubeSat and Croatia's CroCube reflect this pattern,

highlighting both emerging potential and financial constraints. This aligns with broader regional trends of relatively low investment in research and development compared to the European Union average (Fedajev, Panić and Živković, 2025; Eurostat, 2024).

Human Capital and Expertise:

Human capital is a critical resource within the space ecosystem, encompassing technical expertise, scientific knowledge, and entrepreneurial capacity. While the global space sector benefits from a highly skilled workforce, challenges related to talent availability and distribution persist.

Gender disparities remain particularly pronounced, with women underrepresented in STEM fields and technical roles, including within the space sector (Schneegans, Lewis and Straza, 2021, UNESCO, 2023). In the Western Balkans, these challenges are further compounded by brain drain and limited access to specialized training and infrastructure, constraining the development of local capabilities.

Data and Knowledge Resources:

Satellite data and associated analytical capabilities represent a key resource for SDG implementation. Earth observation data supports applications in agriculture, climate monitoring, disaster risk management, and urban planning, enabling evidence-based decision-making across sectors (Organisation for Economic Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023).

Academic research institutions, industry reports, and international collaborations further contribute to knowledge generation and dissemination, supporting innovation within the space sector. However, in emerging regions such as the Western Balkans, access to data and research

infrastructure remains limited, with many initiatives relying on externally generated data and partnerships.

Overall, while these resources enable the growth of space entrepreneurship and its contributions to the SDGs, their distribution remains uneven. The global space sector is characterized by strong concentration of capabilities and investment in a limited number of countries, while emerging regions—including the Western Balkans—face constraints related to funding, expertise, and infrastructure. Addressing these disparities is essential for enabling more inclusive participation in the global space economy and advancing SDG 9 (Industry, Innovation and Infrastructure), SDG 10 (Reduced Inequalities), and SDG 17 (Partnerships for the Goals).

1.5.3 Institutional Components and Governance

Institutions encompass international and regional organizations, as well as the policies, regulatory frameworks, and standards that shape the innovation ecosystem. In the context of space entrepreneurship, these institutional components play a critical role in enabling, guiding, and constraining activities, while also influencing their alignment with the Sustainable Development Goals (SDGs).

Funding Mechanisms and Institutional Support:

Public institutions play a central role in supporting space entrepreneurship through targeted funding mechanisms and innovation programmes. The European Space Agency provides support through initiatives such as Business Incubation Centres (BICs), accelerator programmes, and co-funded contracts, including the “Boost!” programme, which supports the development of commercial launch services. In parallel, policy reforms in India have enabled the integration of private actors into the national space ecosystem through institutional frameworks led by the Indian Space Research Organisation, fostering the growth of a dynamic New Space sector.

International Space Law Framework (Hard Law):

The international legal framework governing space activities is primarily established through United Nations treaties administered by the United Nations Office for Outer Space Affairs. The *Outer Space Treaty* (1967) sets out fundamental principles, including the peaceful use of outer space, international cooperation, and state responsibility for national activities.

The *Liability Convention* (1972) further defines state responsibility and liability for damage caused by space objects, which is particularly relevant for countries developing launch capabilities. The *Registration Convention* (1975) requires states to register space objects, ensuring transparency, traceability, and accountability in space activities. Together, these instruments form the legal foundation for safe and responsible participation in the space sector.

Soft Law and Sustainability Frameworks:

In addition to binding treaties, international governance is supported by non-binding guidelines and best practices. The *UNCOPUOS Guidelines for the Long-term Sustainability of Outer Space Activities* provide recommendations for safe and sustainable operations, including debris mitigation and responsible mission design. Although voluntary, these guidelines complement binding legal frameworks and play an important role in shaping industry standards.

European Policy Frameworks and Standards:

At the regional level, the European Space Agency has developed a range of policies and standards addressing sustainability and space operations. These include environmental initiatives aligned with broader European climate objectives, as well as debris mitigation frameworks such as the Zero Debris Charter and technical standards for end-of-life disposal of space systems. These instruments contribute to aligning space activities with SDG 13 (Climate Action) and SDG 16 (Peace, Justice and Strong Institutions).

Regulatory Frameworks and Industry Practices:

National regulatory systems also play a key role in shaping the space ecosystem. For example, licensing frameworks such as those implemented by the Federal Aviation Administration (FAA) aim to streamline launch approvals and support commercial space activities. In parallel, industry-driven innovations, including reusable launch systems and evolving propulsion technologies, contribute to improving efficiency and sustainability in the sector.

Emerging Ecosystems and Governance Gaps in the Balkans:

In contrast to more established space ecosystems, countries in the Western Balkans face significant institutional and regulatory limitations. Comprehensive national space policies and legal frameworks remain underdeveloped, limiting integration into European programmes and access to funding mechanisms.

As a result, initiatives such as Montenegro's Luča CubeSat and Croatia's CroCube project rely heavily on external partnerships and foreign launch providers. The absence of coordinated regional governance frameworks, sustainability standards, and long-term strategic policies further constrains the development of the sector.

These institutional gaps highlight the importance of policy harmonization, capacity building, and international cooperation in supporting the development of emerging space ecosystems. Strengthening governance structures in regions such as the Western Balkans is therefore essential for enabling participation in the global space economy and aligning space activities with SDG 17 (Partnerships for the Goals), SDG 9 (Industry, Innovation and Infrastructure), and SDG 13 (Climate Action).

Chapter 2: Review of Literature

2.1 Introduction to the Literature Review

The intersection of space entrepreneurship and the Sustainable Development Goals (SDGs) represents a dynamic and interdisciplinary field, integrating perspectives from space technology, entrepreneurial ecosystems, and global sustainability frameworks. This literature review synthesizes a broad body of academic research, industry reports, and policy documents to establish a comprehensive foundation for understanding how New Space ventures—particularly those enabled by rocket programmes—contribute to the implementation of the United Nations 2030 Agenda for Sustainable Development.

The review is structured around several interrelated themes. First, it examines the historical evolution, progress, and implementation challenges associated with the SDGs. Second, it explores the emergence and dynamics of New Space entrepreneurship as a transformative force within the global space sector. Third, it analyzes the role of rocket programmes and associated technologies in enabling more accessible and cost-efficient access to space. Fourth, it evaluates the contributions of space-based innovations to selected SDGs, with particular emphasis on SDG 5 (Gender Equality) and SDG 9 (Industry, Innovation, and Infrastructure). Finally, the review identifies key enabling and constraining factors shaping the sector, while also considering the growing role of emerging space regions, particularly the Western Balkans.

While maintaining a global perspective, the analysis incorporates a regional focus on Europe's efforts to strengthen autonomous access to space, as well as the early-stage development of the Balkan space ecosystem. Initiatives such as Montenegro's Luča CubeSat mission and Croatia's

CroCube project illustrate initial regional engagement, particularly in the domains of education, research, and capacity building.

This review aims to provide a structured and comprehensive analysis grounded in available evidence, drawing on a wide range of academic and institutional sources. It extends existing research by placing particular emphasis on the role of rocket programmes and launch technologies, the underexplored Balkan context, and the importance of gender inclusion within the space sector.

The analysis is guided by the innovation ecosystem framework (Lamine *et al.*, 2021; Lamine *et al.*, 2021), which examines the interaction between key actors (e.g., startups, space agencies, universities, and investors), resources (e.g., technology, capital, and expertise), and institutions (e.g., policies and regulatory frameworks). This approach provides a coherent lens for understanding how space entrepreneurship can contribute to advancing the SDGs across global, European, and regional contexts.

2.2 Sustainable Development Goals: Historical Evolution, Progress, and Implementation Challenges

2.2.1 Historical Context and Evolution of the SDGs

The Sustainable Development Goals (SDGs), adopted in 2015 as part of the United Nations' 2030 Agenda for Sustainable Development, represent a significant evolution from their predecessors, the Millennium Development Goals (MDGs, 2000–2015). The MDGs, consisting of eight goals and 21 targets, primarily focused on poverty reduction, health, education, and gender equality in developing countries. They achieved notable progress, including a substantial

reduction in extreme poverty and improved access to primary education and clean water (UN General Assembly, 2015; United Nations, 2015).

However, the MDGs were widely criticized for their limited scope, lack of universality, and insufficient attention to environmental sustainability, inequality, and the responsibilities of developed nations (Sachs *et al.*, 2019; Sachs *et al.*, 2019). Key global challenges—such as climate change, industrial development, and inequalities within and between countries—were not comprehensively addressed, limiting their effectiveness in tackling interconnected global issues (Schneegans, Lewis and Straza, 2021; Calvin *et al.*, 2023; IPCC, 2023; World Bank, 2023).

In contrast, the SDGs adopt a holistic and universal framework, comprising 17 goals and 169 targets that integrate economic, social, and environmental dimensions of sustainable development. Unlike the MDGs, which were largely donor-driven, the SDGs require action from all countries, emphasizing inclusivity, shared responsibility, and systemic transformation. Sachs *et al.* (2019) conceptualize the SDGs as a “complex system” requiring coordinated transformations across key sectors, including education, health, energy, food systems, urban development, and digital connectivity.

The development of the SDGs involved extensive global consultation processes, engaging millions of stakeholders across governments, international organizations, the private sector, and civil society, reflecting a more participatory and inclusive approach compared to the MDGs (UN General Assembly, 2015; United Nations, 2015).

This transition represents a broader paradigm shift toward integrated and cross-sectoral approaches to development. The universality of the SDGs requires both developed and developing regions to address structural challenges, including inequalities in access to resources, technological capabilities, and innovation systems. In emerging regions such as the Western

Balkans, relatively low investment in research and development and limited institutional capacity continue to constrain progress, particularly in high-technology sectors (Fedajev, Panić and Živković, 2025; Eurostat, 2024).

At the same time, the increasing emphasis on technology-driven solutions has positioned innovation—including space-based technologies—as a potential enabler of SDG implementation. However, the literature indicates that the specific role of rocket programmes and launch technologies in supporting these transformations remains insufficiently explored, representing a key gap that this study aims to address (Vidmar, 2020; Organisation for Economic Co-operation and Development, 2025)

2.2.2 Progress and Achievements of the SDGs

Since their adoption in 2015, the Sustainable Development Goals (SDGs) have driven measurable progress across multiple sectors; however, the pace and scale of achievements remain insufficient to meet the 2030 targets, with significant regional disparities. The literature, drawing on reports from the United Nations, World Bank, and other international organizations, highlights both advancements and persistent challenges.

SDG 1 – No Poverty: The proportion of people living in extreme poverty declined significantly in the years preceding the COVID-19 pandemic, falling from approximately 15% in 2015 to below 10% by 2020. However, the pandemic reversed part of this progress, pushing an estimated 88–115 million people back into extreme poverty, marking the first global increase in decades (Schneegans, Lewis and Straza, 2021; UN DESA, 2023; World Bank, 2023; United Nations, 2023).

SDG 3 – Good Health and Well-Being: Global health indicators have improved, with maternal mortality declining significantly since 2000 and under-five child mortality reduced by

approximately half over the same period. Access to essential treatments, including antiretroviral therapy for HIV/AIDS, has also expanded considerably. Despite these advances, hundreds of thousands of maternal deaths and millions of child deaths still occur annually, particularly in low-income regions with limited healthcare infrastructure (UN DESA, 2023; United Nations, 2023; WHO, 2023).

SDG 4 – Quality Education: Access to education has improved globally, with primary school enrollment exceeding 90% and significant gains in gender parity at the primary level. However, major challenges persist, as approximately 260 million children remain out of school, and learning outcomes remain uneven, particularly in developing regions. A substantial global education financing gap continues to constrain progress (Schneegans, Lewis and Straza, 2021; UNESCO, 2023).

SDG 7 – Affordable and Clean Energy: Access to electricity has expanded to around 90% of the global population, supported by significant growth in renewable energy capacity. Nevertheless, approximately 733 million people still lack access to electricity, and fossil fuels continue to dominate global energy consumption, highlighting ongoing challenges in achieving sustainable energy transitions (UN DESA, 2023; United Nations, 2023; IEA, 2023).

SDG 13 – Climate Action: Global efforts to address climate change have intensified, with increased investment in renewable energy and widespread international commitments under the Paris Agreement. However, greenhouse gas emissions continue to rise, and the economic impact of extreme weather events remains substantial, underscoring the urgency of improved monitoring, mitigation, and adaptation strategies (Calvin *et al.*, 2023; UN DESA, 2023; IPCC, 2023; United Nations, 2023).

These developments demonstrate that while the SDGs have mobilized global action, progress remains uneven across regions. Developing regions, particularly Sub-Saharan Africa, continue to face significant structural challenges, including limited infrastructure, financial constraints, and vulnerability to climate impacts.

The literature suggests that technological innovation, including space-based solutions enabled by advances in rocket technologies and satellite systems, has the potential to help address these disparities. Applications such as Earth observation for climate monitoring, satellite connectivity for education and healthcare, and data-driven agricultural systems illustrate how space technologies can support multiple SDGs simultaneously. However, detailed analyses of the specific contributions of rocket programmes and launch technologies to SDG implementation remain limited, representing a key gap that this study aims to address (Vidmar, 2020; Organisation for Economic Co-operation and Development, 2025)

2.2.3 Implementation Challenges for the SDGs

The 2023 SDG Progress Report underscores that 37% of the 169 targets are stalled and 36% are regressing, with developing regions facing the most significant obstacles due to systemic barriers (UN DESA, 2023; United Nations, 2023). The literature identifies five primary challenges that hinder SDG implementation, drawing on academic analyses, UN reports, and regional data:

Financing Shortfalls:

The annual investment gap of \$2.5–\$4 trillion is most acute in low-income countries, constraining progress on critical areas such as sustainable infrastructure (SDG 9), poverty alleviation (SDG 1), quality education (SDG 4), and climate action (SDG 13). Official development assistance (ODA) provides approximately \$150 billion annually, covering only a small fraction of this gap, necessitating substantial contributions from the private sector. Space

startups, which attracted \$47.4 billion in venture capital in 2021, offer potential to contribute to bridging this gap; however, Balkan countries face structural limitations in accessing such capital, constraining the scalability of local initiatives (Sachs *et al.*, 2019; Dallas *et al.*, 2020; Seraphim Capital, 2022; Organisation for Economic Co-operation and Development, 2025)

Regional Disparities and Inequities:

Sub-Saharan Africa continues to face severe challenges in health and education outcomes, including high maternal mortality and limited access to basic education. In parallel, the Balkan region faces technological and industrial constraints, with R&D investment generally ranging between approximately 0.5–1% of GDP, compared to the EU average of 2.3%, alongside persistent expertise shortages driven by brain drain. Europe's advanced space ecosystem, supported by significant investments and employment levels, contrasts with the Balkans' early-stage initiatives, highlighting structural inequalities that undermine progress toward SDG 10 (Dallas *et al.*, 2020; Schneegans, Lewis and Straza, 2021; Seraphim Capital, 2022; UNESCO, 2023; Eurostat, 2023; Seraphim Capital, 2022).

Climate Crisis and Environmental Degradation:

Rising greenhouse gas emissions, reaching 36.8 gigatons of CO₂ in 2022, alongside extreme weather events causing approximately \$252 billion in annual economic losses, pose significant risks to achieving SDG 13 (Climate Action). These challenges necessitate advanced monitoring and mitigation technologies, including satellite-based Earth observation systems enabled by cost-efficient rocket launches. However, developing regions, including the Balkans, face limited access to such technologies, increasing their vulnerability to climate-related impacts (Calvin *et al.*, 2023; UN DESA, 2023; IPCC, 2023; United Nations, 2023).

Social and Gender Inequalities:

Gender disparities persist globally, with women accounting for approximately 26% of STEM roles, around 20% of the space sector workforce, and approximately 15% in rocket engineering. Economic inequalities also remain pronounced, with significant portions of the global population lacking access to digital infrastructure. In the Balkans, initiatives such as Croatia's CroCube and regional STEM programmes demonstrate efforts toward inclusion; however, their scale remains limited due to funding and capacity constraints (Schneegans, Lewis and Straza, 2021; UNESCO, 2023; Oxfam, 2023; World Bank, 2023).

Governance, Institutional Weaknesses, and Partnership Gaps:

Weak institutional frameworks, governance challenges, and insufficient international cooperation continue to hinder progress on SDGs related to Peace, Justice and Strong Institutions, and Partnerships for the Goals. In the Balkans, the absence of national space policies delays integration into broader European space frameworks. Globally, governance challenges include the voluntary nature of debris mitigation guidelines, with approximately 60% compliance among operators, as well as the increasing prevalence of dual-use satellite technologies (European Space Agency, 2021; UN DESA, 2023, United Nations, 2023; European Space Agency, 2023).

The literature underscores the critical role of technological innovation in overcoming these implementation barriers. Space-based solutions, enabled by cost-efficient rocket launches, offer unique advantages, including global coverage for climate monitoring, connectivity for education and healthcare, and data-driven agricultural analytics (Vidmar, 2020).

Cross-sectoral integration is identified as essential for SDG success. For example, satellite-based agricultural solutions require collaboration between governments, farmers, and cooperatives

(SDG 2), while telemedicine applications depend on regulatory frameworks and affordable access to satellite services (SDG 3). Educational initiatives, including CubeSat projects such as Croatia’s CroCube, require collaboration between universities, schools, and space agencies to maximize outreach (Organisation for Economic Co-operation and Development, 2025).

The financing gap, in particular, necessitates innovative funding models, such as blended finance, combining public and private investment. While space startups represent a growing source of capital, the Balkan region’s relatively low R&D investment (approximately 0.1–0.5% of GDP) and reliance on external funding mechanisms continue to limit participation in such models (Dallas *et al.*, 2020; Seraphim Capital, 2022; Seraphim Capital, 2022; Eurostat, 2023).

A converging conclusion of the literature positions space entrepreneurship as a potential catalyst for accelerating SDG implementation through technology-driven solutions. Table 2.1 provides an overview of the identified SDG challenges and the potential contributions of space entrepreneurship in addressing these barriers.

Table 2.1: SDG Progress and Implementation Challenges (2023)

SDG	Progress Status	Key Challenges	Potential Space Contributions
SDG 1	Stalled	\$2.5–\$4T financing gap, 88–115M pushed into poverty	Satellite connectivity for economic inclusion
SDG 3	Slow	600,000 maternal deaths, limited healthcare access	Telemedicine via satellite networks
SDG 4	Slow	260M out of school, \$148B funding gap	CubeSats for STEM education outreach
SDG 5	Regressing	26% female STEM, women remain underrepresented in STEM and the space sector	Inclusive STEM programs, leadership roles

SDG 7	Moderate	733M without electricity, fossil fuel dominance	Satellite data for renewable energy planning
SDG 9	Slow	relatively low R&D investment compared to the EU average	Rocket-driven industrial ecosystems
SDG 10	Regressing	2.9B unconnected, widening wealth gaps	Global internet access via satellite constellations
SDG 13	Regressing	rising emissions	Earth observation, green propulsion technologies
SDG 16	Stalled	Weak governance, space debris risks	Debris mitigation, peaceful space use policies
SDG 17	Slow	Limited cooperation, Balkan policy gaps	Public-private partnerships, technology transfer

Source: Author

2.2.4 The Role of Space Entrepreneurship in SDG Implementation

The literature positions space entrepreneurship as a key enabler of Sustainable Development Goal (SDG) implementation, leveraging advances in rocket technologies and satellite systems to deliver scalable, technology-driven solutions to global challenges. The emergence of reusable launch systems and dedicated small satellite launch services has significantly improved access to space, enabling a broader range of actors to participate in space-based applications (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025).

Commercial launch providers such as SpaceX have demonstrated how reusable rocket systems can increase launch frequency and support the deployment of large satellite constellations. These constellations play a critical role in expanding global connectivity, supporting SDG 10 (Reduced Inequalities), while also enabling applications in climate monitoring (SDG 13), education (SDG 4), and disaster management (Calvin *et al.*, 2023; World Bank, 2023; IPCC, 2023).

Similarly, dedicated small satellite launchers developed by companies such as Rocket Lab and missions supported by the Indian Space Research Organisation facilitate the deployment of

CubeSats and microsatellites for a wide range of applications. These include Earth observation for agriculture (SDG 2), environmental monitoring (SDG 13), and STEM education initiatives (SDG 4), illustrating the versatility of space-based solutions in addressing development challenges.

In addition, increasing attention is being given to the environmental sustainability of space activities. Research into greener propulsion technologies and reusable systems reflects growing efforts to align space operations with SDG 13 (Climate Action), although access to such technologies remains uneven across regions (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025).

Despite these advances, the literature reveals important gaps in the understanding of the socioeconomic and environmental impacts of rocket programmes, particularly in developing and emerging space ecosystems. In the Western Balkans, initiatives such as Montenegro's Luča CubeSat mission and Croatia's CroCube project illustrate early-stage engagement with space technologies, but remain constrained by limited financial resources, restricted access to infrastructure, and shortages of technical expertise (Dallas *et al.*, 2020; Eurostat, 2024).

Furthermore, gender inclusion—central to SDG 5 (Gender Equality)—remains insufficiently explored within the context of space entrepreneurship. While STEM outreach initiatives across the region contribute to increasing awareness and participation, the lack of systematic data and limited representation of women in technical and leadership roles highlight the need for more inclusive approaches (Schneegans, Lewis and Straza, 2021; UNESCO, 2023).

These gaps underscore the need for a more comprehensive analysis of how space entrepreneurship and rocket programmes can support SDG implementation, particularly in

underrepresented regions such as the Western Balkans. Addressing these challenges, including regional capacity building and gender inclusion, represents a central objective of this study.

2.3 The Rise of New Space Entrepreneurship: A Paradigm Shift in the Space Industry

2.3.1 Historical Development and Emergence of New Space

New Space entrepreneurship emerged in the early 2000s as a transformative shift within the space sector, marking a transition from state-led, high-cost programmes toward a more dynamic and market-driven ecosystem characterized by private-sector participation and innovation. Unlike traditional space activities, which were predominantly funded and operated by government agencies such as NASA and the European Space Agency, New Space emphasizes commercial viability, cost efficiency, and faster development cycles (Peeters, 2018; *The Space Economy in Figures*, 2019; Organisation for Economic Co-operation and Development, 2023).

This transition has been accompanied by significant growth in the global space economy, driven in large part by private investment and the emergence of new market segments, including satellite communications, Earth observation, and data-driven services (Brukart, 2024; Organisation for Economic Co-operation and Development, 2025, Morgan Stanley, 2020; Organisation for Economic Co-operation and Development, 2023). Key actors such as SpaceX, Rocket Lab, Planet Labs, and PLD Space have played a central role in shaping this new ecosystem by introducing innovative business models and technologies.

Milestones in the development of New Space include the successful launch of privately funded orbital rockets, the emergence of dedicated small satellite launch services, and the expansion of commercial satellite constellations. These developments have collectively contributed to

increasing access to space and enabling a broader range of actors to participate in space-related activities (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025).

The literature attributes the rise of New Space to a convergence of technological, economic, and regulatory drivers. Technological advancements—including satellite miniaturization, reusable launch systems, and digital technologies such as artificial intelligence—have significantly improved efficiency and reduced barriers to entry. At the same time, the growth of venture capital and private investment has supported the scaling of space startups, while regulatory reforms in more mature space ecosystems have facilitated faster development and commercialization (European Space Agency, 2021; Seraphim Capital, 2022; Organisation for Economic Co-operation and Development, 2025).

Public-private partnerships have further accelerated this transformation by enabling collaboration between governments and commercial actors, reducing financial risk and supporting innovation across the sector. Initiatives led by organizations such as NASA and the European Space Agency demonstrate how institutional support mechanisms can foster the growth of New Space ventures and associated ecosystems.

In the Western Balkans, engagement with New Space remains at an early stage but is gradually developing. Emerging initiatives, including Montenegro's Luča CubeSat mission and Croatia's CroCube project, illustrate initial participation in space-related activities, particularly in the domains of education, research, and capacity building. However, the absence of comprehensive national space policies, limited investment, and restricted access to infrastructure continue to constrain regional development.

Overall, the emergence of New Space represents a paradigm shift that has broadened access to space and enabled new actors to participate in the global space economy. At the same time, significant disparities remain between established and emerging space ecosystems, highlighting the need for targeted policy interventions and regional cooperation—particularly in underrepresented regions such as the Western Balkans.

2.3.2 Key Players and Their Contributions to SDGs

The literature identifies a diverse range of New Space actors whose activities demonstrate how rocket programmes and space technologies contribute to the Sustainable Development Goals (SDGs). These actors span launch providers, satellite operators, data analytics companies, and research-oriented ventures, reflecting the multidimensional nature of the New Space ecosystem.

Leading commercial launch providers, such as SpaceX, have played a central role in expanding access to space through reusable launch systems. These capabilities have enabled the deployment of large satellite constellations that support global connectivity, Earth observation, and scientific missions, contributing to SDG 10 (Reduced Inequalities), SDG 13 (Climate Action), and SDG 4 (Quality Education) (Calvin *et al.*, 2023, World Bank, 2023; IPCC, 2023).

Earth observation companies, including Planet Labs, provide high-frequency satellite imagery used in applications such as agriculture, environmental monitoring, and disaster response, supporting SDG 2 (Zero Hunger) and SDG 13. These services illustrate the growing importance of satellite data in enabling data-driven decision-making across sectors.

Dedicated small satellite launch providers, such as Rocket Lab, enable more flexible and responsive access to space for research institutions, startups, and educational programmes. Their missions support scientific research, innovation, and STEM education, contributing to SDG 4 (Quality Education) and SDG 9 (Industry, Innovation and Infrastructure).

In Europe, emerging private actors such as PLD Space illustrate the role of entrepreneurial ventures in strengthening regional launch capabilities and fostering industrial ecosystems, contributing to SDG 9 and SDG 8 (Decent Work and Economic Growth).

In India, data-driven companies such as SatSure leverage satellite data provided through missions supported by the Indian Space Research Organisation to enhance agricultural planning, risk assessment, and infrastructure monitoring, contributing to SDG 2 and SDG 9.

Emerging ventures in other regions, including companies focused on geospatial analytics and disaster monitoring, further demonstrate the application of satellite technologies in addressing societal challenges such as climate resilience and risk management (SDG 13). Similarly, microgravity research companies such as SpacePharma highlight the role of space-based experimentation in advancing biomedical research, contributing to SDG 3 (Good Health and Well-Being).

In the Western Balkans, participation in the New Space ecosystem is at an early stage but steadily evolving. In Montenegro, Montenegro Space Research has initiated projects such as the Luča CubeSat mission, developed with an estimated budget of approximately €200,000 and launched in 2025, serving as a scientific and educational platform. In Croatia, the CroCube project represents a student-oriented satellite initiative that integrates technological development with STEM outreach and education.

Across the broader region, including Serbia, North Macedonia, and Bosnia and Herzegovina, space-related activities are primarily focused on educational initiatives, digital transformation, and the application of satellite data in sectors such as agriculture. However, these efforts are typically fragmented and supported by limited funding, with a lack of standardized data on their scale and impact.

Overall, these examples demonstrate the diversity of New Space actors and their contributions to multiple SDGs, including SDG 2, SDG 3, SDG 4, SDG 9, SDG 10, and SDG 13. The literature emphasizes the critical role of rocket programmes and launch technologies in enabling these activities by providing access to space infrastructure. However, the socioeconomic impact of these developments remains uneven, particularly in emerging regions such as the Western Balkans, where structural constraints—including limited investment, restricted access to launch services, and shortages of technical expertise—continue to limit participation. This gap represents an important focus of this study.

2.3.3 Drivers of New Space Entrepreneurship Success

The literature identifies several key drivers that have contributed to the rapid growth of New Space entrepreneurship, enabling it to reshape the space industry and support the achievement of the Sustainable Development Goals (SDGs).

Venture Capital and Private Investment: The expansion of private investment has played a central role in accelerating innovation and enabling the commercialization of space activities. Increased availability of venture capital has supported the development of launch systems, satellite technologies, and downstream applications. In Europe, emerging companies such as PLD Space illustrate how targeted investment can foster industrial development. In contrast, in the Western Balkans, space-related initiatives are typically supported through comparatively modest project-based funding, often at the level of several hundred thousand euros. Projects such as Montenegro's Luča CubeSat and Croatia's CroCube reflect this trend, highlighting both regional potential and financial constraints. This aligns with broader patterns of lower research and development investment relative to the European Union average (Dallas *et al.*, 2020; Organisation for Economic Co-operation and Development, 2025).

Public-Private Partnerships: Collaboration between public institutions and private companies has been instrumental in reducing financial risk and enabling large-scale space projects. Programmes led by organizations such as NASA and the European Space Agency demonstrate how coordinated funding mechanisms and institutional support can facilitate technological development and market entry. In the Western Balkans, early forms of such partnerships are emerging, with initiatives supported through combinations of national funding and European programmes, although these remain limited in scale and institutional maturity.

Technological Advancements and Innovation: Advances in key technologies—including reusable launch systems, satellite miniaturization, and digital technologies such as artificial intelligence—have significantly transformed the space sector. Companies such as SpaceX and Rocket Lab have demonstrated how innovation can reduce barriers to entry and expand access to space. In the Western Balkans, early-stage technological efforts, including propulsion research and small satellite development, indicate emerging capabilities, although these remain constrained by limited access to advanced infrastructure and expertise (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025).

Regulatory Reforms and Policy Support: Efficient regulatory frameworks play a crucial role in enabling the growth of New Space ventures. Streamlined licensing procedures and supportive policy environments can accelerate project development and improve competitiveness. While more mature space ecosystems have established regulatory mechanisms, countries in the Western Balkans generally lack comprehensive national space policies, which limits institutional development and integration into broader European space programmes (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025).

Market Demand and Societal Needs: Growing demand for space-based services, including satellite communications, Earth observation, and data-driven applications, continues to drive the expansion of the New Space sector. These services support a wide range of SDG-related applications, including connectivity (SDG 10), climate monitoring (SDG 13), agriculture (SDG 2), and education (SDG 4). In the Western Balkans, interest in such applications is increasing, particularly in the areas of education and digital transformation; however, limited infrastructure and funding constrain the ability to fully respond to this demand (Organisation for Economic Co-operation and Development, 2025; World Bank, 2023; Organisation for Economic Co-operation and Development, 2023).

Collectively, these drivers have contributed to lowering barriers to entry and enabling the expansion of New Space entrepreneurship. However, the literature highlights that their impact remains uneven, with developing regions such as the Western Balkans facing structural constraints that limit their ability to fully benefit from these dynamics. Addressing these disparities requires strengthened policy frameworks, increased investment, and enhanced international cooperation.

2.3.4 Challenges Facing New Space Entrepreneurship

Despite its rapid growth and transformative potential, New Space entrepreneurship faces a range of structural, regulatory, and technological challenges that influence its alignment with the Sustainable Development Goals (SDGs), particularly in developing regions such as the Western Balkans. The literature identifies several key obstacles.

High Financial Entry Barriers: The development of rocket programmes and associated infrastructure requires substantial financial investment, creating significant barriers to entry for emerging space actors. While leading space companies operate with large-scale funding and

access to capital, initiatives in the Western Balkans are typically supported through comparatively limited project-based funding, often relying on national resources and European support mechanisms. This disparity reflects broader regional trends, where research and development investment remains below the European Union average (Dallas *et al.*, 2020; European Space Agency, 2021; European Space Agency, 2024).

Regulatory Inconsistencies and Delays: Complex and fragmented regulatory environments can slow down the development of space activities, particularly in Europe. Licensing procedures, coordination requirements, and institutional fragmentation create challenges for startups seeking to scale operations. In contrast, more streamlined regulatory frameworks in other regions illustrate the importance of efficient governance structures. In the Western Balkans, the absence of comprehensive national space policies further limits the development of domestic space sectors and complicates integration into European programmes (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

Space Debris and Orbital Sustainability: The growing number of objects in orbit presents increasing risks to long-term sustainability and safe operations in space. International guidelines, developed under the United Nations framework, promote responsible behaviour, including debris mitigation and post-mission disposal. However, implementation remains inconsistent, and regulatory frameworks in emerging regions, including the Western Balkans, remain underdeveloped (European Space Agency, 2021; UN DESA, 2023; European Space Agency, 2023; United Nations, 2023).

Environmental Impact of Rocket Launches: Environmental concerns associated with rocket launches, including emissions and lifecycle impacts, present additional challenges for aligning

space activities with SDG 13 (Climate Action). While advances in reusable launch systems and research into greener propulsion technologies aim to reduce environmental impact, access to these innovations remains uneven, particularly in developing regions that rely on external launch providers (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

Workforce Diversity and Gender Disparities: Gender imbalance remains a persistent challenge within the space sector, limiting progress toward SDG 5 (Gender Equality). Barriers related to access to STEM education, career advancement, and leadership opportunities continue to affect participation. In the Western Balkans, initiatives such as CroCube and other STEM outreach programmes demonstrate efforts to promote inclusion, but their scale and impact remain constrained by limited resources and the absence of systematic data on participation (Schneegans, Lewis and Straza, 2021; UNESCO, 2023).

Inequitable Access to Space Benefits: Access to space infrastructure and services remains unevenly distributed, with a small number of spacefaring nations dominating launch capabilities and technological development. Emerging regions, including the Western Balkans, remain dependent on external providers, limiting their ability to fully benefit from space-based services and participate in the global space economy (Brukart, 2024; Organisation for Economic Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023; Morgan Stanley, 2020).

The literature emphasizes that addressing these challenges requires a combination of technological innovation, effective governance, and inclusive policy frameworks. Advances in sustainable propulsion, improved regulatory coordination, and strengthened international

collaboration are identified as key enablers. At the same time, inclusive approaches—such as expanding STEM education and supporting underrepresented groups—are essential for ensuring broader participation.

However, there remains a lack of detailed analysis on how these solutions can be effectively implemented in resource-constrained regions such as the Western Balkans. Addressing this gap represents a central focus of this study.

Table 2.2 summarizes the drivers and challenges of New Space Entrepreneurship (Source: Author).

Table 2.2: Drivers and Challenges of New Space Entrepreneurship, source: Author

Category	Drivers	Challenges
Financial	\$47.4B venture capital (2021), \$15B for launches	\$1–\$5B rocket development costs, Balkan funding gaps (€500,000–€1M)
Technological	90% cost reduction (\$2,000/kg, \$100,000 satellites), reusable rockets	Space debris (27,000 objects, \$707M costs), emissions (approximately 400 tons CO ₂ /launch)
Regulatory	U.S. FAA Part 450 (6-month approvals), ESA frameworks	6–12 month delays in Europe (€1–€5M costs), no Balkan space policies
Economic	Market demand (10,000 satellites by 2030), \$252B climate losses	Inequitable access (80% launches by U.S./China), Balkan reliance on foreign providers
Social	Public-private partnerships (NASA \$8B, ESA €120M)	Gender disparities (20% women in space, 15% rocket engineering)

(Source: Author)

2.4 Rocket Programmes: The Backbone of New Space Entrepreneurship

2.4.1 Historical Evolution of Rocket Programmes and Technologies

Rocket programmes and technologies have undergone a profound transformation since the Apollo era (1960s–1970s), when state-led, single-use launch systems dominated space exploration. Early programmes, led primarily by national space agencies such as NASA, were characterized by high costs, limited launch frequency, and a strong focus on scientific and geopolitical objectives.

The transition toward modern launch systems began in the early 2000s with the emergence of private space companies. Firms such as SpaceX introduced new design philosophies centered on reusability, operational efficiency, and commercial viability. The successful development of vehicles such as Falcon 1 and Falcon 9 marked a turning point, demonstrating the feasibility of privately funded orbital launch systems and contributing to a shift toward more frequent and cost-efficient access to space (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023; European Space Agency, 2024).

This transformation was further reinforced by the emergence of specialized launch providers. Companies such as Rocket Lab developed dedicated small satellite launchers, enabling more flexible and responsive access to space for research institutions and commercial actors. In Europe, initiatives led by companies such as PLD Space reflect growing efforts to establish competitive launch capabilities within the small launcher segment.

In parallel, national space agencies such as the Indian Space Research Organisation have demonstrated how sustained institutional investment and cost-efficient approaches can support participation in the global launch market, even under resource constraints.

In the Western Balkans, rocket technology development remains in its early stages. Initial efforts, such as Montenegro's emerging propulsion research initiatives and the development of the Luča CubeSat mission, illustrate growing interest in space technologies and represent foundational steps toward building regional capabilities. In Croatia, projects such as CroCube further demonstrate engagement with satellite technologies, particularly through educational and research-oriented activities.

Overall, the evolution of rocket programmes has contributed to the gradual democratization of access to space, enabling a broader range of actors—including startups, universities, and emerging regions—to participate in the space economy. However, structural challenges such as limited funding, lack of infrastructure, and the absence of comprehensive policy frameworks continue to constrain the pace of development in regions such as the Western Balkans, highlighting a key gap addressed in this study.

2.4.2 Key Trends in Rocket Technology Development

The literature identifies several transformative trends in rocket technology development that have reshaped New Space entrepreneurship and its contributions to the Sustainable Development Goals (SDGs).

Reusable Launch Vehicles: The development of reusable rocket systems, pioneered by companies such as SpaceX, represents a major shift in launch economics. By enabling multiple uses of launch vehicles, reusability has contributed to reducing the cost of access to space and increasing launch frequency. Similar approaches are being explored by other actors, including Rocket Lab and European initiatives such as Ariane Next and PLD Space, reflecting a broader transition toward more efficient and sustainable launch systems (European Space Agency, 2021;

Organisation for Economic Co-operation and Development, 2025; European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

Lightweight and Small Satellite Launchers: The growing demand for small satellites has driven the development of dedicated launch systems optimized for CubeSats and microsatellites. Launch vehicles such as Rocket Lab's Electron and those developed by the Indian Space Research Organisation enable more flexible and responsive access to space for research institutions, startups, and educational programmes. These systems support applications related to education (SDG 4), climate monitoring (SDG 13), and digital infrastructure, contributing to the expansion of the space economy.

Green Propulsion Technologies: Increasing attention to the environmental impact of space activities has accelerated research into more sustainable propulsion systems. Efforts include the development of methane-based engines, reusable launch technologies, and alternative propulsion concepts aimed at reducing emissions and improving efficiency. European initiatives, such as ESA's Prometheus programme, illustrate ongoing efforts to align space activities with SDG 13 (Climate Action) through more sustainable technological solutions (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

These trends have collectively lowered barriers to entry and expanded participation in the space sector, enabling startups, universities, and emerging space actors to engage in space activities and develop SDG-aligned applications.

However, the adoption of these technologies remains uneven. In emerging regions such as the Western Balkans, limited financial resources, restricted access to advanced technologies, and reliance on external launch providers constrain the ability to fully benefit from these

developments. As a result, while global trends point toward increased accessibility and sustainability, regional disparities persist—an issue further explored in this study through case studies and comparative analysis (Dallas *et al.*, 2020; Organisation for Economic Co-operation and Development, 2025; Eurostat, 2024; Organisation for Economic Co-operation and Development, 2023).

2.4.3 Case Studies of Rocket Technology Applications

The literature provides a range of case studies illustrating how rocket programmes enable New Space ventures to contribute to the Sustainable Development Goals (SDGs), across both global and emerging space ecosystems.

In the United States, reusable launch systems developed by SpaceX, particularly the Falcon 9 rocket, have significantly increased launch frequency and enabled the deployment of large-scale satellite constellations. These systems support applications such as global connectivity, Earth observation, and scientific research, contributing to SDG 10 (Reduced Inequalities), SDG 13 (Climate Action), and SDG 4 (Quality Education) through the deployment of communication satellites and educational payloads (World Bank Group, 2016; Calvin *et al.*, 2023, World Bank, 2023; IPCC, 2023).

Similarly, Rocket Lab’s Electron launch vehicle represents a key example of a dedicated small satellite launcher, supporting scientific missions, commercial applications, and educational CubeSat programmes. These missions contribute to expanding access to space and fostering innovation in emerging sectors, aligning with SDG 9 (Industry, Innovation and Infrastructure) and SDG 4 (Quality Education).

In India, launch vehicles developed by the Indian Space Research Organisation, including PSLV and SSLV, demonstrate how sustained institutional investment can support both commercial and

societal applications. These include satellite-enabled services for agriculture, disaster management, and infrastructure development, contributing to SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 9.

In Europe, emerging launch providers such as PLD Space illustrate the role of private actors in strengthening regional launch capabilities and fostering industrial ecosystems. These initiatives contribute to technological development and economic activity, supporting SDG 9 and SDG 8 (Decent Work and Economic Growth).

In the Western Balkans, early-stage initiatives highlight growing engagement with space technologies. Montenegro's Luča satellite mission, developed with an estimated budget of approximately €200,000 and launched in 2025, represents a significant milestone as a scientific and educational CubeSat platform. In Croatia, the CroCube project demonstrates how small satellite missions can be integrated into educational and research frameworks, contributing to STEM engagement and capacity building.

Beyond Europe, Brazil's VLM-1 programme represents an example of an emerging national launch initiative aimed at supporting small satellite missions and fostering regional industrial development, with potential relevance as a comparative model for other developing regions.

These case studies collectively illustrate the transformative role of rocket programmes in enabling New Space ventures to address SDG-related challenges, including connectivity (SDG 10), climate monitoring (SDG 13), education (SDG 4), and industrial development (SDG 9). However, the literature also highlights that developing regions—such as the Western Balkans—face persistent barriers related to limited financial resources, restricted access to launch infrastructure, and shortages of technical expertise, underscoring the importance of international collaboration, policy development, and capacity-building initiatives (Dallas *et al.*,

2020; Organisation for Economic Co-operation and Development, 2025; Eurostat, 2024; Organisation for Economic Co-operation and Development, 2023).

2.4.4 Europe's Pursuit of Launch Independence

Europe's pursuit of autonomous access to space has intensified in response to geopolitical developments in the early 2020s, including the disruption of cooperation with Russian launch providers and increased reliance on commercial actors such as SpaceX. In this context, the European Space Agency and European institutions have prioritized the development of independent launch capabilities as a strategic objective.

Key programmes supporting this objective include Ariane 6, Vega-C, and the planned Ariane Next. Ariane 6 represents Europe's next-generation heavy-lift launch system, designed to ensure reliable access to space for institutional and commercial missions. Vega-C complements this capability by targeting smaller payloads, including scientific and educational satellites, while Ariane Next reflects longer-term ambitions to incorporate reusability and more cost-efficient technologies.

These programmes contribute to SDG 9 (Industry, Innovation and Infrastructure) by supporting the development of industrial ecosystems, technological capabilities, and strategic autonomy. They also enable SDG-aligned applications, including Earth observation for climate monitoring (SDG 13) and missions supporting research and education (SDG 4).

Despite these efforts, Europe faces several structural challenges. Cost competitiveness remains a key concern in comparison to leading commercial launch providers, while programme delays and technical setbacks have affected reliability and market positioning. In addition, the environmental impact of launch activities and the need for sustainable propulsion solutions have become increasingly important considerations within the European space strategy (European

Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

Furthermore, development timelines for next-generation systems highlight the complexity of maintaining competitiveness in a rapidly evolving global market. While reusable launch technologies are being explored, their large-scale implementation in Europe remains ongoing.

From a broader perspective, Europe's pursuit of launch independence strengthens its strategic autonomy and its ability to support SDG-aligned missions. However, high costs, regulatory complexity, and limited launch availability may reduce accessibility for developing regions, including the Western Balkans, which remain dependent on external providers.

The literature suggests that enhanced collaboration, technology transfer, and institutional support mechanisms could help bridge this gap. In this context, models from other space ecosystems illustrate how coordinated approaches may enable emerging regions to benefit more effectively from global space developments, although their application in the Western Balkans remains insufficiently explored.

2.4.5 Rocket Technology Development in the Balkans

In the Western Balkans, rocket technology development remains at an early stage, reflecting the region's nascent space ecosystem and broader structural constraints. Nevertheless, several emerging initiatives indicate growing interest and potential for future development.

In Montenegro, activities led by Montenegro Space Research focus on early-stage propulsion research and small satellite development. The Luča CubeSat mission—developed with an estimated budget of approximately €200,000 and launched in 2025—represents a significant milestone for the country, serving primarily as a scientific and educational platform. In parallel,

initial efforts in rocket propulsion research illustrate ambitions to develop lightweight launch capabilities for small satellite missions, positioning Montenegro as a potential regional contributor to space technology development.

In Croatia, the CroCube project represents a notable example of a student-oriented satellite initiative, integrating technological development with educational outreach. As a CubeSat mission, CroCube supports hands-on learning in areas such as satellite design, mission operations, and data utilization, contributing to the strengthening of STEM education and research capacity.

Despite these developments, the scalability of such initiatives remains constrained by structural challenges, including limited financial resources, dependence on foreign launch providers, and restricted access to advanced technologies and expertise. In addition, the absence of comprehensive national space policies and coordinated regional frameworks further limits integration into broader European space programmes (*Key figures on Europe – 2025 edition*, 2025, European Commission, 2023; Eurostat, 2024).

The literature suggests that while these initiatives demonstrate the region's potential to participate in the global space economy, sustained progress will depend on stronger institutional support, increased investment, and enhanced regional coordination. Building on this, this study explores the potential of a coordinated regional approach—such as a Balkan Space Consortium—as a mechanism to strengthen collaboration, pool resources, and support the development of space technologies and infrastructure across the region.

2.4.6 Challenges and Opportunities for Rocket Programmes

Rocket programmes face several structural and technological challenges that influence their alignment with the Sustainable Development Goals (SDGs), particularly in developing regions

such as the Western Balkans, where domestic launch capabilities and supporting infrastructure remain underdeveloped.

High Development Costs: The development of rocket systems requires substantial financial investment, often reaching levels that are not accessible to most developing economies. This creates significant entry barriers and limits the ability of smaller nations to develop indigenous launch capabilities. As a result, countries in the Western Balkans rely on externally funded projects and partnerships, which constrains scalability and long-term sustainability (European Space Agency, 2021; Chebukhanova and Zimakov, 2022; Chebukhanova & Zimakov, 2022; European Space Agency, 2024).

Space Debris and Orbital Sustainability: The increasing concentration of objects in orbit raises concerns related to collision risks, long-term sustainability, and governance, with implications for SDG 16 (Peace, Justice and Strong Institutions). Although international guidelines developed under the United Nations framework promote responsible behavior in space, their implementation remains inconsistent, particularly in emerging space ecosystems (European Space Agency, 2021; UN DESA, 2023; European Space Agency, 2023; United Nations, 2023).

Environmental Impact: Rocket launches contribute to environmental concerns, particularly in relation to emissions and sustainability. While emerging technologies such as reusable launch systems and research into greener propulsion solutions aim to reduce environmental impact, their adoption remains uneven across regions, with developing countries facing limited access to such innovations (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

Balkan-Specific Constraints: In the Western Balkans, structural limitations—including comparatively low levels of research and development investment, ongoing challenges related to human capital, and dependence on foreign launch providers—restrict the development of domestic space capabilities. Projects such as Montenegro’s Luča satellite mission and Croatia’s CroCube illustrate early-stage engagement, but their scale remains constrained by financial and institutional factors (*Key figures on Europe – 2025 edition*, 2025, Eurostat, 2024).

Despite these challenges, several opportunities can support the development of rocket programmes and their alignment with the SDGs:

Green Propulsion Technologies: Advances in sustainable propulsion systems, including reusable and lower-emission technologies, offer pathways for reducing the environmental impact of launches and aligning space activities with SDG 13 (Climate Action).

Technology Transfer and International Cooperation: Models of collaboration observed in more advanced space ecosystems demonstrate how knowledge sharing, partnerships, and institutional support can enable emerging regions to develop capabilities and participate more actively in the global space economy (Organisation for Economic Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023).

Regional Cooperation Frameworks: Building on these approaches, this study explores the potential of coordinated regional initiatives—such as a Balkan Space Consortium—as a mechanism to pool resources, strengthen institutional capacity, and support the development of space-related infrastructure and innovation ecosystems, contributing to SDG 9 (Industry, Innovation and Infrastructure) and SDG 17 (Partnerships for the Goals).

The literature highlights that while these opportunities exist, there is a lack of detailed analysis regarding their applicability in developing regions, particularly in the Western Balkans. This

study addresses this gap through the integration of regional case studies and policy-oriented recommendations.

2.5 Contributions of Space Entrepreneurship to Specific SDGs

2.5.1 SDG 2: Zero Hunger

New Space ventures increasingly leverage satellite data and Earth observation technologies to enhance agricultural productivity, contributing to SDG 2 (Zero Hunger). Satellite-based solutions enable precision agriculture by supporting crop monitoring, resource optimization, and data-driven decision-making, improving efficiency and resilience in food production systems (Organisation for Economic Co-operation and Development, 2025; World Bank, 2023; Organisation for Economic Co-operation and Development, 2023).

Companies such as Planet Labs provide high-frequency satellite imagery that supports agricultural analytics, while data-driven platforms developed in collaboration with space agencies and private actors demonstrate the growing role of space technologies in modern farming. Similarly, initiatives associated with the Indian Space Research Organisation illustrate how satellite data can be applied to support agricultural planning, monitoring, and risk management.

In the Western Balkans, Serbia's AgroSense platform, developed by the BioSense Institute, represents a notable example of the application of satellite data and digital tools in agriculture. The platform supports crop monitoring and farm-level decision-making and forms part of broader efforts toward digital transformation in the agricultural sector. However, standardized and publicly available data on its quantitative impact remain limited.

These applications depend on access to launch services and satellite infrastructure, which enable the deployment and operation of Earth observation systems. While global actors benefit from established launch capabilities, emerging regions such as the Western Balkans remain dependent on external providers, which constrains scalability and limits the broader adoption of space-based agricultural solutions.

The literature highlights that space-based technologies have significant potential to support food security and sustainable agriculture. However, unequal access to infrastructure, funding, and technical expertise continues to limit their impact in developing regions, emphasizing the need for increased collaboration, technology transfer, and institutional support.

2.5.2 SDG 3: Good Health and Well-Being

Space-based technologies increasingly contribute to improving healthcare systems and supporting SDG 3 (Good Health and Well-Being), particularly through satellite-enabled connectivity and microgravity research. Satellite communication systems enable telemedicine services in remote and underserved regions, improving access to healthcare and supporting more inclusive health systems (Organisation for Economic Co-operation and Development, 2025, World Bank, 2023; Organisation for Economic Co-operation and Development, 2023).

Commercial constellations developed by companies such as SpaceX demonstrate the potential of satellite connectivity to support digital health services, including remote consultations, medical data exchange, and emergency response coordination. In parallel, microgravity research conducted by private companies, such as SpacePharma, highlights the role of space-based experimentation in advancing biomedical research, including studies related to disease mechanisms and drug development.

These developments are enabled by increased access to launch services and the growing availability of commercial space infrastructure. However, in emerging regions such as the Western Balkans, limited financial resources, restricted access to launch opportunities, and the absence of indigenous space capabilities constrain the ability to fully leverage space technologies for healthcare applications.

As a result, while space-based innovations offer significant potential for improving health outcomes and reducing inequalities, their impact remains uneven across regions. Expanding access through international collaboration, technology transfer, and regional initiatives could help address these disparities and strengthen the contribution of space technologies to SDG 3.

2.5.3 SDG 4: Quality Education

CubeSat missions and small satellite programmes have emerged as important tools for advancing STEM education, directly contributing to SDG 4 (Quality Education). These platforms enable students and educational institutions to engage in hands-on learning experiences related to satellite design, data analysis, and space systems engineering, thereby fostering practical skills and interdisciplinary knowledge (Organisation for Economic Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023; National Aeronautics and Space Administration).

A notable example is Croatia's CroCube project, which illustrates how small satellite missions can be integrated into educational frameworks to support student engagement and public outreach. Through activities such as satellite development, mission operations, and data utilization, such initiatives contribute to increasing interest in STEM fields and building foundational competencies in aerospace-related disciplines.

Globally, programmes such as NASA’s CubeSat Launch Initiative (CSLI), as well as missions supported by Rocket Lab and Indian Space Research Organisation, demonstrate how access to space can enhance educational opportunities. These initiatives enable universities and research institutions to design and operate satellites, supporting both educational outcomes and scientific research, including applications related to climate monitoring and space science.

In the Western Balkans, space and STEM initiatives remain limited in scale and are typically supported through fragmented, project-based funding rather than comprehensive national programmes. In Montenegro, the Luča satellite mission, launched in December 2025, has been positioned both as a technological milestone and as an educational platform, with its data intended for use in student engagement and research activities. Across the region, including in North Macedonia and Bosnia and Herzegovina, STEM initiatives are present but lack standardized reporting on participation and measurable outcomes.

This reflects broader structural constraints, as investment in research and development remains comparatively low relative to the European Union average (*Key figures on Europe – 2025 edition*, 2025; Eurostat, 2024). As a result, while CubeSat initiatives contribute to democratizing access to space technologies and enhancing STEM education, emerging regions such as the Western Balkans continue to face barriers related to funding, expertise, and access to launch services.

The literature suggests that technology transfer, international collaboration, and regional cooperation mechanisms could play a key role in expanding access to such initiatives. Building on this, this study explores the potential of coordinated regional approaches, such as a Balkan Space Consortium, to strengthen educational capacity, support CubeSat development, and enhance participation in space-related STEM activities.

2.5.4 SDG 5: Gender Equality

Gender equality in STEM and the space sector remains a significant challenge, with persistent underrepresentation of women in technical and engineering roles reflecting broader systemic barriers that hinder progress toward SDG 5 (Gender Equality) (Schneegans, Lewis and Straza, 2021) (United Nations Educational, Scientific and Cultural Organization, 2023; United Nations Office for Outer Space Affairs, 2024). New Space entrepreneurship presents opportunities to address these disparities through STEM outreach, inclusive policies, and increased visibility of female leadership. However, the literature identifies important gaps in both research and implementation, particularly in emerging regions such as the Western Balkans.

Globally, space agencies and private actors have introduced initiatives aimed at promoting gender inclusion. Programmes led by organizations such as the European Space Agency and NASA focus on increasing participation in STEM fields, supporting career development, and encouraging diversity within the space workforce. Similarly, initiatives associated with the Indian Space Research Organisation highlight the role of outreach and education in fostering broader inclusion in science and engineering disciplines (Schneegans, Lewis and Straza, 2021; Organisation for Economic Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023; UNESCO, 2023).

In the Western Balkans, space and STEM initiatives are primarily implemented through small-scale, project-based activities, with limited availability of standardized data on participation and outcomes. In Croatia, projects such as CroCube include educational and outreach components aimed at engaging students and the broader public, although consistent data on gender participation remain limited. In Montenegro, the Luča satellite mission has been positioned not only as a technological milestone but also as an educational platform supporting

student engagement and research activities. Similar patterns are observed across the region, including in North Macedonia and Bosnia and Herzegovina, where STEM initiatives exist but remain fragmented and lack comprehensive reporting.

Overall, while these initiatives contribute to promoting inclusion and interest in STEM fields, the absence of systematic, gender-disaggregated data limits the ability to assess their impact on SDG 5. The literature further highlights that women continue to face barriers in access to technical roles, leadership positions, and funding within the space sector.

Opportunities for advancing gender inclusion include expanding STEM outreach initiatives, strengthening institutional support mechanisms, and promoting more inclusive policy frameworks. Building on this, the potential for regional cooperation—such as through a Balkan Space Consortium—could provide a platform for prioritizing inclusive participation and supporting female-led initiatives, contributing to both SDG 5 and SDG 17.

Despite these developments, there remains a notable lack of region-specific research on gender dynamics within emerging space ecosystems, particularly in the Western Balkans. This study addresses this gap through the integration of case studies and qualitative insights from interviews with female leaders and practitioners in the space sector.

2.5.5 SDG 9: Industry, Innovation, and Infrastructure

New Space entrepreneurship plays a significant role in driving industrial ecosystems, fostering innovation, and supporting economic growth, directly contributing to SDG 9 (Industry, Innovation and Infrastructure). Technological advancements in launch systems, satellite platforms, and supporting infrastructure have reduced barriers to entry and enabled a growing number of actors to participate in the space economy. In particular, reductions in launch costs and increased launch frequency have supported the expansion of commercial space activities and

downstream applications (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023; European Space Agency, 2024).

Emerging launch providers, such as PLD Space, illustrate how targeted investment and institutional support can contribute to the development of national space capabilities and industrial ecosystems. Similarly, reusable launch systems developed by companies such as SpaceX have transformed the launch market by enabling frequent and more cost-efficient access to space, supporting innovation and the growth of commercial services. In parallel, national space programmes, including those led by Indian Space Research Organisation, demonstrate how sustained investment and institutional coordination can contribute to the development of domestic space industries and broader economic benefits.

In the Western Balkans, space and STEM initiatives are generally characterized by modest financial resources and early-stage development, limiting their immediate economic impact but contributing to longer-term capacity building. In Montenegro, projects such as early-stage rocket propulsion research and the Luča CubeSat mission—developed with an estimated budget of approximately €200,000—represent foundational steps toward building national capabilities in space technologies and innovation ecosystems. In Croatia, initiatives such as CroCube combine technological development with educational outreach, contributing to research and educational infrastructure. In Serbia, data-driven and satellite-supported initiatives in sectors such as agriculture demonstrate the application of advanced technologies in industry, while in North Macedonia, STEM programmes support skills development and human capital formation.

Overall, while these initiatives indicate growing regional engagement with space and STEM domains, their scale remains constrained by comparatively low levels of research and

development investment relative to the European Union average (*Key figures on Europe – 2025 edition*, 2025; Eurostat, 2024).

The literature emphasizes that rocket programmes, associated technologies, and satellite applications are key drivers of industrial growth and innovation. However, structural constraints in emerging regions—such as limited investment, restricted access to advanced technologies, and reliance on external partners—continue to limit the pace and scale of development.

2.5.6 SDG 10: Reduced Inequalities

Satellite constellations play an increasingly important role in addressing global digital divides by improving connectivity and access to information, thereby contributing to SDG 10 (Reduced Inequalities). Space-based communication systems enable internet access in remote and underserved areas, supporting education, healthcare, and economic inclusion (Organisation for Economic Co-operation and Development, 2025; World Bank, 2023; Organisation for Economic Co-operation and Development, 2023).

Commercial initiatives, including large-scale satellite constellations developed by companies such as SpaceX, demonstrate the potential of space technologies to expand connectivity and reduce disparities in access to digital infrastructure.

In the Western Balkans, emerging initiatives such as Croatia’s CroCube and Montenegro’s Luča satellite project reflect growing engagement with space technologies, particularly in relation to educational access, capacity building, and awareness. While these projects operate at a smaller scale, they contribute to reducing knowledge gaps and fostering inclusion within the region.

However, the literature highlights persistent inequalities in access to space infrastructure and launch capabilities, which remain concentrated among a limited number of established

spacefaring nations. This imbalance constrains the ability of emerging regions, including the Western Balkans, to fully benefit from space-based services.

Mechanisms such as technology transfer and international cooperation—illustrated by models of collaboration in more advanced space ecosystems—have the potential to reduce these disparities. Nevertheless, detailed analyses of how such approaches can be effectively implemented in developing regions remain limited.

2.5.7 SDG 13: Climate Action

Space-based technologies, particularly Earth observation satellites, play a critical role in supporting climate action by enabling environmental monitoring, disaster management, and data-driven policymaking, directly contributing to SDG 13 (Climate Action). Satellite systems provide essential data for tracking climate change, managing natural resources, and improving early warning systems for extreme weather events (European Space Agency, 2021; Calvin *et al.*, 2023; IPCC, 2023; European Space Agency, 2024).

Launch vehicles developed by commercial and institutional actors, including SpaceX and European launch systems such as Vega, facilitate the deployment of Earth observation satellites that support these applications. At the same time, the environmental impact of rocket launches has become an increasing concern within the literature, particularly in relation to emissions and the long-term sustainability of space activities (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

Emerging technologies, including reusable launch systems and research into greener propulsion solutions such as ESA's Prometheus programme, reflect ongoing efforts to

reduce the environmental footprint of space activities and align the sector more closely with climate-related objectives.

In the Western Balkans, emerging initiatives such as Montenegro's Luča satellite project illustrate growing engagement with space technologies, particularly in scientific research and educational applications. However, limited access to advanced technologies and reliance on external launch providers constrain the ability of the region to actively contribute to and shape sustainable space practices.

2.5.8 SDG 16: Peace, Justice, and Strong Institutions

Challenges related to space debris, orbital congestion, and the dual-use nature of satellite technologies raise important governance and security concerns, directly affecting SDG 16 (Peace, Justice, and Strong Institutions). The increasing density of objects in orbit elevates collision risks and complicates the sustainable management of space activities, while the dual-use character of many space systems introduces regulatory and geopolitical complexities (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; European Space Agency, 2023; United Nations, 2023; Organisation for Economic Co-operation and Development, 2023).

International frameworks, particularly those developed under the United Nations through the Committee on the Peaceful Uses of Outer Space (COPUOS), provide guidelines for responsible behavior in space, including debris mitigation and transparency measures. In parallel, the European Space Agency has established best practices and technical standards to support safer and more sustainable operations.

However, these frameworks remain largely non-binding, and their implementation varies across regions. In emerging space ecosystems such as the Western Balkans, limited institutional capacity and underdeveloped regulatory frameworks further constrain the ability to effectively address these challenges.

2.5.9 SDG 17: Partnerships for the Goals

Partnerships between public institutions, private companies, and international organizations play a central role in advancing New Space activities and supporting SDG 17 (Partnerships for the Goals). Collaborative frameworks led by organizations such as the European Space Agency, NASA, and Indian Space Research Organisation demonstrate how coordinated efforts between public and private actors can accelerate technological development, reduce risks, and expand access to space-based services (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023; European Space Agency, 2024).

These partnerships enable knowledge transfer, resource sharing, and the scaling of space-related applications aligned with the SDGs. However, in emerging regions such as the Western Balkans, the development of effective partnerships is constrained by limited institutional capacity and the absence of comprehensive national space policies.

The literature suggests that enhanced regional cooperation could improve participation in the space sector. Building on this, this study explores the potential of a regional framework, such as a Balkan Space Consortium, as a mechanism to strengthen partnerships, improve coordination, and facilitate more inclusive participation in the global space economy.

2.6 Enabling and Inhibiting Factors

The success of New Space entrepreneurship in contributing to the Sustainable Development Goals (SDGs) hinges on a complex interplay of enabling and inhibiting factors that shape its capacity to deliver scalable, technology-driven solutions. These factors operate within the innovation ecosystem framework, encompassing actors (startups, space agencies, universities, investors), resources (technological, financial, human, data), and institutions (policies, regulations, standards) across global, European, and Balkan contexts (Lamine *et al.*, 2021; Lamine et al., 2021). This section provides an in-depth analysis of the enabling factors that have propelled New Space's growth and the inhibiting factors that pose significant challenges, particularly for developing regions like the Balkans signal emerging potential. The analysis draws on over 50 sources, including academic literature, industry reports, policy documents, and web-based data, to explore how these factors influence SDG 5 (Gender Equality), SDG 9 (Industry, Innovation, and Infrastructure), and broader SDG alignment, addressing gaps in the Concept Paper (CP), Literature Review (LR), and Research Proposal (RP).

2.6.1 Enabling Factors

The rise of New Space entrepreneurship and its contributions to the SDGs are driven by several key enabling factors that have lowered barriers to entry, accelerated innovation, and facilitated the scaling of space-based solutions. These factors are deeply interconnected, operating within the innovation ecosystem to create a conducive environment for startups, space agencies, and developing regions to participate in the global space economy (Morgan Stanley, 2020).

2.6.1.1 Financial Investment and Venture Capital

Significant private investment has been a cornerstone of New Space growth, providing the financial capital necessary to develop and scale rocket programmes, satellite systems, and associated infrastructure, as well as SDG-aligned applications. Global investment in the space sector has increased substantially in recent years, reflecting growing confidence in its commercial potential and long-term economic relevance (Seraphim Capital, 2022; Organisation for Economic Co-operation and Development, 2025; Seraphim Capital, 2022; Organisation for Economic Co-operation and Development, 2023).

Private capital has enabled the emergence of new launch providers and satellite operators, contributing to reductions in the cost of access to space and supporting applications such as satellite connectivity and Earth observation. These developments have facilitated the expansion of services addressing SDG 10 (Reduced Inequalities) and SDG 2 (Zero Hunger), particularly through improved connectivity and data-driven agriculture (Organisation for Economic Co-operation and Development, 2025; World Bank, 2023; Organisation for Economic Co-operation and Development, 2023).

In Europe, the European Space Agency supports investment and commercialization through programmes such as ESA Business Incubation Centres (ESA BICs), the Accelerator, and initiatives like Boost!, which provide co-funding and technical support to emerging launch companies, including PLD Space. These mechanisms contribute to industrial development and innovation, aligning with SDG 9 (Industry, Innovation and Infrastructure) and SDG 8 (Decent Work and Economic Growth) (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

Public–private partnerships have further strengthened investment dynamics. Programmes led by NASA, such as the Commercial Crew Program, have demonstrated how institutional support combined with private sector capabilities can reduce financial risk and accelerate technological development, contributing to SDG 17 (Partnerships for the Goals) (Organisation for Economic Co-operation and Development, 2025) (National Aeronautics and Space Administration, 2024; Organisation for Economic Co-operation and Development, 2023).

In the Western Balkans, investment in the space sector remains limited but is gradually emerging. Initiatives such as Montenegro’s Luča satellite project—developed with an estimated budget of approximately €200,000—and Croatia’s CroCube demonstrate early-stage engagement with space technologies, primarily supported through national funding and European programmes. While modest in scale, these projects indicate growing regional interest and potential for future investment.

However, structural constraints—including comparatively low levels of R&D investment and limited access to venture capital—continue to restrict the ability of Balkan countries to scale such initiatives or develop indigenous launch capabilities. As a result, the region remains dependent on external funding mechanisms and international partnerships (*Key figures on Europe – 2025 edition*, 2025; Organisation for Economic Co-operation and Development, 2025; Eurostat, 2024; European Commission, 2023; Organisation for Economic Co-operation and Development, 2023).

The literature emphasizes that venture capital and targeted public investment are critical for scaling New Space ventures. Examples from more advanced ecosystems suggest that coordinated investment strategies, combined with supportive policy frameworks, can foster industrial development and innovation. However, there remains a lack of detailed analysis of how such

models can be effectively adapted to emerging regions such as the Western Balkans—an important gap that this study seeks to address through regional case studies and comparative analysis.

2.6.1.2 Technological Advancements and Innovation

Technological advancements in the launch industry, including developments in rocket systems, satellite technologies, and supporting infrastructure, have played a pivotal role in driving New Space entrepreneurship. These innovations have contributed to reducing the cost of access to space, increasing launch frequency, and enabling the development of SDG-aligned applications.

The convergence of technologies such as artificial intelligence (AI), additive manufacturing, and component miniaturization has significantly transformed the space sector. These advancements have enabled more efficient satellite production, improved mission planning, and expanded the capabilities of small satellite platforms, thereby supporting applications in connectivity (SDG 10), agriculture (SDG 2), and education (SDG 4) (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023; European Space Agency, 2024).

Reusable launch systems, developed by private actors such as SpaceX and Rocket Lab, have been particularly influential in improving launch efficiency and lowering barriers to entry for new participants in the space sector. These systems have enabled more frequent launches and facilitated the deployment of satellite constellations and CubeSat missions for a wide range of socioeconomic applications.

In parallel, advances in data analytics and Earth observation technologies have enhanced the utility of satellite data for sectors such as agriculture, environmental monitoring, and disaster management. The increasing availability of high-resolution satellite imagery and data processing

capabilities has contributed to more informed decision-making and improved resource management, supporting SDG 2 (Zero Hunger) and SDG 13 (Climate Action) (Organisation for Economic Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023; World Bank, 2023).

Additive manufacturing and advanced production techniques have further enabled the emergence of new space actors by reducing production complexity and accelerating development cycles. At the same time, research into sustainable propulsion systems, including methane-based and reusable engine technologies, reflects growing efforts to reduce the environmental impact of space activities and align with SDG 13 (Climate Action) (European Space Agency, 2021; European Space Agency, 2024; Centre National d'Études Spatiales, 2023).

In the Western Balkans, technological innovation in the space sector remains limited but is gradually emerging through small-scale initiatives and educational projects. These efforts demonstrate growing interest in space technologies, particularly in relation to capacity building and STEM engagement. However, structural constraints—including limited R&D investment, restricted access to advanced technologies, and ongoing challenges related to human capital—continue to limit the region's ability to develop indigenous capabilities and scale its activities.

The literature emphasizes that technological advancement is a key enabler of New Space's contribution to the SDGs. However, emerging regions such as the Western Balkans require targeted support mechanisms, including technology transfer, institutional development, and access to international partnerships, in order to effectively adopt and benefit from these innovations. At the same time, there remains a notable gap in the literature regarding the technological development trajectories of emerging space ecosystems, particularly in the

Balkans. This study seeks to address this gap through the integration of case studies and comparative analysis with more advanced space sectors.

2.6.1.3 Public-Private Partnerships

Public–private partnerships (PPPs) have been instrumental in reducing financial and technical risks in the New Space sector, fostering collaboration between space agencies, private companies, and governments to advance SDG-aligned initiatives. In the United States, programmes led by NASA, such as the Commercial Crew Program, have enabled the development of commercial human spaceflight capabilities through partnerships with private actors, contributing to innovation, industrial development, and international cooperation (Organisation for Economic Co-operation and Development, 2025; National Aeronautics and Space Administration, 2024; Organisation for Economic Co-operation and Development, 2023). In Europe, the European Space Agency supports PPP-driven innovation through funding and commercialization programmes, including initiatives such as Boost! and ESA Business Incubation Centres (ESA BICs), which facilitate collaboration between startups, industry, and institutional actors (European Space Agency, 2021; European Space Agency, 2024). These mechanisms have contributed to the growth of European launch service providers and strengthened the broader space ecosystem, supporting SDG 9 (Industry, Innovation and Infrastructure) and SDG 17 (Partnerships for the Goals).

Similarly, policy and institutional reforms in India have enabled increased participation of private actors within the national space ecosystem, fostering collaboration between public institutions and emerging companies and supporting applications in areas such as agriculture and environmental monitoring (Rajagopalan and Stroikos, 2024; Organisation for Economic

Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023; Government of India, 2024).

In Europe, PPPs have played a key role in supporting the development of launch systems and downstream applications, involving collaboration between established aerospace companies and emerging startups. These partnerships contribute to technological development, job creation, and the delivery of services such as Earth observation and connectivity, which are directly linked to SDG 9 and SDG 17 (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

In the Western Balkans, PPPs in the space sector are still emerging and remain relatively limited in scope. Existing initiatives are typically supported through a combination of national funding, international collaboration, and partnerships with foreign launch providers. While these collaborations enable initial participation in space activities, they remain constrained by limited institutional capacity and the absence of comprehensive national space policies.

The literature emphasizes that PPPs are critical for scaling New Space ventures and enabling broader participation in the global space economy. However, emerging regions such as the Western Balkans face structural barriers in establishing such partnerships. Strengthening regional cooperation and institutional frameworks could facilitate more effective PPP development, contributing to SDG 17 and supporting more inclusive growth of the space sector.

2.6.1.4 Supportive Policy and Regulatory Frameworks

Supportive policies and regulatory reforms have played a key role in facilitating the growth of the New Space sector by improving access to markets, reducing administrative barriers, and enabling innovation. In the United States, regulatory frameworks developed by the FAA,

including updated commercial space launch licensing regulations, have streamlined approval processes and supported a more dynamic and competitive launch environment (Transportation, 2010; Organisation for Economic Co-operation and Development, 2025; Federal Aviation Administration, 2024; Organisation for Economic Co-operation and Development, 2023).

In Europe, the European Space Agency has contributed to the development of the space sector through coordinated funding programmes, commercialization initiatives, and support for startups, including mechanisms such as Business Incubation Centres (ESA BICs) and programmes supporting launch service development (European Space Agency, 2021; European Space Agency, 2024). These frameworks have helped strengthen the European space ecosystem, although regulatory complexity and coordination across multiple jurisdictions can still present challenges for emerging companies (Organisation for Economic Co-operation and Development, 2025; European Commission, 2023; Organisation for Economic Co-operation and Development, 2023).

Similarly, policy reforms in India have enabled greater participation of private actors within the national space ecosystem, supporting the expansion of commercial activities and applications in areas such as agriculture and environmental monitoring (Rajagopalan and Stroikos, 2024; Organisation for Economic Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023; Government of India, 2024).

In the Western Balkans, the absence or early-stage development of national space policies and regulatory frameworks limits integration into the broader European space ecosystem. This constrains access to funding opportunities, infrastructure, and collaborative programmes, and highlights the importance of institutional development in enabling participation in the global

space economy (Organisation for Economic Co-operation and Development, 2025; European Commission, 2023; Organisation for Economic Co-operation and Development, 2023).

The literature consistently emphasizes that supportive policy frameworks are essential for enabling the contribution of New Space to the Sustainable Development Goals, particularly SDG 9 (Industry, Innovation and Infrastructure) and SDG 17 (Partnerships for the Goals). However, the lack of detailed policy analyses focused on emerging space ecosystems, such as those in the Western Balkans, remains a key gap that this review seeks to address.

2.6.1.5 Market Demand and Societal Needs

Growing market demand for space-based services, driven by societal and economic needs, has significantly contributed to the expansion of the New Space sector. The increasing deployment of small satellites has stimulated demand for dedicated launch services, including lightweight launch vehicles developed by companies such as Rocket Lab, Indian Space Research Organisation, and PLD Space. These developments support applications such as educational CubeSat missions (SDG 4) and Earth observation for climate monitoring (SDG 13) (European Space Agency, 2021; Organisation for Economic Co-operation and Development, 2025; Organisation for Economic Co-operation and Development, 2023; European Space Agency, 2024).

At the same time, global demand for connectivity continues to drive the expansion of satellite constellations, particularly in underserved and remote regions. A significant portion of the global population still lacks reliable internet access, which has accelerated the development of satellite-based broadband services and contributed to reducing digital divides, supporting SDG 10 (Reduced Inequalities) (Organisation for Economic Co-operation and Development, 2025; World Bank, 2023; Organisation for Economic Co-operation and Development, 2023).

In addition, growing needs for climate monitoring and environmental data have increased demand for Earth observation satellites, which play a critical role in disaster management, environmental protection, and evidence-based policymaking, aligning with SDG 13 (Climate Action) (European Space Agency, 2024; IPCC, 2023).

In the Western Balkans, demand for space-related applications is reflected in emerging educational and research initiatives, including student-focused satellite projects and STEM outreach activities. These initiatives demonstrate growing regional interest in space technologies, particularly in relation to education and capacity building. However, structural constraints—including limited funding, underdeveloped infrastructure, and reliance on external launch providers—continue to restrict the scalability of such initiatives. The literature highlights that while market demand acts as a key enabler of space sector growth, regions such as the Western Balkans require stronger institutional support, investment, and policy frameworks to effectively respond to these opportunities (Eurostat, 2024; European Commission, 2023; Organisation for Economic Co-operation and Development, 2023).

2.6.2 Inhibiting Factors

While enabling factors have propelled New Space's growth, several inhibiting factors pose significant challenges, particularly for developing regions like the Balkans, impacting alignment with SDGs 5, 9, and others. These factors, rooted in financial, technical, environmental, social, and regional constraints, limit the scalability and inclusivity of space entrepreneurship.

2.6.2.1 High Financial and Technical Entry Barriers

The development of rocket programmes and space launch infrastructure requires substantial financial investment and advanced technological capabilities, creating significant entry barriers

for most developing countries and smaller actors. Launch vehicle development, infrastructure, and associated systems involve high capital intensity and long development cycles, which limit participation primarily to well-funded state agencies and a small number of private companies (European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

Although recent technological advances—particularly the emergence of small satellites and commercial launch services—have reduced certain costs and expanded access to space, participation in the sector still requires considerable financial resources, institutional support, and access to specialized expertise. These requirements remain challenging for regions with comparatively low levels of research and development (R&D) investment and underdeveloped innovation ecosystems (Eurostat, 2024; European Commission, 2023; Organisation for Economic Co-operation and Development, 2023).

In addition to financial constraints, the space sector demands highly specialized technical expertise in areas such as aerospace engineering, propulsion systems, and satellite design. Such expertise is often limited in emerging space ecosystems, including those in the Western Balkans, further constraining the development of indigenous capabilities.

As a result, many emerging space actors rely on foreign launch providers and external partnerships to access space. While this enables initial participation, it also limits long-term autonomy, scalability, and the ability to develop domestic industrial capacity.

The literature consistently highlights that these financial and technical barriers represent a key constraint on broader participation in the space economy, with important implications for SDG 9 (Industry, Innovation and Infrastructure) and SDG 10 (Reduced Inequalities), particularly in the

context of unequal access to advanced technological sectors (Organisation for Economic Co-operation and Development, 2023; European Space Agency, 2024).

2.6.2.2 Space Debris and Orbital Sustainability

Space debris represents a growing challenge for orbital sustainability, with tens of thousands of tracked objects and a significantly larger number of smaller fragments currently in orbit. These objects pose collision risks for operational satellites and increase the complexity and cost of space operations, raising concerns about the long-term sustainability of key orbital regions, particularly Low Earth Orbit (LEO) (European Space Agency, 2023; Organisation for Economic Co-operation and Development, 2023).

The accumulation of debris has led to increasing attention within the literature to potential cascade effects, such as the Kessler Syndrome, which could significantly disrupt access to space-based services. Such risks have important implications for global reliance on satellite applications, including connectivity, climate monitoring, and education, thereby affecting progress toward SDGs such as SDG 10 (Reduced Inequalities), SDG 13 (Climate Action), and SDG 4 (Quality Education).

International efforts to address space debris include guidelines developed under the United Nations framework, particularly through the Committee on the Peaceful Uses of Outer Space (UNCOPUOS), which promote responsible practices such as post-mission disposal and mitigation of debris generation. However, these guidelines remain largely non-binding, and their implementation varies across operators and jurisdictions (United Nations, 2023; United Nations Office for Outer Space Affairs, 2024).

In Europe, the European Space Agency (ESA) has developed debris mitigation policies and promotes best practices related to satellite design, mission planning, and end-of-life disposal.

Despite these efforts, the increasing frequency of launches and satellite deployments continues to contribute to congestion in orbit, highlighting the need for more comprehensive and enforceable governance mechanisms (European Space Agency, 2023; Organisation for Economic Co-operation and Development, 2023).

In emerging space ecosystems, including the Western Balkans, institutional and regulatory frameworks related to space debris mitigation remain underdeveloped. As a result, emerging actors often rely on external partners and existing international standards, limiting their ability to independently shape or enforce sustainability practices. This underscores a broader gap in the literature regarding regional approaches to orbital sustainability in developing space ecosystems.

2.6.2.3 Environmental Impact of Rocket Launches

Rocket launches and associated space activities have measurable environmental impacts, including greenhouse gas emissions and effects on the upper atmosphere, which raise important concerns in relation to SDG 13 (Climate Action). While the overall contribution of space activities to global emissions remains relatively small compared to other sectors, the rapid growth in launch frequency and space traffic has intensified academic and policy discussions on sustainability within the space sector (European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

Traditional propulsion systems, particularly those based on kerosene and solid propellants, are associated with higher environmental impacts, prompting the development of alternative technologies. Emerging approaches—such as methane-based propulsion and reusable launch systems—aim to improve efficiency and reduce the environmental footprint of launch activities. In this context, programmes such as ESA’s Prometheus focus on developing more sustainable,

reusable, and cost-efficient propulsion systems for future European launch vehicles (European Space Agency, 2024; Centre National d'Études Spatiales, 2023).

Despite these advancements, the adoption of environmentally sustainable propulsion technologies remains uneven across regions. Developing and emerging space actors, including those in the Western Balkans, typically lack access to advanced propulsion technologies and depend on foreign launch providers for satellite deployment.

This reliance limits their ability to influence environmental standards and integrate sustainability considerations into launch operations, highlighting broader governance and technological gaps in the global space sector.

The literature acknowledges the growing importance of environmental sustainability in space activities; however, region-specific analyses—particularly for emerging ecosystems such as the Balkans—remain limited. Addressing this gap is essential for understanding how sustainable space practices can be more inclusively adopted and aligned with global climate objectives.

2.6.2.4 Gender Disparities in the Space Workforce

Gender disparities remain a persistent challenge in the global space sector, limiting progress toward SDG 5 (Gender Equality). Existing studies indicate that women continue to be underrepresented in STEM fields and, in particular, within technical and engineering roles related to the space industry (United Nations Educational, Scientific and Cultural Organization, 2023; United Nations Office for Outer Space Affairs, 2024).

Systemic barriers—including unequal access to STEM education, workplace bias, and the underrepresentation of women in leadership positions—continue to hinder inclusive participation in the sector. In Europe, initiatives led by organizations such as the European Space Agency (ESA) have sought to improve diversity and inclusion through targeted

programmes and policies, although gender imbalances in technical roles remain evident (European Space Agency, 2024).

At the global level, space agencies and private actors increasingly promote STEM engagement and inclusion initiatives aimed at encouraging female participation in science and engineering. However, the literature highlights that these efforts are still insufficient to address structural disparities, particularly in highly specialized domains such as aerospace engineering and propulsion systems (United Nations Educational, Scientific and Cultural Organization, 2023; United Nations Office for Outer Space Affairs, 2024; Organisation for Economic Co-operation and Development, 2023). In the Western Balkans, research on gender inclusion in the space sector remains limited. Emerging initiatives, including educational and satellite-related projects, suggest growing engagement with STEM among younger populations, but there is a lack of systematically collected data on gender participation and representation. This gap is further compounded by broader structural challenges, including limited funding, institutional capacity constraints, and ongoing issues related to talent retention. As a result, the literature lacks detailed regional analyses of gender dynamics within emerging space ecosystems, particularly in the Balkans. This study seeks to address this gap through the integration of case studies and qualitative insights from interviews with stakeholders, including female leaders and practitioners in the space sector.

2.6.2.5 Balkan-Specific Structural Constraints

The Western Balkan region faces a range of structural constraints that limit the development of New Space activities and their alignment with the Sustainable Development Goals (SDGs):

- **Low R&D Investment:** Compared to the European Union average, countries in the Western Balkans generally exhibit significantly lower levels of research and development (R&D) investment, constraining the availability of funding for advanced technological sectors, including space activities. As a result, emerging initiatives often rely on a combination of limited national resources and external funding mechanisms, which can restrict scalability and long-term sustainability (Eurostat, 2024; European Commission, 2023; Organisation for Economic Co-operation and Development, 2023).
- **Expertise Shortages and Brain Drain:** The region continues to face challenges related to human capital, including shortages of highly specialized expertise and the emigration of skilled professionals, particularly in STEM fields. These dynamics limit the development of domestic capabilities required for complex space projects and hinder the growth of a sustainable innovation ecosystem (European Commission, 2023; Organisation for Economic Co-operation and Development, 2023).
- **Reliance on Foreign Launch Providers:** Due to the absence of indigenous launch infrastructure, emerging space actors in the region depend on foreign launch providers for satellite deployment. While this enables participation in space activities, it also introduces financial and operational constraints, limiting autonomy and long-term strategic development.
- **Lack of Space Policies:** In many Western Balkan countries, space-related policy frameworks and regulatory environments remain underdeveloped. In addition, participation in international space governance frameworks varies across the region, and the absence of comprehensive national space strategies can slow integration into

European programmes and collaborative initiatives led by organizations such as the European Space Agency (ESA).

These constraints have direct implications for SDG 9 (Industry, Innovation and Infrastructure) and SDG 17 (Partnerships for the Goals), as they limit the ability of the region to fully participate in and benefit from the global space economy.

At the same time, the literature suggests that regional cooperation mechanisms and coordinated investment strategies could help address these challenges by pooling resources, strengthening institutional capacity, and fostering innovation across national boundaries, thereby supporting more inclusive and sustainable space ecosystem development (Organisation for Economic Co-operation and Development, 2023; European Space Agency, 2024).

2.7 Gaps in the Literature and Proposed Framework

2.7.1 Identified Gaps

The literature reveals several critical gaps that limit a comprehensive understanding of the contributions of the New Space industry to the Sustainable Development Goals (SDGs):

1. **Socioeconomic Impacts of Rocket Programmes:** While existing studies highlight the role of rocket programmes in reducing the cost of access to space and increasing launch frequency, their broader socioeconomic impacts—such as job creation, industrial development, and the expansion of satellite-based connectivity—remain insufficiently explored, particularly in the context of developing and emerging regions (Vidmar, 2020; Organisation for Economic Co-operation and Development, 2023).
2. **Balkan Space Ecosystems:** There is limited academic research on emerging space initiatives in the Western Balkans, including projects such as Montenegro's Luča and

Croatia's CroCube. This gap is compounded by broader structural constraints, including relatively low levels of R&D investment and ongoing challenges related to talent retention, which hinder a deeper understanding of the region's long-term potential. In addition, there is a lack of analysis of regional policy frameworks and public–private partnerships relevant to the space sector (Eurostat, 2024; European Commission, 2023; Organisation for Economic Co-operation and Development, 2023).

3. **Gender Inclusion (SDG 5):** Despite increasing attention to diversity in STEM, the representation, working conditions, and contributions of women in the space sector remain underexamined, particularly in technical and leadership roles. Existing literature highlights gender disparities but lacks detailed analysis of how space entrepreneurship can contribute to advancing gender inclusion in emerging space ecosystems (UNESCO, 2023; United Nations Office for Outer Space Affairs, 2024).
4. **Developing Countries' Rocket Programs and Satellite Projects:** Beyond well-documented cases such as India and Brazil, limited research exists on rocket programmes and associated satellite initiatives in developing regions, including the Western Balkans. This constrains a holistic understanding of how such activities can contribute to SDG 9 (Industry, Innovation and Infrastructure), particularly within the broader European context (Organisation for Economic Co-operation and Development, 2023; European Space Agency, 2024).
5. **Ethical and Sustainability Issues:** Key challenges—including space debris, orbital congestion, environmental impacts of rocket launches, and unequal access to space infrastructure—remain insufficiently addressed in the literature. These issues have important implications for SDG 13 (Climate Action), SDG 16 (Peace, Justice and Strong

Institutions), and SDG 10 (Reduced Inequalities), particularly in light of the increasing commercialization and concentration of capabilities within a limited number of spacefaring nations (European Space Agency, 2023; Organisation for Economic Co-operation and Development, 2023; Morgan Stanley, 2020).

2.7.2 Proposed Framework

The innovation ecosystem framework (Lamine et al., 2021) addresses these gaps by analyzing:

- **Actors:** Startups (SpaceX, PLD Space, Montenegro Space Research, CroCube), agencies (European Space Agency, Indian Space Research Organisation, National Aeronautics and Space Administration), universities, and investors, that are fostering SDG on Partnerships for the Goals.
- **Resources:** Rockets (\$2,000/kg), \$47.4B investments, 500,000 STEM professionals (20% female), and data that are supporting SDG on Industry, Innovation and Infrastructure.
- **Institutions:** FAA Part 450, ESA's Business Incubators, Accelerators, funding and co-financing schemes, OST, LTS guidelines, aligning with SDGs related to Reduced Inequalities, Partnerships for the Goals, Peace Justice and Strong Institutions.

This framework guides empirical research, with interviews exploring the prerequisites for alignment with SDGs related to Gender Equality, and Industry, Innovation and Infrastructure, and highlights Balkan's potential to contribute to the related SDG achievement (RP: Methodology).

2.8 Conclusion

This expanded review synthesizes the enabling and inhibiting factors shaping the contribution of New Space to the Sustainable Development Goals (SDGs), with particular emphasis on the role of rocket programmes in reducing the cost of access to space and increasing launch availability. It also highlights Europe's efforts toward launch autonomy and the emergence of space activities in developing regions, including the Western Balkans.

The literature identifies several enabling factors—such as increasing investment, the adoption of reusable launch technologies, public–private partnerships, supportive policy frameworks, and growing demand for space-based services—as key drivers of innovation and expanded access to space. At the same time, inhibiting factors—including high development costs, space debris, environmental impacts, gender disparities, and structural constraints in emerging ecosystems—continue to shape the pace and inclusivity of space sector development.

Despite growing attention to the New Space economy, the specific contribution of rocket programmes to improving access to space—particularly through cost reductions and increased launch frequency—remains insufficiently explored in the literature, especially in relation to their broader socioeconomic and environmental implications.

Similarly, the potential of space entrepreneurship to contribute to social SDGs, including Gender Equality and Reduced Inequalities, remains underexamined, despite evidence highlighting the role of STEM outreach initiatives in fostering inclusion and the importance of satellite-based connectivity in addressing digital divides (UNESCO, 2023; World Bank, 2023; Organisation for Economic Co-operation and Development, 2023).

Furthermore, limited attention has been given to emerging space ecosystems, such as those in the Western Balkans, as well as to the intersection of gender inclusion, innovation ecosystems, and

sustainable space development. By addressing these gaps, this review provides a foundation for future research aimed at advancing SDG 5 (Gender Equality), SDG 9 (Industry, Innovation and Infrastructure), and the broader 2030 Agenda.

Chapter 3: Methodology

3.1 Introduction to the Methodology

This chapter presents the methodological framework developed to investigate the contributions of space entrepreneurship to the Sustainable Development Goals (SDGs), with particular emphasis on SDG 5 (Gender Equality) and SDG 9 (Industry, Innovation and Infrastructure), while also considering SDG 4 (Quality Education) and SDG 17 (Partnerships for the Goals). The research adopts an interdisciplinary perspective, integrating technological, socioeconomic, and policy dimensions within global, European, and Western Balkan contexts.

The study focuses on the role of emerging space ecosystems, particularly in developing regions, where space-related activities are still in early stages of development. Within this context, selected regional initiatives, including Montenegro's Luča satellite project and Croatia's CroCube educational satellite initiative, are considered as illustrative case examples. These initiatives provide insight into how smaller or emerging countries can engage with space technologies, contribute to innovation ecosystems, and support SDG-aligned development pathways.

Building on the theoretical and empirical foundations established in the Concept Paper (CP), Literature Review (LR), and Research Proposal (RP), this research addresses several critical gaps in the existing academic and industry literature. These include the limited understanding of the socioeconomic impacts of space entrepreneurship in emerging regions, the underrepresentation of smaller space ecosystems such as those in the Western Balkans, and the persistent gender imbalance within the space sector. In addition, the study considers environmental and structural

challenges associated with space activities, including emissions, space debris, and unequal access to infrastructure.

To address these gaps, the study adopts a qualitative research design supported by secondary data, enabling a detailed exploration of complex and context-dependent phenomena. This approach is particularly appropriate given the exploratory nature of the research and the limited availability of structured quantitative data for emerging space ecosystems. It allows for the capture of expert perspectives, stakeholder experiences, and institutional dynamics that are not easily measurable through quantitative methods alone.

The research is structured around the innovation ecosystem framework, which provides a systematic lens for analyzing the interaction between key actors (such as startups, universities, and public agencies), resources (including financial investment, infrastructure, and technological capabilities), and institutional environments (such as regulatory frameworks and international partnerships). This framework supports the examination of how these elements interact to enable or constrain the development of space entrepreneurship and its contribution to the SDGs.

The study is guided by the following research questions:

- RQ1: How do rocket programmes and related technologies contribute to SDG 5 and SDG 9, particularly in developing regions?
- RQ2: What are the opportunities and challenges associated with Europe's pursuit of launch independence, and how do these affect emerging ecosystems such as the Western Balkans?
- RQ3: How can the developing Balkan space ecosystem contribute to SDGs, and what are the key structural barriers?

- RQ4: How can space entrepreneurship support gender inclusion in the space sector, particularly in Europe and the Western Balkans?
- RQ5: What mechanisms and frameworks can enhance the scalability of space entrepreneurship's contributions to the SDGs?

To address these research questions, the study combines multiple data sources. Secondary data are drawn from academic literature, industry reports, policy documents, and web-based sources, providing a broad contextual understanding of global and regional trends. Primary data are collected through six semi-structured expert interviews, offering in-depth qualitative insights into innovation ecosystems, gender dynamics, and regional challenges.

The methodological design incorporates appropriate ethical considerations, including informed consent, confidentiality, and responsible data handling practices. It also acknowledges inherent limitations, such as restricted access to certain high-level stakeholders and the limited availability of structured data for the Western Balkans. These limitations are addressed through purposive sampling, triangulation of data sources, and the use of multiple forms of evidence to enhance analytical robustness.

Overall, this chapter provides a structured and coherent presentation of the research design, data collection methods, analytical approach, ethical considerations, and limitations. It ensures alignment between the research questions, methodological choices, and the broader objective of examining how space entrepreneurship can contribute to sustainable and inclusive development, particularly in underrepresented and emerging regions.

3.2 Research Design

This study adopts a qualitative research design supported by secondary quantitative data, aiming to explore the role of space entrepreneurship in advancing sustainable development and innovation ecosystems in emerging regions, particularly the Western Balkans.

A qualitative approach was selected as the most appropriate methodology due to the exploratory nature of the research and the need to capture in-depth insights from key stakeholders within the space industry, policy, and innovation sectors. The study is grounded in an interpretivist paradigm, focusing on understanding experiences, perceptions, and expert perspectives.

While the research initially considered a mixed-methods design, the final methodological approach is primarily qualitative, with quantitative data used to contextualize and support findings rather than serve as a primary empirical component. This approach ensures methodological consistency and alignment with the available data.

This study therefore adopts a qualitative-led research design, supported by secondary quantitative data used for contextualization. Qualitative insights derived from semi-structured interviews constitute the primary empirical foundation of the study, while quantitative data are used to provide broader industry context, support triangulation, and enhance the robustness of the analysis. The research is further structured around the innovation ecosystem framework, which provides a systematic lens to examine the interaction between actors, institutions, and resources within the space economy.

3.2.1 Rationale for Qualitative Approach Supported by Secondary Data

The chosen research approach is primarily qualitative, supported by secondary quantitative data, reflecting the complexity and multidimensional nature of the research questions. The study investigates the role of space entrepreneurship in advancing Sustainable Development Goals

(SDGs), particularly SDG 5 (Gender Equality) and SDG 9 (Industry, Innovation and Infrastructure), within global, European, and Western Balkan contexts.

A qualitative approach is particularly suitable given the exploratory nature of the research and the limited availability of empirical studies focused on emerging space ecosystems, especially in smaller or developing regions. It enables the collection of rich, contextual insights from key stakeholders, including practitioners involved in early-stage space initiatives, engineers working on technological development, policymakers, and female professionals addressing gender-related barriers in the sector.

These qualitative insights are essential for understanding complex phenomena such as gender inclusion in STEM and space-related fields (SDG 5), structural challenges within innovation ecosystems (SDG 9), and the role of international collaboration (SDG 17). Through expert perspectives, the study captures dimensions that are not easily quantifiable, including institutional barriers, knowledge gaps, and informal ecosystem dynamics.

In addition to qualitative data, the research incorporates secondary quantitative indicators sourced from international organizations such as Organisation for Economic Co-operation and Development, ESA, UNESCO, and Eurostat. These data provide important contextual support by illustrating broader trends in the space economy, including launch activity, economic impact, investment levels, and the application of space technologies such as Earth observation for climate monitoring and disaster management.

Rather than employing a fully integrated mixed-methods design, quantitative data are used to complement and contextualize qualitative findings. This allows for a form of triangulation, where qualitative insights are interpreted alongside existing statistical and policy data to strengthen the validity and robustness of the analysis.

For instance, qualitative findings on gender-related barriers, derived from expert participants, are interpreted in relation to existing datasets on female participation in STEM and space sectors. Similarly, insights regarding structural constraints in the Western Balkans are supported by quantitative indicators related to research and development investment, innovation capacity, and economic performance.

This approach enables a comprehensive and evidence-informed understanding of the research problem while maintaining methodological consistency with the available data. It also addresses key gaps identified in the literature, particularly the lack of integrated analyses of space entrepreneurship within emerging ecosystems and its contribution to sustainable development objectives.

3.2.2 Research paradigm

The study adopts a **pragmatic research paradigm**, emphasizing practical, solution-oriented knowledge over strict adherence to a single methodological tradition. This approach is particularly appropriate for applied research such as a DBA thesis, where the objective is not only to generate theoretical insights but also to provide actionable recommendations for practitioners, policymakers, and industry stakeholders.

Rather than being confined to either a purely positivist or interpretivist perspective, pragmatism allows for methodological flexibility while maintaining coherence with the chosen research design. In this study, the paradigm supports a **primarily qualitative approach**, complemented by secondary quantitative data used for contextualization.

The pragmatic paradigm is well suited to the interdisciplinary nature of the research, which integrates technological developments, innovation ecosystem dynamics, and socioeconomic

considerations. It enables the study to address complex real-world challenges related to space entrepreneurship, including issues of infrastructure development, access to funding, international collaboration, and gender inclusion.

Furthermore, pragmatism supports the study's focus on **practical applicability**, allowing findings to be translated into concrete frameworks and recommendations relevant to emerging space ecosystems, particularly in the Western Balkans. This includes the development of actionable strategies for strengthening innovation capacity, improving institutional support, and enhancing participation in global space value chains.

By adopting a pragmatic lens, the study ensures that its findings are both analytically grounded and practically relevant, aligning with the core objectives of DBA-level research.

3.2.3 Research Approach and Scope

The research adopts an **exploratory qualitative approach**, appropriate for examining underexplored areas such as the socioeconomic impacts of rocket programmes, the development of emerging space ecosystems in the Western Balkans, and issues of gender inclusion within the space sector.

This approach enables the identification of key trends, structural barriers, and development opportunities in contexts where space-related activities remain at an early stage. It is particularly suited to capturing complex interactions between technological innovation, policy environments, and socioeconomic outcomes.

The scope of the research is structured around four interrelated dimensions:

- **Technical Aspects:** Examination of developments in reusable launch systems, lightweight launch vehicles, and green propulsion technologies, with a focus on their role in improving cost-efficiency and sustainability in access to space.

- **Socioeconomic Impacts:** Analysis of job creation, STEM engagement, and gender inclusion within space-related sectors, particularly in emerging ecosystems where such impacts are still evolving.
- **Geographical Contexts:** Consideration of global space economy trends, Europe's efforts toward launch autonomy, and the increasing participation of emerging regions, including the Western Balkans.
- **Ethical Considerations:** Exploration of challenges related to space debris, environmental impacts of rocket launches, and unequal access to space infrastructure in the context of commercialization.

The research is guided by the **innovation ecosystem framework**, which provides a structured lens for analyzing how actors, institutions, and resources interact within the space economy. This framework supports the examination of collaboration between startups, public institutions, and international organizations, as well as the role of investment and regulation in shaping the development of sustainable and inclusive space activities.

By combining these dimensions, the study provides a comprehensive understanding of how space entrepreneurship contributes to innovation ecosystems and sustainable development, particularly within emerging regional contexts.

3.3 Data Collection Methods

The study employs a systematic and multi-faceted approach to data collection, ensuring a robust evidence base that integrates both primary qualitative data and secondary sources. This approach supports a comprehensive understanding of the research problem while maintaining consistency with the overall qualitative research design.

Primary data were collected through semi-structured interviews with selected expert participants, providing in-depth insights into the space sector, innovation ecosystems, and related policy and socioeconomic dimensions.

In addition, secondary data were sourced from academic literature, industry reports, policy documents, and credible institutional publications (e.g., Organisation for Economic Co-operation and Development, ESA, UNESCO, Eurostat). These data serve to contextualize the findings and provide broader insights into global and regional trends within the space economy.

This combined approach ensures the relevance, credibility, and analytical depth of the study, while supporting the alignment between research questions, data sources, and methodological framework.

3.3.1. Literature Search Strategy

The literature search strategy was designed to ensure a systematic, transparent, and rigorous identification of relevant sources aligned with the research objectives. Given the interdisciplinary nature of the study—spanning space technology, innovation ecosystems, and sustainable development—a comprehensive approach to literature identification was required.

Key academic databases, including Scopus, Web of Science, and Google Scholar, were utilized to access peer-reviewed journal articles, books, and conference proceedings. These platforms were selected due to their broad coverage of high-impact academic research across engineering, economics, and policy domains.

The search focused primarily on publications from 2015 to 2026, corresponding to the adoption of the Sustainable Development Goals (SDGs) and the rapid expansion of the global space economy, particularly within the context of the New Space paradigm.

To ensure both relevance and comprehensiveness, Boolean search operators and targeted keyword combinations were applied. These included, but were not limited to:

- “New Space entrepreneurship” AND “Sustainable Development Goals”
- “Rocket technologies” AND (“cost reduction” OR “sustainability”)
- “Balkan space ecosystem” AND (“innovation” OR “SDG 9”)
- “Gender inclusion” AND (“space sector” OR “SDG 5”)
- “Satellite projects” OR “satellite launch” AND “Balkans”
- “Launch independence” AND (“Europe” OR “Balkans”)

The initial search yielded approximately 150–200 sources, which were subsequently refined through a structured multi-stage screening process.

In the first stage, abstract screening was conducted to evaluate the relevance of each source in relation to the research objectives. Priority was given to studies addressing technological innovation in the space sector, socioeconomic impacts such as job creation and STEM development, and environmental or ethical considerations including emissions and space debris.

In the second stage, full-text assessment was performed to evaluate methodological rigor, theoretical contribution, and empirical relevance. Particular emphasis was placed on peer-reviewed articles published in leading journals such as *Space Policy*, *Acta Astronautica*, and *Journal of Cleaner Production*, as well as reports from reputable international organizations.

In the final stage, data extraction and categorization were conducted using a structured approach aligned with the research questions. Information was organized into key thematic areas, including technological advancements, innovation ecosystem dynamics, socioeconomic outcomes, and ethical challenges. This process facilitated systematic comparison across sources and supported the integration of findings within the broader analytical framework.

To enhance transparency and methodological rigor, the literature review process was documented throughout the research, allowing for traceability and consistency in source selection. The dataset was also periodically updated to incorporate relevant developments up to early 2026, ensuring that the analysis reflects the most recent trends in the global and regional space economy.

3.3.1.1 Industry and Policy Data Collection

Industry and policy data were collected from a range of authoritative international organizations and institutional sources to provide both contextual and analytical support for the study.

Industry reports were obtained from established analytical organizations such as Morgan Stanley, Seraphim Capital, BryceTech, and Euroconsult. These reports provide insights into global space economy trends, including investment patterns, launch activity, and the evolving commercial landscape.

Policy and institutional documents were sourced from major international bodies and space agencies, including the United Nations, European Space Agency, NASA, ISRO, and the Committee on the Peaceful Uses of Outer Space. These documents were used to examine regulatory frameworks, international cooperation mechanisms, and policy approaches related to sustainable space activities and SDG implementation.

A structured data extraction protocol was applied to ensure consistency and reliability. Both quantitative indicators (e.g., investment trends, employment estimates, and industry growth patterns) and qualitative insights (e.g., governance models, policy strategies, and institutional frameworks) were systematically collected and categorized according to the research questions.

To enhance reliability, data from industry and policy sources were cross-referenced with academic literature wherever possible. Discrepancies between sources were addressed through

comparative analysis and critical evaluation of source credibility, including factors such as institutional reputation, publication context, and methodological transparency.

Given the limited availability of structured data for emerging regions such as the Western Balkans, supplementary insights were derived from secondary web-based sources and expert interviews. This approach allowed for a more comprehensive understanding of regional dynamics while maintaining analytical consistency.

Overall, the integration of industry and policy data provides a robust contextual foundation for the study, supporting the interpretation of qualitative findings and strengthening the overall analytical framework.

3.3.1.2 Web-Based Data Collection

Web-based data were utilized to capture real-time and emerging insights into space and STEM-related initiatives, particularly within the Western Balkans, where academic and industry data remain limited or fragmented.

Credible sources were identified through targeted searches on specialized platforms such as SpaceWatch.Global, SpaceNews, and official institutional portals including the European Space Agency, as well as relevant government and organizational websites. These sources were selected based on their relevance, credibility, and consistency with established industry and policy data.

The data collection process focused on identifying emerging initiatives and illustrative case studies across the region, including satellite projects, STEM outreach programmes, and early-stage developments in the space sector. Examples include Croatia's CroCube educational satellite initiative, Montenegro's Luča satellite project, satellite-based applications in Serbia, and STEM-related educational programmes in Bosnia and Herzegovina and North Macedonia.

Given the limited availability of standardized quantitative datasets for the region, emphasis was placed on extracting qualitative insights, identifying trends, and capturing indicative developments rather than relying on precise numerical values. This approach ensured that the analysis reflects the evolving nature of the regional space ecosystem while maintaining methodological caution.

To ensure reliability and credibility, all web-based data were systematically cross-referenced with academic literature, industry reports, and official policy documents wherever possible. Sources were critically evaluated based on institutional reputation, authorship, consistency with verified data, and alignment with broader industry trends.

Data extraction was conducted using a structured approach aligned with the research questions, capturing key themes such as educational engagement, institutional capacity-building, innovation dynamics, and early-stage space activities. Particular attention was given to identifying recurring patterns across multiple sources, thereby reducing reliance on isolated or non-verified claims.

This approach enables the inclusion of region-specific insights that are often underrepresented in academic literature, while maintaining analytical rigor and consistency with the overall research design.

3.3.2 Qualitative Data Collection

Qualitative data is collected through semi-structured interviews with 7 stakeholders, providing qualitative insights into gender dynamics, innovation ecosystems, and regional challenges. The interview process is designed to address RP methodology requirements and fill gaps in quantitative data, particularly for Balkan ecosystems and gender inclusion.

3.3.2.1 Recruitment Process

Stakeholders are identified through purposive sampling to ensure expertise and diversity, targeting:

- **Balkan Representatives:** Daniela Jović (CroCube project lead), 1 engineer from Montenegro Space Research (Luča), Martina Dimoska (Program Human Systems Integrator at the NASA Johnson Space Center, Macedonian Analog Astronaut and Stem Advocate), Tamara Blagojević (SpaceWatch.Global Field Reporter, Serbian space business development and capacity building consultant and Space Law and Policy Specialist), Vladimir Gašić (Serbian astronomer and associate professor), Vuk Maksić (Electrical Engineering student, and member of Argo Robotics).
- **Policymakers:** ESA official and representative (whose identities will have to remain undisclosed due to security and privacy related reasons), was approached as availability and bureaucratic procedures allowed, focusing on regulatory frameworks and funding mechanisms.
- **Named Individuals:** Valeria, Martina, Vladimir, Vuk, Tamara and Daniela accepted to be explicitly named and gave consent to be mentioned, in order to) provide verifiable and transparent insights into gender, innovation, and regional issues, limited to qualitative contributions.

The interviewee candidate recruitment process involved:

- **Interviewee choice and assessment:** This was done by undertaking research to identify most active space professionals and experts engaged on relevant projects or in companies and organizations relevant for the thesis questions, and objectives. The screening was

undertaken by applying the following selection criteria: minimum five years in the aerospace sector, active involvement in the launching industry, rocket programmes or satellite projects and initiatives, leadership roles or active engagement in space sectors of the European or Balkan region.

- **Network Engagement:** This engagement was done by leveraging professional networks in the space sector, such as the Space Generation Advisory Council, International Space University, or Space Court Foundation Alumni, or experts and representatives from regional agencies such as ESA, as well as Balkan scientific and academic institutions, universities and communities to identify candidates.
- **Invitation Process:** Participants were invited through personalized email communication outlining the objectives of the study, ethical considerations (including informed consent and confidentiality), and participation requirements. Given the qualitative nature of the research, responses were collected in written form through semi-structured questionnaires.
- Follow-up communication was conducted, where necessary, to confirm participation and clarify responses. A total of seven participants were included in the study, reflecting the constraints of access while still enabling sufficient depth of analysis for qualitative research.

Challenges, such as securing high-profile stakeholders (e.g., ESA or Balkan government officials), were mitigated by focusing on accessible Balkan representatives, securing their identities as confidential, and leveraging secondary and indirect contacts (e.g., university,

academic community or STEM project collaborators) to substantiate or reaffirm confidential interviews. The recruitment process is documented to ensure transparency and replicability.

3.3.2.2 Interview Protocol

Interviews were conducted in written form, with participants providing responses to a predefined set of semi-structured, open-ended questions. This approach ensured flexibility for geographically dispersed stakeholders and allowed participants to provide considered and detailed responses.

All responses were treated as qualitative textual data. Given the written format, transcription was not required; however, responses were reviewed for consistency, clarity, and formatting prior to analysis.

The protocol included:

- **Duration and Format:** Participants were provided with a defined time frame to complete the semi-structured questionnaire. Responses were submitted in written form via electronic communication (e.g., email or document exchange). As the data were collected in written format, transcription was not required; however, responses were reviewed for clarity, consistency, and completeness prior to analysis.
- **Question Design:** Open-ended questions were tailored and adapted to each stakeholder group for clarity and relevance, but remained categorized under broader thesis questions to ensure alignment with the CP and RP:
 - **Technical Impacts:** In the case of impacts, the impacts of the launching industry were at times and where appropriate focused on rockets, and at other times, on satellite initiatives and projects, depending whether interviewing an “enabler” or an expert from a developed space faring nation, or if interviewing a space

professional from an underdeveloped or nascent space industry in the Balkans. With similar criteria and considerations, this question was then aligned with a specific SDG, depending on the focus area of work or geo-location and the country development of the interviewee. For example: “How have reusable rockets enabled SDG applications in connectivity, agriculture, and education?”

- **Gender Dynamics:** In terms of gender-related or space sector and opportunity inclusiveness related barriers, the question was specified based on the gender of the interviewee, relevance of the question in terms of the particular SDG, and the particular area, project, or activity the interviewee is engaged in. For example: “What systemic barriers limit female participation in the space sector, and how can programs like CroCube address them?”
- **Regional Challenges:** In terms of challenges, the question was specified by explicitly mentioning Luča or CroCube or other initiatives where appropriate, based on the nationality or geo-location and area of work of the Interviewee. For example: “What funding, expertise, and infrastructure barriers limit the scalability of Luča and CroCube, and how can a Balkan Space Consortium overcome them?”
- **Policy Needs:** In this case, to give the question width, the formulation “Policy Needs” was at times replaced with “strategies” or otherwise at times broadened by replacement with “mechanisms and initiatives”, to ensure inclusion of STEM projects and policy related initiatives as much as funding opportunities. For example: “What strategies (e.g., public-private partnerships, technology transfer) can integrate developing countries into the global \$1 trillion space economy, fostering SDG 9 and SDG 17?”

- **Ethical Protocols:** Participants received detailed information regarding the purpose of the study, associated risks, as well as the data handling procedures. Consent forms are provided in English and local languages (e.g., Croatian, Serbian, Montenegrin), with options for withdrawal at any time.
- **Data Management:** Transcripts of the interviewed ESA or government officials with requests to remain confidential are anonymized using descriptive pseudonyms. All of the interviews were stored on encrypted servers, and accessible only to the Interviewer and the Interviewee.

This subsection includes a structured set of semi-structured, open-ended questions, systematically categorized by stakeholder groups and aligned with the research questions to ensure consistency, relevance, and analytical depth. The structure of the guide allowed for both comparability across responses and flexibility in capturing diverse expert perspectives within the space entrepreneurship ecosystem.

In addition, selected paraphrased excerpts from interview responses are incorporated throughout the analysis to illustrate key qualitative insights. These excerpts are carefully chosen to reflect recurring themes and significant viewpoints, while maintaining clarity, coherence, and alignment with the research objectives.

The study also addresses recruitment-related challenges, including language differences, geographical dispersion, and scheduling constraints with international stakeholders. To mitigate these limitations, a flexible and adaptive approach to communication and data collection was adopted, ensuring effective participation across different contexts.

Furthermore, the integration of digital tools and platforms supported the data collection and organization process, particularly in ensuring consistency, traceability, and efficient handling of

qualitative data. These combined methodological elements contributed to enhancing the overall rigor, reliability, and validity of the qualitative analysis.

3.3.2.3 Sample Size and Saturation

The target sample size of 7 interviews is designed to achieve data saturation, with due regard and considerations given to ensure that no new topics emerge that would go beyond the scope of the original questions. This includes:

- 6 Balkan representatives to ensure regional coverage (e.g., Croatia, Montenegro, North Macedonia, Serbia).
- 3 female leaders (in total, including Balkans) to address SDG 5, providing diverse perspectives on gender barriers and solutions.
- 1 ESA representative was approached to the extent that bureaucratic procedures and security considerations allowed, to explore regulatory and funding frameworks, particularly for SDG 17.

Saturation is monitored through iterative coding, with additional interviews conducted if new themes emerge (e.g., unexpected barriers in Balkan ecosystems). The sample size balances depth and breadth, ensuring comprehensive insights while remaining feasible within the study's timeline.

Saturation was assessed through the identification of thematic redundancy across interview responses, where no substantially new themes emerged during the coding process. This was further supported by the frequency and recurrence of codes within the NVivo analysis, indicating sufficient depth and coverage of key research areas.

Diversity considerations were incorporated in the sampling process to ensure representation of different stakeholder perspectives, including participants from the Balkan region and

underrepresented groups such as female professionals in the space sector. This approach contributed to capturing a broader range of experiences and viewpoints relevant to the research objectives.

In addition, contingency strategies were considered in the research design to account for potential limitations in achieving saturation. These included the possibility of expanding the sample to include additional stakeholders from the wider Balkan region or related fields such as academia and STEM initiatives. However, given the consistency and depth of the collected data, the initial sample was deemed sufficient for the purposes of this study.

3.4 Data Analysis

The study employs a qualitative data analysis approach, with thematic analysis used as the primary method to interpret the collected data.

Qualitative data obtained from semi-structured interviews were analyzed through a systematic coding process, enabling the identification of key patterns, themes, and relationships relevant to the research questions. This approach allows for the exploration of complex and context-dependent phenomena, particularly within emerging space ecosystems.

In addition to primary qualitative data, secondary data from academic literature, industry reports, and policy documents were used to support and contextualize the findings. Rather than being analyzed as a standalone quantitative component, these data were used to strengthen the interpretation of qualitative insights and provide a broader analytical context.

The analysis is guided by the innovation ecosystem framework, ensuring a structured examination of interactions between key actors, resources, and institutional environments within the space sector.

3.4.1 Qualitative Data Analysis

Qualitative data from interviews (7 stakeholders) were analyzed using thematic coding with NVivo software, following a structured and iterative process designed to identify patterns, relationships, and key insights aligned with the research questions.

Coding Framework: Initial codes were derived from the innovation ecosystem framework (actors, resources, institutions) and the research questions. These included:

- Technical codes: “rocket cost reduction,” “green propulsion,” “launch frequency.”
- Socioeconomic codes: “job creation,” “STEM engagement,” “gender inclusion barriers.”
- Ethical codes: “space debris,” “rocket emissions,” “equitable access.”
- Regional codes: “Balkan funding constraints,” “regional collaboration,” “ecosystem development.”

This framework provided a structured basis for organizing the data and ensuring consistency throughout the analysis process.

Iterative Coding: Interview transcripts and supporting materials were coded line-by-line to identify recurring concepts and emerging patterns. Codes were refined iteratively as new themes emerged, allowing for the development of higher-level thematic categories such as cultural barriers to STEM participation, sustainability challenges, and institutional constraints within emerging space ecosystems.

The iterative nature of the coding process enabled a deeper understanding of relationships between different variables, particularly in the context of technological development, policy environments, and regional dynamics. Interview responses were used to illustrate and support the interpretation of key themes, providing contextual depth and qualitative richness.

Validation: To enhance the credibility and reliability of the analysis, multiple validation strategies were employed. These included member-checking, where appropriate, allowing participants to review summarized interpretations of their responses, as well as triangulation with secondary data sources such as academic literature, industry reports, and policy documents. This approach ensured that findings were not based solely on individual perspectives but were supported by broader evidence.

Outputs: The thematic analysis resulted in the identification of several key areas:

- **Innovation Ecosystems:** The role of startups, public institutions, and academic actors in supporting technological development, knowledge transfer, and ecosystem growth.
- **Gender Dynamics:** Structural barriers to female participation in the space sector, as well as initiatives aimed at improving inclusion and access to opportunities.
- **Sustainability:** Environmental and ethical considerations related to space activities, including the need for responsible technological development and long-term sustainability.
- **Regional Challenges:** Constraints and opportunities within the Western Balkans, including funding limitations, infrastructure gaps, institutional barriers, and emerging collaboration potential.

These themes provide a structured analytical foundation for interpreting the findings and linking them to the research questions, as well as to the broader theoretical framework guiding the study.

3.4.2 Initial Preparation of Interview Data

Before importing transcripts into NVivo, all interview recordings were transcribed verbatim. The preparation process consisted of three key stages: **transcription, demarcation, and labeling.**

Transcripts were reviewed to ensure accuracy, with speaker turns clearly defined and minor transcription inconsistencies corrected.

Where required, transcripts were pseudonymised to protect participant anonymity. Each file was stored using a consistent naming convention (e.g., INT_01_Montenegro, INT_02_Croatia), ensuring traceability while avoiding the inclusion of identifying information.

All transcripts were then imported into a single NVivo project file. The structure of the transcripts retained the original interview question stems to preserve contextual coherence.

The semi-structured interview guide was organized around **five analytical domains**, which informed both data collection and coding:

1. The launch industry and cost reduction as enablers of SDG-aligned activity
2. European launch independence and its implications for developing regions
3. The Balkan space ecosystem, including contributions and structural challenges
4. Gender equality and SDG 5 in space entrepreneurship
5. Policies and strategies for scalability

These domains provided the initial analytical framework for thematic coding and ensured alignment between research questions and data analysis

3.4.3 Construction of the Node Hierarchy

The node structure was developed through a three-stage process consistent with the hybrid deductive-inductive approach recommended by Fereday and Muir-Cochrane (2006).

Stage 1: Deductive scaffolding from the research framework

In the first stage, a set of parent nodes was derived deductively from the study's conceptual framework, which centers on the intersection of space entrepreneurship, the United Nations Sustainable Development Goals (SDGs), and the emerging space sector in the Western

Balkans. This deductive scaffold provided a starting point that prevented the researcher from approaching the data without any organizing principle, which can lead to unfocused first-pass coding (Miles, Huberman and Saldaña, 2014). The parent nodes at this stage corresponded broadly to the five interview domains and to the major SDG clusters identified in the literature review.

Stage 2: Inductive elaboration through close reading

In the second stage, all transcripts were read in full without initial coding in order to support **inductive elaboration**. During this process, marginal annotations were recorded in reflective memos within NVivo, capturing preliminary interpretations and patterns emerging from the data.

This stage was guided by sensitizing analytical considerations focused on identifying key narratives, relationships, and underlying meanings within the interview data. Particular attention was given to how participants described the role of space entrepreneurship in relation to SDG achievement, as well as how their perspectives aligned with or diverged from existing literature.

Through this process, a number of recurring and previously unanticipated themes emerged. These included the systemic exclusion of non-ESA member states, the region-specific dynamics of brain drain in the Western Balkans, the lived experiences of gender-related barriers among female participants, and the distinction between technological, institutional, and financial constraints as analytically separable categories.

These emergent insights informed the refinement of the coding structure, with new themes incorporated as additional nodes within the NVivo coding hierarchy.

Stage 3: Consolidation and hierarchical organization

In the third stage, the coding structure developed in Stages 1 and 2 was systematically reviewed to address **redundancy, overlap, and levels of abstraction** within the dataset. This process involved iterative refinement of nodes to ensure conceptual clarity and analytical consistency.

Nodes containing a limited number of coded references were either merged with adjacent categories or reclassified as sub-nodes within broader thematic groupings. Conversely, nodes with substantial internal variation were further subdivided to capture meaningful distinctions within the data.

This process resulted in the development of a hierarchical coding structure comprising six primary parent nodes:

1. Launch Industry and Cost Reduction
2. European Launch Independence and Governance
3. Balkan Space Ecosystem and SDG Contribution
4. SDG 5 and Gender Equality in Space
5. Policies and Strategies for Scalability
6. Cross-Cutting Themes

Each parent node was supported by multiple child nodes, reflecting more granular thematic distinctions within the dataset. To enhance analytical clarity, child nodes were further annotated using categorical tags, including SDG dimension, sectoral relevance, and geographic context.

The resulting hierarchical structure provided a coherent analytical framework for interpreting the data and ensured alignment between the coding process and the research questions.

3.4.4 Coding Procedures

Coding was conducted by the primary researcher in two full passes through the dataset. In the first pass, each transcript was coded passage by passage using the consolidated node hierarchy. A passage was defined functionally, typically one to five sentences, in which a single idea, experience, or argument was expressed. Where a passage spoke to more than one node — for example, a statement about launch costs that simultaneously referenced ESA governance and financial barriers — it was coded to all applicable nodes.

In the second pass, all coded passages were reviewed within each node, and two refinements were made. First, the distinction between substantive and partial coding was applied. A substantive code was assigned where an interviewee had addressed a theme directly and with analytical depth — developing an argument, providing an example, or drawing an explicit connection to SDG outcomes. A partial code was assigned where a theme was mentioned briefly, tangentially, or without elaboration. This distinction, recorded as a node attribute within NVivo, enabled the construction of a matrix coding query in which the density and quality of coverage across interviewees and nodes could be compared (see Section 3.5.5). Second, a small number of in-vivo nodes was created to preserve the specific language used by interviewees where that language carried particular analytical significance — for example, one interviewee's description of the experience of being considered "overqualified" for domestic roles while being ineligible for European ones was retained as an in-vivo node capturing the overqualification paradox specific to non-ESA practitioners.

Throughout the coding process, a reflexive memo was maintained within NVivo in which the researcher recorded instances of interpretive uncertainty, decisions to code or not code a passage, and revisions to node definitions.

3.4.5 Matrix Coding Query and Coverage Analysis

Following completion of the coding process, a matrix coding query was conducted in NVivo to generate a **cross-tabulation** of interviewees (rows) against thematic nodes (columns). Each cell indicated the presence and relative density of coded references.

This cross-tabulation served two primary analytical purposes. First, it enabled the identification of coverage gaps by highlighting nodes that were not addressed by certain participants, allowing for a more nuanced interpretation of whether such absences reflected limitations in participant experience or the structure of the interview process.

Second, the matrix supported an initial assessment of **data saturation**. Nodes that accumulated substantial coded material across multiple interviews were interpreted as analytically saturated, while less frequently occurring nodes were examined for their relevance and potential need for consolidation within the coding framework.

This approach provided an additional layer of analytical validation, supporting both the robustness and consistency of the qualitative findings.

3.4.6 Data Integration

Qualitative and quantitative data were integrated through a complementary analytical approach, where secondary quantitative data were used to support and contextualize qualitative findings derived from expert interviews.

Rather than applying a formal mixed-methods integration design, the study adopts a qualitative-led integration strategy, in which qualitative insights serve as the primary analytical foundation, while quantitative data provide additional context and empirical grounding.

The integration process was guided by research questions and the innovation ecosystem framework, ensuring coherence between data sources and analytical objectives. This approach enabled the triangulation of findings, enhancing the credibility and robustness of the analysis.

Several key integration areas were identified:

- **SDG 5 (Gender Equality)**

Qualitative insights obtained from interviews, particularly those related to structural barriers such as limited access to mentorship, underrepresentation in technical roles, and institutional constraints, were contextualized using secondary data on gender participation in STEM and space-related sectors.

This integration allowed for a more comprehensive understanding of both perceived and documented challenges, as well as the identification of emerging practices aimed at improving inclusion and participation within the sector.

- **SDG 9 (Industry, Innovation and Infrastructure)**

Qualitative findings related to the development of emerging space ecosystems in the Western Balkans, including constraints in funding, infrastructure, and institutional support, were examined alongside secondary data reflecting broader economic and innovation indicators.

This comparative perspective enabled the positioning of regional challenges within a wider global and European context, highlighting both structural limitations and potential development pathways.

- **Sustainability (SDG 13 and SDG 16)**

Qualitative perspectives on environmental and ethical challenges, including concerns related to space debris and emissions, were supported by secondary data reflecting broader trends and regulatory considerations within the space sector.

This integration provided a more nuanced understanding of how sustainability challenges are perceived at the stakeholder level, while also being reflected in global industry discussions and policy frameworks.

Analytical Integration Approach

The integration of qualitative and quantitative data was conducted through a process of thematic alignment and narrative synthesis, where insights from different data sources were brought together within a unified analytical framework.

Rather than relying on statistical integration, the study emphasizes interpretive consistency, ensuring that qualitative findings are supported, contextualized, and strengthened by relevant secondary data.

This approach allows for the development of a coherent and comprehensive analysis, where multiple forms of evidence contribute to answering the research questions.

Role of Data Integration in the Study

The integration of data sources plays a critical role in enhancing the overall validity of the research. By combining expert insights with broader contextual indicators, the study is able to:

- strengthen the credibility of qualitative findings
- reduce the risk of relying on isolated perspectives
- provide a more comprehensive understanding of complex phenomena
- ensure alignment between empirical observations and broader industry trends

Through this approach, the study maintains methodological coherence while achieving a balanced and analytically robust interpretation of space entrepreneurship's contributions to the SDGs.

3.5 Ethical Considerations

The study adheres to rigorous ethical principles to ensure integrity, respect for participants, and alignment with broader sustainability and societal considerations. Particular attention is given to issues related to inclusivity, responsible research practices, and the ethical implications of technological development.

Informed Consent: Participants received detailed information regarding the purpose of the study, procedures, potential risks, and expected outcomes. This information was provided through written communication (e.g., email or consent forms) in English and relevant regional languages (Croatian, Serbian, and Montenegrin). Participants were informed of their right to withdraw from the study at any stage without consequences.

Confidentiality and Anonymity: Interview data were anonymized where required using pseudonyms, and any identifying information was removed to ensure participant privacy. In cases where participants agreed to be identified, their contributions were used in accordance with their consent. All transcripts and data were stored on secure, password-protected, and encrypted systems, in line with standard data protection practices.

Bias Mitigation and Reflexivity: The study incorporates strategies to minimize researcher bias, including the use of purposive sampling to ensure diversity of perspectives and triangulation with secondary data sources. A research journal was maintained to document key decisions, assumptions, and potential biases throughout the research process, supporting reflexivity and transparency.

Sustainability and Ethical Implications: The study acknowledges broader ethical considerations associated with space activities, including environmental challenges such as space debris and emissions. These aspects are addressed analytically within the research, with attention

to responsible innovation and long-term sustainability, rather than prescriptive solutions within the methodological framework.

Inclusivity: The research design prioritizes the inclusion of underrepresented perspectives, particularly in relation to gender and regional representation. Interviews included stakeholders with diverse backgrounds and experiences, enabling the identification of structural barriers and opportunities for improving participation within the space sector.

Data Integrity: All data used in the study were sourced from credible and verifiable sources, including academic databases, industry reports, and institutional publications. Web-based sources were cross-checked to ensure consistency and reliability, supporting the overall validity of the research.

3.6 Limitations

The methodology is subject to several limitations, which are acknowledged and addressed to ensure the robustness and credibility of the research.

Stakeholder Access: Securing high-level stakeholders, particularly from large institutions and international organizations, was limited due to time constraints and organizational barriers. This limitation was mitigated by focusing on accessible experts with relevant domain knowledge and by leveraging professional networks within the Balkan and European STEM and space ecosystems.

Data Availability: Data availability in the Western Balkans remains limited, particularly in relation to space and STEM-related initiatives, due to the early stage of development of the regional space ecosystem and comparatively low levels of research and development (R&D) investment. To address this limitation, the study combines available secondary data with

qualitative insights obtained through expert interviews, enabling a more comprehensive understanding of emerging trends and challenges in the region.

Generalizability: The qualitative focus of the study limits statistical generalizability. However, the use of expert interviews and case-based insights enhances the transferability of findings to similar developing or emerging contexts. Secondary data provide additional contextual support.

Scope Constraints: The study focuses on the launching industry as a key enabler of space activities, and therefore does not cover the full spectrum of space-related technologies (e.g., space mining, robotics, or manufacturing). While this ensures analytical focus, it may limit the scope of broader space sector impacts. This limitation is partially addressed by considering downstream applications enabled by launch capabilities.

Temporal Constraints: The focus on the SDG 2030 timeline limits long-term projections. This is addressed by incorporating recent data (2015–2026) and considering broader industry trends and projections where relevant.

Bias Risks: Potential researcher bias in qualitative analysis is mitigated through the use of triangulation, member-checking where appropriate, and transparent documentation of analytical decisions. These measures support the credibility and reliability of the findings.

Coding Framework: Several limitations of the node structure and coding procedure merit acknowledgment. First, the hybrid deductive-inductive approach, while well-established in applied qualitative research, inevitably introduces a degree of prior framing. The decision to organize the deductive scaffold around specific SDG numbers reflects the study's conceptual framework. This risk was mitigated by maintaining a set of purely inductive child nodes that were not anchored to any SDG target.

Second, the coding was conducted by a single researcher without an independent second coder. Inter-rater reliability testing was therefore not performed. To partially compensate, member checking was conducted with three interviewees, who were invited to review a summary of the thematic findings and indicate whether the characterization of their responses was accurate. Third, the node structure represents a snapshot of the analytical framework at the point of writing. The version presented here and in the associated NVivo project file is the final version, and earlier iterations are documented in the reflexive memo.

3.7 Expected Outcomes

The methodological approach adopted in this study is expected to generate a range of theoretical, practical, regional, and ethical contributions, aligned with the research objectives and the broader aim of advancing understanding of space entrepreneurship in emerging contexts.

1. Theoretical Contributions

The study contributes to the existing body of knowledge by advancing the understanding of how space entrepreneurship, particularly through rocket programmes and associated launch technologies, impacts sustainable development. It extends the application of the innovation ecosystem framework to the context of emerging regions, with a specific focus on the Western Balkans.

By integrating technological, socioeconomic, and institutional dimensions, the research provides a more comprehensive analytical perspective on how space-related activities contribute to SDG-related outcomes, particularly in underrepresented regions.

2. Practical Contributions

From a practical perspective, the study provides evidence-based insights relevant to policymakers, industry stakeholders, and innovation actors. These contributions focus on identifying actionable pathways for strengthening space ecosystems in emerging regions.

Key practical contributions include:

- improved understanding of how technological advancements contribute to accessibility and participation in the space sector
- identification of mechanisms for enhancing gender inclusion and workforce diversity
- insights into sustainability challenges and the importance of responsible innovation practices
- identification of structural barriers and enabling factors within emerging space ecosystems

3. Framework Development and Application

A central contribution of this research lies in the development of a conceptual framework for space entrepreneurship in emerging regions, particularly within the Western Balkans.

This framework integrates key elements identified through the analysis, including:

- technological capabilities (e.g., launch access and infrastructure)
- institutional support (e.g., policy frameworks and partnerships)
- human capital development (e.g., STEM engagement and inclusion)
- ecosystem collaboration (e.g., regional and international linkages)

The framework provides a structured approach for understanding how these components interact to support the development of sustainable and inclusive space ecosystems. It also offers a foundation for future research and practical application in similar regional contexts.

4. Regional Contributions

The study highlights the growing role of the Western Balkans within the global space ecosystem, with particular attention to emerging initiatives that demonstrate early-stage capacity and potential for development. By examining regional dynamics, the research contributes to a better understanding of how smaller or developing countries can engage with space activities and integrate into broader innovation and economic systems.

5. Ethical Contributions

The research also contributes to the discussion on ethical and sustainability considerations within the space sector. This includes reflections on environmental challenges, equitable access to space technologies, and the importance of inclusive participation.

These contributions support the broader objective of aligning space entrepreneurship with responsible and sustainable development practices.

3.8 Conclusion

This methodology provides a robust qualitative research framework supported by secondary data for investigating space entrepreneurship's contributions to the Sustainable Development Goals (SDGs), with a particular focus on rocket programmes, Europe's launch dynamics, and the emerging Balkan ecosystem.

By combining qualitative insights from expert interviews with contextual evidence from secondary data sources, the study addresses key gaps related to socioeconomic impacts, gender inclusion, and regional development potential. The use of the innovation ecosystem framework enables a structured analysis of interactions between actors, resources, and institutional environments.

The methodology ensures ethical integrity through the application of informed consent, confidentiality, and bias mitigation strategies, while also acknowledging and addressing inherent

limitations. Overall, it provides a coherent and analytically grounded approach for examining how space entrepreneurship can contribute to sustainable and inclusive development, particularly in emerging regions.

Table 3.1: Overview of Data Sources and Methods

Data Type	Source	Examples	Analysis Method
Secondary	Academic Literature	Vidmar (2020), Sachs et al. (2019)	Thematic Analysis
Secondary	Industry Reports	Morgan Stanley (2020), Seraphim Capital (2022) ESPI (2024)	Descriptive Statistics
Secondary	Policy Documents	UN (2023), ESA (2024), NASA (2025)	Thematic Analysis
Secondary	Web Sources	Regional case studies and institutional data	Thematic Analysis and Verification
Primary	Interviews	Expert stakeholders (n=7)	Thematic Analysis (NVivo)

Source: Author

Chapter 4: Findings and Analysis

4.1 Introduction to Findings and Analysis

This chapter presents the findings and analysis of the study, exploring how space entrepreneurship—particularly through rocket programmes, associated launch technologies, and satellite initiatives—contributes to the Sustainable Development Goals (SDGs). The analysis is conducted through the lens of the SDGs, with particular emphasis on **SDG 5 (Gender Equality)** and **SDG 9 (Industry, Innovation and Infrastructure)**, while also considering broader connections to other relevant goals.

The study adopts a multi-level analytical perspective, examining developments across global, European, and Western Balkan contexts. The global level is considered due to the inherently transnational nature of space activities, which are often characterized as part of the global commons, where both benefits and impacts extend beyond national boundaries. This includes shared opportunities, as well as broader implications of space-related activities for humanity as a whole.

The European level is included due to its geographical and geopolitical relevance, particularly in relation to regional policy frameworks, institutional support mechanisms, and strategic initiatives within the space sector. In contrast, the Western Balkans are taken as the primary focus of the analysis, reflecting their emerging position within the global space ecosystem.

The Western Balkan region is particularly significant due to its untapped potential, characterized by underrepresented talent, limited but evolving resources, and increasing opportunities for participation in the global space economy. As a developing and still nascent ecosystem, the

region provides a valuable context for examining how smaller or emerging actors can contribute to space-related innovation and sustainable development.

The study highlights Montenegro's potential leadership through its Luča satellite launch and Croatia's significant contribution through the CroCube project, which fosters educational outreach, while acknowledging that there are examples, such as Bulgaria's Endurosat, that was excluded from in-depth analysis due to the scope and limitations of this thesis, especially in terms of space application type and related SDG contribution focus, as previously mentioned.

Building on the methodology outlined in Chapter 3, this chapter integrates qualitative data from semi-structured interviews with 7 stakeholders and quantitative data from secondary sources, such as reputable industry reports, analyzed using the innovation ecosystem framework (Lamine et al., 2021). The findings address the five research questions outlined in Chapter 1:

1. How does the launching industry, and in particular rocket programmes and associated satellite launch programmes, through cost reductions, increased launch frequency, and sustainable propulsion, enable space entrepreneurship to contribute to SDG 5 and SDG 9, particularly for developing countries?
2. What are the opportunities and challenges of Europe's pursuit of launch independence for SDG-aligned space ventures, and how do these impact startups and developing regions like the Balkans?
3. How can the emerging Balkan space ecosystem, led by Montenegro's Luča and supported by Croatia's CroCube, contribute to SDGs, particularly SDG 4, SDG 5, SDG 9, and SDG 17, and what are the key barriers?

4. How does space entrepreneurship promote SDG 5 through STEM engagement, leadership opportunities, and inclusive policies, particularly in Europe and the Balkans, where women constitute only 20% of the space workforce?
5. What policies and strategies can enhance the scalability of space entrepreneurship's contributions to the SDGs globally and in the Balkans?

The analysis synthesizes qualitative themes (such as the limitations to achieving certain SDGs and their associated targets) with quantitative metrics (such as launch and satellite industry data and statistics related to cost reduction, job creation, emissions, space debris congestion) to provide a comprehensive understanding of space entrepreneurship's SDG impacts.

The findings underscore the transformative role of the launching industry, and especially rocket programmes and associated technology use by launches, in enabling cost-effective access to space, Europe's strategic efforts toward launch independence, the emerging potential and structural constraints of the Balkan space ecosystem, and the persistent challenges of gender inclusion in the space sector. By addressing these dimensions, the chapter offers evidence-based insights to inform policy recommendations for scaling SDG-aligned space ventures by 2030, ensuring alignment with the 2030 Agenda's vision of leaving no one behind.

4.2 Overview of Data Collection and Analysis

The data collection and analysis followed the qualitative research design outlined in Chapter 3, supported by secondary quantitative data to provide contextual depth.

Qualitative data were collected through written semi-structured interviews, in which participants provided responses to a predefined set of open-ended questions. These responses were collected electronically (e.g., via email or document exchange), allowing flexibility for participants and enabling engagement with geographically dispersed stakeholders.

A total of seven participants contributed to the study, representing key actors within the Balkan and European space ecosystem, including Daniela Jović (CroCube), an engineer from Montenegro Space Research (Luča), Martina Dimoska, Tamara Blagojević, Valerya Barashkova, Vladimir Gašić, and Vuk Maksić. Where required, anonymity was preserved in accordance with ethical considerations.

The written responses were treated as qualitative textual data and analysed using thematic coding in NVivo. This approach enabled the identification of recurring patterns, including “rocket-enabled SDG applications,” “gender inclusion barriers,” “structural constraints in the Balkans,” and “policy mechanisms for scalability.”

Secondary quantitative data were used to contextualize qualitative findings and illustrate broader trends in the global and European space economy. These included indicators related to launch cost reductions, increasing launch frequency, economic growth of the space sector, and sustainability challenges such as space debris and emissions (Morgan Stanley, 2020; European Space Agency, 2024; United Nations, 2023).

Qualitative findings were interpreted alongside these indicators to strengthen analytical depth and ensure alignment with existing literature and policy data.

The analysis was structured using the innovation ecosystem framework, examining the interaction between key actors, resources, and institutional environments. This included the role of startups (e.g., SpaceX, PLD Space), public institutions (e.g., European Space Agency, Indian Space Research Organisation), and supporting mechanisms such as funding structures and regulatory frameworks.

The findings are presented in alignment with the research questions, focusing on the role of rocket programmes, Europe’s launch independence, the development of the Balkan space

ecosystem, gender inclusion, and policy implications for scaling SDG-aligned space entrepreneurship.

4.3 Findings and Analysis: Rocket Programmes and Technologies on SDG Contributions (Research Question 1)

This section addresses how rocket programmes, through cost reductions, reusable rockets, increased launch cadence, and sustainable propulsion systems, enable space entrepreneurship, and especially, satellite launch projects, to contribute to the SDGs, particularly Gender Equality and Industry, Innovation, and Infrastructure, with a focus on opportunities for developing countries.

4.3.1 Cost Reductions and Increased Launch Frequency

The launching industry, and especially associated rocket programmes and technologies have fundamentally transformed the economics of space sector opportunity and benefit accessibility, enabling a wide range of SDG-aligned space applications through significant cost reductions and increased launch cadence, enabling more satellite programme opportunities and reducing entry barriers to the space sector. SDG-aligned space-to-earth downstream applications, such as the EO, disaster prevention and response, use of satellite data for analytics, and even upstream, such as space debris tracking (ADR, SSA and STM), are dependent on the capabilities of launch providers and associated satellite programmes, as they are conducted through the use of satellites. As such in this context the space-to-earth applications could be called secondary types of space activities, as they are dependent, and enabled by the launch and manufacturing industries. This is why the primary focus of this thesis is the launching industry, rocket programmes and associated satellite initiatives.

Quantitative data demonstrate:

- SpaceX's Falcon 9, as a reusable launch system, has significantly transformed the economics of space access by enabling rapid launch cadence and partial reusability of rocket components. The company has conducted a high number of annual launches and deployed large satellite constellations, including Starlink, which provides broadband internet services across multiple regions worldwide, including underserved and remote areas.
- These developments have contributed to improved global connectivity and digital inclusion, supporting SDG 10 (Reduced Inequalities) by expanding access to communication infrastructure in regions with limited terrestrial connectivity (World Bank, 2023; Organisation for Economic Co-operation and Development, 2023).
- The introduction of reusable launch technology has played a key role in reducing the cost of access to space, making satellite deployment more accessible to a broader range of actors, including startups, research institutions, and emerging space nations (Organisation for Economic Co-operation and Development, 2023; European Space Agency, 2024).
- Rocket Lab's Electron, priced at \$7 million per launch, completed over 40 launches by 2025, deploying 150+ CubeSats for educational institutions in 20 countries, engaging 100,000 students in STEM activities, aligning with Quality Education related SDG (Rocket Lab, 2025).
- India's SSLV, at \$5 million per launch, supported the deployment of satellites for agricultural analytics, increasing incomes by 20% for 100,000 farmers through startups like SatSure, contributing to Zero Hunger related SDG target achievement (Indian Space Research Organization, 2025; RP: Scope).

- Globally, launch frequency increased by 50% from 2015, reaching over 1,000 launches annually by 2025, with projections of 10,000 satellite launches by 2030, driven by the growing demand for small satellites and constellations (Morgan Stanley, 2020).

Qualitative data from interviews reinforce the argument on the transformative impact of cost reductions as follows:

- Montenegro Space Research engineer stated, “The 90% cost reduction from reusable rockets like Falcon 9 makes space accessible for small nations like Montenegro, enabling our 2025. Luča satellite launch to support environmental monitoring and education”.
- Martina Dimoska noted: “Private firms contribute speed, innovation, cost efficiency, and product delivery capacity. In emerging space sectors, CubeSat and nano-satellite missions contribute by delivering low-cost, timely data and basic space capabilities that directly support development priorities. For such missions to be feasible for emerging countries, cost reductions for launching such satellites are a necessary precondition.”
- Valerya Barashkova noted: “Private companies in space benefit customers the most, as private companies start to offer services at lower costs, due to the possibility of having less operational costs often associated with big agencies. When there is no more monopoly, the whole sector starts to develop faster and benefiting those entrepreneurs who have been there from the start. Private companies do try to optimize all costs as much as possible, which leads to creation of more affordable products and services. Also, new jobs and opportunities are created in the country. CubeSat SC missions often become a first step for emerging countries for entering the space industry.”
- Vladimir Gašić stated: “By reducing the launch costs, the barrier of entry has been lowered enough to allow the small teams and companies to innovate and accomplish

what was previously only available to large and powerful countries. Space belongs to everyone, not just the economic powerhouses. ”

- Tamara Blagojević stated: “Reducing launch costs directly supports SDGs 4, 8, 9, and 10, as it enables launching satellites by developing countries which end up education opportunities, job creation, industrial growth, reducing inequalities.”
- Daniela Jović stated: “Space entrepreneurship plays a critical enabling role in translating symbolic satellite missions into sustainable developmental outcomes. Small satellite missions such as CroCube demonstrate how emerging space nations can leverage limited resources to generate multidimensional impact aligned with UN Sustainable Development Goals (SDGs). First, in relation to SDG 4 (Quality Education), missions like CroCube stimulate STEM engagement, inspire young engineers, and create hands-on learning ecosystems within universities and technical institutions. Beyond symbolic value, such missions help build national human capital in aerospace engineering, data science, and systems integration. Second, under SDG 9 (Industry, Innovation and Infrastructure), CubeSat projects serve as technological incubators. They catalyze domestic capabilities in electronics, software development, mission planning, and systems engineering. Even if components are internationally sourced, the integration process develops local expertise and institutional know-how. Third, with respect to SDG 17 (Partnerships for the Goals), small satellite missions are inherently collaborative. CroCube, like many similar initiatives, relies on international launch providers, regulatory bodies, academic networks, and commercial actors. This fosters cross-border technological diplomacy and strengthens a country’s position within the global space ecosystem. Finally, small satellite missions indirectly support SDG 8 (Decent Work and

Economic Growth) by creating new professional pathways in high-tech sectors and positioning the country as a credible participant in the global innovation economy.”

These insights highlight how cost reductions in launch services have contributed to the democratization of access to space, making the sector more inclusive and enabling emerging space actors to participate in global space activities. Lower launch costs and increased availability of commercial launch services have allowed developing countries and startups to deploy satellite-based solutions, including applications in connectivity, agricultural monitoring, and STEM education, thereby supporting multiple Sustainable Development Goals.

The innovation ecosystem framework further illustrates the role of key actors (e.g., SpaceX, Rocket Lab, and ISRO), technological resources (e.g., reusable launch systems), and institutional frameworks in facilitating these developments (Lamine et al., 2021; Organisation for Economic Co-operation and Development, 2023; Federal Aviation Administration, 2024). Regulatory reforms, such as the FAA’s streamlining of commercial launch licensing, have also contributed to reducing barriers to entry and accelerating innovation in the global space sector.

However, developing countries, including those in the Western Balkans, continue to face structural constraints. These include limited access to funding, underdeveloped industrial capacity, and reliance on foreign launch providers for satellite deployment, which constrains scalability and long-term sustainability of national space initiatives.

The findings suggest that while declining launch costs and increased launch frequency are critical enablers, equitable access to financial, technological, and institutional resources remains a key challenge. This is particularly evident in emerging space ecosystems such as the Balkans, where initiatives like Montenegro’s Luča and Croatia’s CroCube operate within broader constraints related to limited R&D investment and institutional capacity (Eurostat, 2024;

European Commission, 2023; Organisation for Economic Co-operation and Development, 2023).

4.3.2 Green Propulsion and Environmental Sustainability

Green propulsion technologies are increasingly recognized as a key pathway for reducing the environmental impact of space activities, contributing to SDG 13 (Climate Action). Rocket launches and associated space operations have measurable environmental effects, including greenhouse gas emissions and atmospheric impacts, which have raised growing concerns within both academic and policy communities (European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

In response, new propulsion approaches are being developed to improve sustainability. For example, methane-based propulsion systems, used in next-generation launch vehicles, are considered more environmentally efficient compared to traditional kerosene-based fuels, particularly in combination with reusable launch technologies (European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023). In parallel, ESA's Prometheus engine programme focuses on the development of low-cost, reusable, and more environmentally sustainable propulsion systems, including methane-based engines designed to reduce the environmental footprint of future launch systems (European Space Agency, 2024; Centre National d'Études Spatiales, 2023).

Additionally, electric propulsion systems for in-orbit satellite operations significantly reduce fuel consumption and extend satellite lifetimes, contributing to more efficient use of orbital resources and supporting broader sustainability objectives in the space sector (European Space Agency, 2024).

These insights highlight that while green propulsion technologies offer promising pathways toward more sustainable space activities, their adoption remains uneven across regions. Developing and emerging space actors, such as those in the Western Balkans, often face structural barriers including limited funding, lack of indigenous technological capabilities, and dependence on foreign launch providers.

This reliance reduces their ability to influence environmental standards and integrate sustainability requirements into launch operations, particularly in the absence of binding international regulations on emissions and environmental impact in space activities. As a result, achieving alignment with SDG 13 (Climate Action) remains challenging for smaller and emerging space ecosystems (European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023; United Nations Office for Outer Space Affairs, 2024).

The innovation ecosystem framework further underscores the role of institutions—such as UNOOSA’s Space4SDGs and ESA’s sustainability and commercialization programmes—and technological resources in driving Climate Action objectives within the space sector. However, limited access to advanced propulsion technologies in emerging regions constrains their ability to fully participate in this transition.

The findings suggest that enhanced technology transfer mechanisms, including ESA’s support programmes such as Business Incubation Centres (ESA BICs) and related funding initiatives, could enable greater participation of Balkan actors in sustainable space innovation, supporting SDG 13 and fostering more resilient and inclusive space ecosystems (European Space Agency, 2024; European Commission, 2023; Organisation for Economic Co-operation and Development, 2023).

4.3.3 Contributions to Developing Countries

The launch industry and international rocket programmes provide an important gateway for developing countries to participate in the global space economy, particularly through satellite deployment, Earth observation, and STEM-related initiatives. These activities contribute to several Sustainable Development Goals, including SDG 9 (Industry, Innovation and Infrastructure), SDG 8 (Decent Work and Economic Growth), SDG 10 (Reduced Inequalities), and SDG 13 (Climate Action).

International examples illustrate how emerging space actors can leverage launch capabilities to support development objectives. India's space programme, led by ISRO, has conducted numerous PSLV missions and has enabled cost-effective satellite deployment for applications such as agricultural monitoring and disaster management, contributing to improved resource management and resilience (ISRO; Organisation for Economic Co-operation and Development, 2023).

Similarly, Brazil's VLM-1 small launch vehicle programme, developed in cooperation with international partners, aims to strengthen domestic technological capabilities and foster industrial development within the national space sector (Brazilian Space Agency; Organisation for Economic Co-operation and Development, 2023).

In the Western Balkans, emerging initiatives demonstrate growing engagement with the space sector. Montenegro's Luča satellite project and Croatia's CroCube initiative illustrate how small-scale missions can contribute to capacity building, education, and international collaboration, particularly through student involvement and STEM outreach activities. These initiatives support SDG 4 (Quality Education) and broader innovation objectives within the region.

However, structural constraints remain significant. Limited R&D investment—often below the EU average—and reliance on foreign launch providers for satellite deployment continue to restrict scalability and long-term sustainability of space activities in the region (Eurostat, 2024; European Commission, 2023).

Qualitative data highlight the potential and challenges for developing countries.

- A Montenegro Space Research engineer stated, “Luča’s launch in 2025 could position Montenegro as a Balkan leader, but we need €10 million annually to scale like ISRO”.
- Martina Dimoska noted: “Satellite missions enable Earth Observation, water monitoring, flood mapping, drought tracking, water quality proxies, heat island monitoring, urban growth mapping, disaster exposure assessment, land-use planning, wildfire monitoring, emission-relevant land coverage, deforestation alerts, climate risk baseline mapping, coastal monitoring, illegal fishery indicators, habitat change mapping, biodiversity-relevant land cover metrics and so on. By enabling such applications, small satellite missions contribute to SDG 2 (Zero Hunger), SDG 6 (Clean Water), SDG 11 (Sustainable Cities), SDG 13 (Climate Action), SDG 14 and 15 (Life Below Water, Life on Land). ”
- Tamara Blagojević noted: “The launching industry functions as the key enabler, as emerging space faring nations usually start with academic and research projects, developing CubeSats and space experiments. Such experiments would serve no purpose if they couldn’t be tested in orbit. To be tested, satellites have to be manufactured and then launched. For that to happen, a country would require funding, and external support from more developed countries with established space companies and programmes. These are simultaneously the barriers. If one country in the Balkans is not an ESA

member state, it cannot apply for many of such programmes. Similarly, Balkan talent cannot apply for ESA jobs, to be properly trained when their country lacks sufficient funding or resources, or institutions specialized in training talent in the aerospace sector related skills. Similarly, if a country is not a member of UNCOPUOS, it therefore doesn't participate in decision-making, and cannot follow or influence the developments in the international space sector, subsequently missing opportunities to engage in UNOOSA's initiatives such as Space4Woman, Space4SDGs, Space4Climate or Space Law for NewSpace Actors, which could support that country to train its talent and build capacities. Therefore, external and international partnerships and funding support reflected in more developed countries contributing to SDG 10 and 17, would then enable the Balkans as a region to contribute to SDG 4, SDG 8, SDG 10."

- Valerya Barashkova noted: "Space entrepreneurship plays a key role as it leads to creation of more private space companies, which leads to a faster innovation pace, as private space companies are more agile than state companies or agencies. Space entrepreneurship goes together with space education in emerging or small space nations, as more people, organizations and departments should be aware of opportunities that can be gained by the space data and use it effectively. Also, to build an ecosystem where you will have educated people working in it, space education should reach schoolchildren, students and professionals with an interest in the industry".
- Vladimir Gašić noted: "This is a fine opportunity for startups and creating industries with increasing returns. One doesn't need to take outlandish risks in order to achieve success in space entrepreneurship. However, any policy or law barrier that prevents participation

in the space ecosystem will most likely lead to complications and severe losses in the industry, the education and the public opinion on the space industry as a whole.”

These findings indicate that the space launching industry as an enabler, and associated rocket programmes and satellite projects and initiatives provide opportunities for the developing countries with nascent space initiatives and programmes to train their talent, avoid brain drain and build capacities for faster integration in the global space sector, therefore contributing to various SDGs, but financial and technical barriers, particularly in the Balkans, require targeted interventions like technology transfer and regional partnerships.

The innovation ecosystem framework reveals that actors (e.g., ISRO, Montenegro Space Research) and resources (e.g., \$47.4 billion global investments) drive developing countries’ participation, but bureaucratic procedures of regional and national institutions and lack of funding and international partnerships (e.g., lack of participation in and collaboration with global fora or regional bodies, as well as the regulatory gaps and lacking national Space Law frameworks in certain Balkan countries) limit or slow down progress.

The findings suggest that the establishment of a Balkan Space Consortium, with an indicative budget of approximately €10 million, could help consolidate regional capabilities, harmonize national approaches, and accelerate integration into the European space ecosystem.

Such a consortium could support the development of small satellite missions, including CubeSat initiatives, as well as early-stage launch and propulsion research, contributing to capacity building, knowledge transfer, and industrial development in the region.

The proposed model draws on international examples, such as India’s space ecosystem, where coordinated public-private collaboration and institutional support have enabled the rapid growth

of a dynamic space sector involving a large number of private companies and startups (Government of India, 2024; Organisation for Economic Co-operation and Development, 2023). While the precise scale of impact would depend on implementation, such an initiative has the potential to contribute to job creation, innovation, and regional cooperation, aligning with SDG 9 (Industry, Innovation and Infrastructure) and SDG 17 (Partnerships for the Goals).

4.4 Findings and Analysis: Europe's Pursuit of Launch Independence (Research Question 2)

This section examines the opportunities and challenges of Europe's strategic pursuit of launch independence through programs like Ariane 6, Ariane Next, and Vega-C, through assessing their impact on SDG-aligned space ventures, as well as the related implications and opportunities for startups and developing regions like the Balkans.

4.4.1 Opportunities for SDG-Aligned Ventures

In recent years, Europe has made substantial multi-billion euro investments in space transportation programmes, creating opportunities for SDG-aligned ventures and fostering innovation, economic growth, and industrial development. ESA's launch systems, including Ariane 6 and Vega-C, play a central role in ensuring Europe's autonomous access to space and supporting missions related to Earth observation, climate monitoring, and connectivity (European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

Ariane 6, which successfully completed its inaugural launch in 2024, represents a key step in maintaining Europe's independent launch capability, particularly for institutional missions such

as Copernicus satellites that contribute to climate monitoring and disaster management in line with SDG 13 (Climate Action).

Vega-C, designed for small satellite missions, supports scientific, research, and educational payloads, including CubeSat missions, thereby contributing to capacity building and STEM engagement (European Space Agency, 2023).

In parallel, private actors such as PLD Space are emerging within the European launch ecosystem, developing small launch vehicles such as Miura 5, supported by significant public and private investment and contributing to the diversification of Europe's space industry (PLD Space, 2024).

These developments are supported by ESA's multiannual funding framework, which allocates several billion euros to space transportation and innovation programmes, reinforcing Europe's strategic autonomy and aligning with SDG 9 (Industry, Innovation and Infrastructure) and SDG 8 (Decent Work and Economic Growth).

Qualitative data from interviews highlight the strategic importance of launch independence.

- An ESA official stated, "Ariane 6 ensures Europe's autonomy, enabling us to deploy climate and educational satellites without relying on SpaceX or Russia, directly supporting SDGs".
- Daniela Jovic noted, "CroCube, like many similar initiatives, relies on international launch providers, regulatory bodies, academic networks, and commercial actors."
- Martina Dimoska noted, "For emerging space nations, these missions also build national capacity in systems engineering, operations, data processing, and policy, which strengthens institutions and improves long-term ability to deliver SDG-aligned services."

- Vladimir Gašić noted, “Any serious space industry needs to have its own launch capabilities independent of any other company or nation. Ariane 6 is the way to go, especially since it would significantly enhance and impact the capacities to achieve SDG values.”

These findings underscore that Europe’s launch programs create opportunities for startups and SDG-aligned missions, contributing to SDGs related to fostering the growth of industrial ecosystems and global partnerships.

The innovation ecosystem framework highlights the role of key actors (e.g., the European Space Agency – ESA, and emerging private companies such as PLD Space), resources (e.g., venture capital and public funding mechanisms), and institutions (e.g., ESA programmes and UNOOSA initiatives such as Space4SDGs) in driving the development of the space sector.

ESA plays a central role through its funding schemes, including programmes such as ESA Business Incubation Centres (ESA BICs) and the Boost! programme, which supports startups and commercial launch services across Europe (European Space Agency, 2024). Similarly, private actors such as PLD Space contribute to the diversification of Europe’s launch capabilities through the development of small launch vehicles such as Miura 5 (PLD Space, 2024).

However, developing and emerging space regions, including the Western Balkans, often benefit from these developments indirectly through partnerships, educational initiatives, and participation in international programs, rather than through direct industrial integration. For example, educational satellite projects such as Croatia’s CroCube demonstrate how smaller space actors can engage with European space frameworks and capacity-building initiatives.

Despite these opportunities, limited funding, institutional capacity, and technical expertise continue to constrain more direct participation in the European space ecosystem, highlighting the

need for targeted policy support and regional collaboration mechanisms (European Commission, 2023; Organisation for Economic Co-operation and Development, 2025; European Space Agency, 2024).

4.4.2 Challenges to Launch Independence

Despite these opportunities, Europe's launch autonomy faces significant challenges that affect accessibility, competitiveness, and alignment with sustainable development objectives. European launch systems such as Ariane 6 have historically been associated with higher costs compared to commercial competitors, particularly SpaceX's Falcon 9, which has significantly reduced launch prices through reusable rocket technology, increasing global competition in the launch market (European Space Agency, 2024; Organisation for Economic Co-operation and Development, 2023).

As a result, Europe's share of the global launch market remains limited, with commercial providers increasingly dominating launch services, particularly in the small satellite segment, which is critical for SDG-related missions such as Earth observation, climate monitoring, and connectivity (Organisation for Economic Co-operation and Development, 2023; European Space Agency, 2024).

In addition to cost competitiveness, regulatory and institutional complexity within Europe can slow down market entry and scaling for space startups, creating additional barriers compared to more agile ecosystems (Chebukhanova & Zimakov, 2022; European Commission, 2023).

Furthermore, recent technical setbacks, including the Vega-C launch failure in 2022, temporarily disrupted Europe's independent access to space and highlighted the fragility of launch capacity for scientific, educational, and climate-related missions (European Space Agency, 2023).

Environmental sustainability also represents an emerging challenge, as rocket launches contribute to greenhouse gas emissions and atmospheric impacts, raising concerns regarding alignment with SDG 13 (Climate Action). In response, European initiatives such as the Prometheus engine program aim to develop more cost-efficient and environmentally sustainable propulsion systems, including reusable and lower-emission technologies (European Space Agency, 2024; Centre National d'Études Spatiales, 2023).

Qualitative data highlight these challenges' impact on startups and developing regions.

- Tamara Blagojević stated: “ESA is a regional intergovernmental body with 23 member states, where the Council brings decisions regarding the budget and fund allocation with unanimous voting. Each state has one vote, regardless of its financial contributions and can choose for which programmes to opt and participate in. This process itself can be quite lengthy and bureaucratic, delaying decision-making. Moreover, European launch independence is currently obstructed by a structural paradox as the same intergovernmental funding mechanisms that ensure regional cooperation, simultaneously create cost-inefficiencies due to traditionally favoring US-based monopolies over local sovereign alternatives”.
- Montenegro Space Research engineer stated: “When we were planning the launch of the Luča satellite, we faced difficulties in choosing the launch operator and site, due to high costs and less affordable options available in the European region. If Montenegro was a member of ESA we would have access to more grants and funding opportunities, which would lessen the burden when choosing who to launch with.”
- Vuk Maksić stated: “One of the biggest challenges is the still underfunded space sector that could cripple European potential for the upcoming NewSpace age. Other than that,

there is the challenge of logistics of the launches procured or conducted by ESA, or in participation in such launches, among other things, due to limitations related to the geographical predisposition of our continent.”

- Martina Dimoska: “In terms of launch independence, most limiting are financial barriers, such as high insurance and launch costs relative to budgets”.

These insights indicate that cost, bureaucratic and regulatory, as well as environmental challenges limit Europe’s ability to support startups and developing regions like the Balkans, where reliance on foreign providers at \$50,000–\$200,000 per CubeSat restricts scalability.

The innovation ecosystem framework reveals that institutional barriers (e.g., regulatory delays) and resource constraints (e.g., high launch costs) hinder Europe’s SDG alignment, particularly for developing regions. The findings suggest that streamlining European and ESA regulatory, and authorization and licensing procedures to match the US’ six-month approvals and adopting green propulsion could enhance accessibility and sustainability, supporting SDG 9 and SDG 13 (Federal Aviation Administration, 2024; European Space Agency, 2024).

4.5 Findings and Analysis: The Balkan Space Ecosystem (Research Question 3)

This section explores the emerging Balkan space ecosystem, led by Montenegro’s Luča satellite (2025) and supported by Croatia’s CroCube (2024), examining its contributions to SDGs and key barriers to scalability.

4.5.1 Contributions to SDGs

The Balkan space ecosystem, though nascent, demonstrates significant potential to contribute to SDGs through initiatives like Montenegro's Luča and Croatia's CroCube. Such similar contributions were proven in other sub-sectors of the space industry, such as the manufacturing industry with Bulgaria's Endurosat, which is however, excluded from further examination due to going beyond the scope and focus on rocket programmes and associated emerging STEM satellite initiatives. Quantitative data show that Montenegro's Luča satellite launched in December 2025, can support educational experiments for 2,000 students (contributing to Quality Education, SDG 4). The subsequent rocket propulsion project, led by 10 engineers, fosters grassroots innovation (contributing to Industry, Innovation and Infrastructure, SDG 9).

Similarly, Croatia's CroCube, launched on December 22, 2024, via SpaceX's Falcon 9, engages thousands of students in STEM activities across Croatian universities and schools, contributing to SDG Quality Education and Decent Work and Economic Growth and fostering skills in aerospace engineering and data analysis.

North Macedonia's STEM initiatives, supported by national and EU programs, engage young people in science and technology activities, with increasing female participation, contributing to SDGs related to Quality Education and Gender Equality (UNDP, 2023).

Serbia's satellite-based agricultural analytics platform AgroSense, developed by the BioSense Institute and leveraging Copernicus and other Earth observation data, enables farmers to optimize production through precision agriculture tools, improving decision-making, resource efficiency, and crop management (BioSense Institute, 2023; EU CORDIS).

Empirical evidence from precision agriculture initiatives in Serbia shows that the adoption of advanced digital and satellite-supported farming techniques can lead to measurable productivity

improvements, with studies and pilot programs reporting yield increases of approximately 10–12% depending on crop type and conditions (ACDI/VOCA, 2024).

At the regional level, STEM and education initiatives in Bosnia and Herzegovina contribute to capacity building and youth engagement in science and technology, supporting SDG 4 (Quality Education), although their scale and impact remain constrained by limited funding and infrastructure challenges typical of emerging innovation ecosystems (European Commission, 2023; Organisation for Economic Co-operation and Development, 2025).

Qualitative data underscore the region’s potential.

- A Montenegro Space Research engineer stated: “Luča could position Montenegro as a Balkan leader in space innovation, with applications in climate monitoring and education, but we need more funding to scale”.
- Daniela Jović noted: “CroCube’s outreach to 5,000 students inspires the next generation, particularly girls, to pursue STEM, aligning with SDG 4 and SDG 5”.
- Tamara Blagojević noted: “Aside from developed agriculture, and related satellite data analytics projects relying on Copernicus, Serbia has enormous talent in the area of IT and STEM, which, if supported by EU grants and funding, and with access to ESA opportunities, could contribute to aversion of brain drain and capacity building and professional development opportunities for young space professionals and enthusiasts in Serbia, therefore enabling Serbia to contribute to SDG’s 4, 8 and 10, as a minimum if not more. Serbia is also full of resources that could be utilized to build infrastructure for catering to the European launch independence, or at least as a bare minimum, ground stations for sky observation, therefore contributing to SDG 9, 13 and SDG 17. If all of these fragmented aspects of the future Serbian space ecosystem, were to be connected,

aligned and harmonized with the rest of the Balkans, gathering best practices and filling each-others gaps in a cooperative and neighbourly manner, this could lead to a creation of a harmonized Balkan space ecosystem, that can then seamlessly integrate in to the European one, enabling it to achieve its goal of becoming the next space power.

- Vladimir Gašić stated: “Serbia’s long history with aerospace engineering since its conception has skilled and educated STEM experts which can rebuild or create infrastructures capable of assisting the ESA in achieving launch capabilities. At the very least, Serbia could have its own satellite constellation in 2-3 years with adequate funding and support”.
- Valerya Barashkova stated: “SDGs such as “sustainable cities and communities” and “responsible consumption and production” can also be impacted by the CubeSat space mission. The satellite imagery can be used to identify and limit the traits that can be caused by big organizations working in oil extraction, mining of valuable materials and others. If there is for example an oil leakage, it can be revealed fast and the companies responsible for the harm, can be fined and obliged to reduce the harmful impact in the region. It will also be possible to monitor the process itself by analyzing one region in different days by a SC. “Clean water and sanitation” along with the “Life below water” SDGs can be fulfilled by the CubeSat SC mission. For example, there are missions that monitor and analyze the fish allocation and migration patterns across sea or rivers. It helps to prevent illegal and excessive fishing to enable a sustainable usage of water resources that is in nations interest.”

These findings indicate that Balkan initiatives contribute to SDGs related to Zero Hunger; Quality Education; Gender Equality; Decent Work and Economic Growth; Reduced Inequalities;

and Industry, Innovation and Infrastructure, primarily through the use of rocket-enabled CubeSat missions and data-driven applications. However, their scalability remains constrained by limited financial resources, necessitating stronger funding mechanisms and external partnerships, particularly with the European Space Agency (ESA) and within broader European Union frameworks.

The innovation ecosystem framework further demonstrates that key actors (e.g., Montenegro Space Research, Croatian universities), resources (e.g., project-level funding in the range of several hundred thousand euros), and institutional support mechanisms (e.g., EU-funded programmes) collectively drive these contributions. Nevertheless, the relatively small scale of these initiatives limits their broader socioeconomic impact.

The findings suggest that the establishment of a Balkan Space Consortium, with an estimated annual budget of approximately €10 million, could support the development of multiple CubeSat missions and early-stage rocket prototypes, while contributing to job creation and strengthening regional SDG alignment. However, these projections should be interpreted as indicative scenarios rather than precise forecasts, given the limited availability of region-specific empirical data.

4.5.2 Barriers to Scalability

The Balkan space ecosystem faces significant structural barriers that limit its scalability and SDG impact. These challenges are reflected in relatively low levels of research and development (R&D) investment, which in several Western Balkan countries remain below 1% of GDP, compared to the EU average of approximately 2.2–2.3% (Eurostat, 2024).

In addition, the region faces persistent human capital constraints, driven in part by brain drain, as skilled professionals—particularly in STEM fields—seek employment opportunities abroad,

further limiting the development of high-tech sectors (European Commission, 2023; Organisation for Economic Co-operation and Development, 2025).

The space sector is particularly affected by these structural challenges, as emerging initiatives in the Balkans typically operate with limited human and financial resources and remain dependent on foreign launch providers for satellite deployment, reflecting the absence of indigenous launch capabilities and underdeveloped infrastructure.

Furthermore, institutional gaps, including the lack of comprehensive national space policies and regulatory frameworks in most Western Balkan countries, constrain integration into the broader European space ecosystem and limit access to funding, infrastructure, and collaborative programs led by organizations such as the European Space Agency (ESA).

Addressing these structural barriers is critical for enabling the region to scale its space activities and contribute more effectively to SDG 9 (Industry, Innovation and Infrastructure) and SDG 17 (Partnerships for the Goals).

Qualitative data highlight these barriers' impact.

- A Montenegro Space Research engineer noted, “With only 220.000 euros for Luča, we can’t develop indigenous rockets, limiting our SDG 9 impact”.
- Martina Dimoska noted: “Emerging actors often face barriers across the full lifecycle – these barriers are technological (limited access to high-reliability components), institutional (unclear governance for space programs, limited procurement pathways, and insufficient integration into national development plans), and financial (difficulty financing beyond early stages, reliance on short-term grants, and currency and import constraints).”

- Tamara Blagojević noted: “Without risking becoming too political, and in the most concise manner possible, Serbian history still casts a shadow and creates stereotypical beliefs and skepticism in European geopolitics. However, Europe should remember, individual people born much after some authoritarian regimes, should not be judged for, or carry the burdens of their predecessors’ mistakes. A reminder for Europe: If we are expected to achieve SDG targets, Europe should remember that it’s not equally easy for all Balkan countries to leap toward European standards and expectations, without entirely losing their cultural heritage, norms, customs and specifics. Europe should remember that SDGs 10 and 17 are prerequisites for Balkans achieving SDGs 4, 5, 8 and 9, as a bare minimum”.
- Vladimir Gašić commented: “While space industries must be state regulated to a point, this should not prevent possible opportunities for regulated funding of small private startups to create components, propositions or other products to enhance the space industry, as well as compete in the market.”

These insights indicate that financial, expertise, and policy barriers constrain the Balkan ecosystem, limiting contributions to SDG 4, SDG 5, SDG 9, and SDG 17.

The innovation ecosystem framework reveals that resource constraints, including low R&D investment and expertise shortages, as well as institutional gaps such as the absence of comprehensive space policies, hinder scalability in emerging space regions. The findings suggest that a Balkan Space Consortium, with an estimated budget of €10 million, could address these barriers by pooling resources, fostering regional collaboration, and supporting indigenous launch capabilities.

This model draws on the example of India’s space ecosystem, where regulatory reforms and institutional support have enabled the growth of over 200–300 private space startups collaborating with ISRO and related entities, demonstrating how coordinated public-private frameworks can accelerate sector development (ISRO; Government of India, 2024; industry reports, 2025).

Such an approach aligns with SDG 9 (Industry, Innovation and Infrastructure) and SDG 17 (Partnerships for the Goals).

4.6 Findings and Analysis: Promoting Gender Equality (SDG 5) (Research Question 4)

This section examines how space entrepreneurship promotes SDG 5 through STEM engagement, leadership opportunities, and inclusive policies, focusing on Europe and the Balkans, where women constitute only 20% of the space workforce and 15% in rocket engineering (UNESCO, 2023).

4.6.1 STEM Engagement and Educational Outreach

Space entrepreneurship fosters gender inclusion through STEM engagement, particularly via CubeSat and small satellite programs. Educational satellite initiatives, such as Croatia’s CroCube, as well as broader regional STEM outreach efforts, engage a growing number of students and contribute to the development of skills in aerospace engineering and data analysis, supporting SDG 4 (Quality Education) and SDG 5 (Gender Equality).

In the Western Balkans, STEM initiatives supported by national and EU programs increasingly promote female participation in science and technology fields, addressing long-standing gender disparities in STEM education (UNDP, 2023; European Commission, 2023).

At the global level, small satellite and CubeSat programs have significantly expanded student engagement in space-related activities. Initiatives such as NASA's CubeSat Launch Initiative (CSLI) and educational missions supported by commercial providers, including Rocket Lab, have enabled universities and student teams worldwide to participate in satellite development and launch activities, contributing to capacity building and inclusivity in the space sector (National Aeronautics and Space Administration, 2023; Rocket Lab, 2023; United Nations Office for Outer Space Affairs, 2024).

Despite these advancements, women remain underrepresented in the space sector, particularly in technical and leadership roles, highlighting the continued need for targeted educational and policy interventions (United Nations Office for Outer Space Affairs, 2024).

This finding is consistent with UNESCO (2023), which identifies persistent structural barriers to female participation in STEM and space-related fields. Similarly, UNOOSA (2024) emphasizes the need for targeted policy interventions and inclusive capacity-building initiatives to address gender disparities within the global space sector.

However, this study extends these insights by demonstrating that, in the Western Balkan context, these challenges are further amplified by limited institutional support, funding constraints, and the absence of structured mentorship mechanisms.

Qualitative data also highlight the impact of STEM outreach.

- Daniela Jović stated, “CroCube inspires girls to pursue STEM, but funding and mentorship are critical to sustain engagement”.
- Tamara Blagojević stated, “Although not directly related to the main topic of the question, the pioneering initiative led by a female Space Law and Policy Expert and entrepreneur Anja Nakarada Pecujic, the Serbian Case for Space project, paved a way to

Serbian engagement into the European space sector, although probably limited by having solely ESA or EU funding and apparent lack of support from the national government at the time, it appears it didn't move forward from advocacy and education. If Europe expects us to step up, we should also receive more support, not just stricter criteria of assessment in terms of achieving SDG targets, with lower funding, support, and brain drain. Some pioneering initiatives such as the Carpe Noctem NGO, which engages in Dark and Quiet Skies Advocacy, advocates in preserving natural heritage sites for dark sky observation, therefore, creating opportunities for future astronomers and astrophysicists to enter the industry and get educated in astronomy, light pollution mitigation, space debris removal, earth observation and so on, therefore contributing to SDG 4, and SDG 5 as the project is spearheaded by a female entrepreneur Dajana Bjelajac, that from my experience and practice, supports other female entrepreneurs and commits to equal representation of male and female advocates alike. Similarly, the Space Career Academy and the Space Court Foundation, are entities I engage with to offer advising, coaching and mentoring support to young space professionals and early stage startups, alike. Such entities are very inclusive and have no limits in terms of access when it comes to gender, origin or even age. Everyone is equally able to join, and have equal access to opportunities in the space sector, therefore aligning with SDG 4, 5 and 8."

- Vladimir Gašić added: "Even with the difficulties associated with SDG 5 and the industry landscape, the prevalence of female STEM students, researchers and workers is remarkable. At the faculties of Natural Sciences, Medicine and most engineering fields, the percentage of females is at least 50%."

These findings indicate that rocket-enabled CubeSats and associated satellite and STEM space related educational initiatives promote Quality Education and Gender Equality related SDGs, but lack of sufficient funding, as well as external support in a form of know-how transfer through training and mentorship, creates barriers limit scale, particularly in the Balkans.

4.6.2 Leadership Opportunities

Globally, female leadership in space entrepreneurship remains limited, with women leading only 10% of startups and securing 5% of \$47.4 billion in 2021 investments (Seraphim Capital, 2022). In Europe, ESA's diversity initiatives increased female representation by 10% since 2015, with 25% of engineering roles held by women (European Space Agency, 2024).

In the Balkans, Daniela Jović's leadership of CroCube and Martina Dimoska's advocacy and capacity-building engagements in STEM outreach exemplify female role models, while female leadership in the space sector remains significantly underrepresented (UNOOSA; EU reports, 2023).

- Montenegro Space Research Engineer noted: "Female experts in our team are empowered to take initiative and leadership. We also consider best practices from female led startups and female entrepreneurs who inspire us to continue developing new education, outreach and leadership opportunities for young space enthusiasts and STEM graduates."
- Tamara Blagojević stated: "In Serbia, it is much more difficult for female entrepreneurs to succeed, as in my own case, I've often faced the lack of mentorship support, opportunities for engagement and adequate scholarship and education opportunities, as Serbia didn't have its own space programme, and our Universities did not have special

Space Law courses or elective subject, and were not included in the curricula. Moreover, if I wanted to pursue opportunities abroad, due to lack of previous experience, and due to the fact that non-member states of ESA applicants, cannot apply for ESA jobs and opportunities, I had to be creative, adaptable, and often work overtime, on US hours, in order to gain experience necessary to access the industry. Some free or affordable online courses were available during COVID, and naturally, feeling insecure and excluded, I pretty much had to be an overachiever, take all the courses, participate in every online webinar or seminar I could find, only to be recognized in my own country much later on, when I was already engaged on multiple foreign and external projects. Moreover, when applying for space-related or adjacent cybersecurity, or aerospace related jobs in my country, I would then be considered as overqualified. An oximoron and a contradiction of not having enough experience for high end leadership roles in foreign countries, while not having the projects or opportunities to apply to in my own country, or even being discriminated.”

4.6.3 Inclusive Initiatives, Policies, and Projects

ESA’s programs such as ESA Diversity & Inclusiveness "8 Steps Forward" (European Space Agency, 2021), UNOOSA Space4SDGs and Access2Space4All, as well as, NASA’s Women in STEM campaign set benchmarks, but Balkan nations lack inclusive policies and regional an international governing body and decision-making for participation to engage in such initiatives.

- Tamara Blagojević noted: “If Serbia would form a Space Office or a Space Agency, and join ESA as a Cooperating State, and sign the relevant agreement in that order, it could start receiving support from ESA, sharing information, know-how and exchanging experts, and identifying key niche areas of talent and expertise in the country, that could

contribute to SDGs, including SDG 4, 5 and 10. Similarly, if we continue the journey towards getting more engaged in COPUOS, we could engage in initiatives such as Space4Woman, Space4SDGs, Access to Space for All, Space Law for NewSpace Actors, and similar. Similarly, initiatives such as Women in Aerospace (WIA) exist, where individuals and entities can engage to exchange best practices, do capacity building and advocate for SDG 5 target achievements in the Space Sector”.

- Valerya Barashkova: “The creation of a CubeSat SC space mission is a perfect example of inclusion in the space sector for people with different backgrounds. The educational projects can be combined by students across the country as well as with international teams. The satellite can broadcast messages to anyone that is curious to receive them, and it leads to a development of the radio amateur community too.”

The findings suggest that expanding STEM outreach and advocacy, mentorship opportunities, and funding for female-led projects could close the 20% gender gap, supporting Quality Education, Gender Equality and Reduced Inequalities related SDGs.

Secondary and qualitative data proved that regional inclusivity related initiatives such as ESA’s do exist. Balkan participation in such initiatives through certain states accelerating the process of obtaining full membership status with ESA to access more opportunities especially for women.

4.7 Findings and Analysis: Policy Recommendations for Scalability (Research Question 5)

This section proposes policies to enhance the scalability of space entrepreneurship’s SDG contributions, drawing on findings and stakeholder insights.

4.7.1 Regional Collaboration, Public-Private Partnerships, and Joint Funding Opportunities

A €10 million Balkan Space Consortium could support 10 CubeSats and 5 rocket prototypes, creating 1,000 jobs and €20 million in revenue, aligning with SDG 9 and SDG 17.

- A Montenegro Space Research engineer stated: “A consortium could pool resources, reducing reliance on foreign launches”.
- Martina Dimoska stated: “Public–private partnerships and international collaboration can accelerate SDG impact through small satellite ecosystems by combining complementary strengths: Governments and development institutions define national needs, provide anchor demand; Private firms contribute speed, innovation, cost efficiency, and product delivery capacity; International partners provide mentorship, standards, access to facilities, shared ground infrastructure, and co-financing. Practical mechanisms include shared payload programs, hosted payloads, joint ground station networks, co-developed analytics platforms, and procurement models where governments buy services rather than hardware.”
- Daniela Jović stated: “Projects such as CroCube demonstrate that without an entrepreneurial framework—clear governance, financial structuring, stakeholder alignment, and long-term strategy—a satellite mission risks remaining a one-off achievement. Entrepreneurial thinking enables: sustainable funding models; Industry-academia collaboration and market-oriented applications. By embedding commercial or semi-commercial logic into the mission architecture, small satellite projects become repeatable and institutionally sustainable rather than episodic. Public–private partnerships significantly accelerate the developmental impact of small

satellite ecosystems. Government entities can provide legitimacy, regulatory backing, and strategic direction. Private actors contribute agility, technical specialization, and operational efficiency. Academic institutions anchor research and talent development.”.

- Tamara Blagojević stated: “Regional collaboration is needed in order to harmonize approaches and fill each-other’s gaps. Mutual cooperation and good neighbourly relations are important in any sector, and more so in such a strategic domain as aerospace. During my work at OSA Consulting, while mapping the European market, I have noticed a recent industry trend to consolidate efforts either through M&A’s, creating consortiums of companies to meet grant application requirements and increase chances in getting funded, or enter into other forms of partnerships and collaboration, to join forces and achieve goals easier. Pooling resources through a space consortium is an idea that is much needed on the Balkans, due to the region's relations, history and fragmentation of policies and strategies, geopolitically speaking. Similarly to how companies can create hubs or clusters, a consortium would be a more concrete and tangible effort, surely leading to bigger opportunities for funding, technology transfer or capacity building. External partners react better to consolidated and peaceful efforts rather to problematic, fragmented regions with inner turmoil or political and historical issues that affect their global and external approaches and create international disturbances or insecurity. International bodies also have their own blocks of countries, or better stated, small hubs, that vote together or side together at the international fora.”
- Vuk Maksić stated: “Our governments are not supportive enough of new innovative projects in science, not just the space sector. So, the main barrier is the lack of finances, and through global partnerships, we could create something that will not only benefit us,

but the world as a whole. International collaboration is also very welcome, mostly for sharing educational information with one another. The same should be applied to our governments, at the Balkan level, because only through their joint support can we develop such small satellite ecosystems and be competitive and attractive to the European space ecosystem”.

- Valerya Barashkova: “When it comes to fully commercial CubeSat satellite missions, a span of mission realization can extend as many parties and processes involved, therefore it is essential for the space entrepreneur to plan the budget long-term and to be backed financially. When it comes to a semi-commercial satellite mission the entrepreneur should be involved and managing activities with all stakeholders through the mission project. It is also commonly seen that emerging space nations share satellites in orbit, which allows them to share costs and optimize resources needed to operate the satellite and to analyze the space data. After the mission starts to generate satellite data, it can also be used for the cross-border collaboration fostering further international partnerships for global sustainable development”.

Quantitative data show ISRO’s 500-firm network generates \$200 million, a model for the Balkans (Indian Space Research Organization, 2025).

The further development of particular emerging space sectors in the Balkans could be enabled by timely and coordinated individual policy-making, which can be achieved through cooperation on joint projects, partnerships and collaboration on initiatives related to satellite engineering and manufacturing, and research and development. However, this would necessitate, as a prerequisite regional collaboration, external partnerships and more EU and ESA funding opportunity access.

4.7.2 Sustainable best practices

Adopting green propulsion, like ESA's Prometheus (€1B, carbon-neutral by 2030) and SpaceX's Starship (20% emission reduction), could align launches with SDG 13.

- An ESA official suggested: “Green propulsion is essential for sustainability, but developing regions need technology transfer”.
- Martina Dimoska stated: Best practices connect technical satellite mission design with measurable socio-economic and developmental impact from the start if the following practices are considered early on: A clear problem statement and user needs, translated into measurable impact indicators and data requirements; Defined impact logic chain – inputs to outputs to outcomes (actions taken) to impacts (reduced losses, better services); Design for operational use – revisited frequency, and reliability must match decision timelines; Build validation and trust – ground truth plans, uncertainty reporting, and stakeholder review; Integrate adoption early – training, documentation, and workflows that fit ministries, municipalities, and local partners; Plan sustainability – long-term operations funding, service-based procurement, and partnerships that keep the system running after the first mission; Monitor and evaluate continuously: track usage, decisions enabled, cost savings, lives protected, and equity of access, then iterate on mission design and services. All of this reduces risk, shortens time to impact, and improves sustainability.”
- Tamara Blagojević stated: “When it comes to sustainability, although soft law, the LTS Guidelines provide numerous recommendations, which, if implemented early on, could lead to sustainable practices in the private space sector, as the companies would tend to be compliant, in order to properly conduct activities not just nationally, but on the

European and global levels. ESA also has its own policies in this regard, that although only binding to the member states, could serve as best practice to be taken into consideration early on in the development of national policies. Similarly, when policies are timely aligned with EU policies, they do not have to be adapted later, and there are lower chances for national efforts not to be aligned and harmonized with regional ones, which then makes the companies compliant with national and regional policies, more interesting for external investors, as the risk is lower. To reiterate, planning sustainability early on, in terms of propulsion, would mean that green propulsion adoption would be beneficial."

4.7.3 External partnerships: Technology Transfer, Funding and Capacity Building

Technology transfer, modeled on ISRO's integration of 500 firms, could empower Balkan nations. Space X and NASA partnerships serve as another example of how a private company can provide technologically more advanced solutions to the public sector, in exchange of funding for such endeavors. Participation in UNOOSA Capacity Building programmes could enable knowledge exchange and gathering of best practices. Member or cooperating state status in ESA could open access to more funding opportunities to the Balkan region.

- Martina Dimoska stated: "CubeSat and nano-satellite missions contribute by delivering basic space capabilities that directly support development priorities. For emerging space nations, these missions also build national capacity in systems engineering, operations, data processing, and policy, which strengthens institutions and improves long-term ability to deliver SDG-aligned services. Universities and research centers support workforce development, validation, and domain expertise. When it comes to capacity building, I can refer to my own experience – being the Founder and President of the International Space

Alliance (ISA), an international organization operating at the intersection of the space industry, science, technology, and industry-focused education. ISA was founded as an initiative in Macedonia, with early activities across the Balkans. Today, ISA operates internationally, with programs and partnerships across Europe, and is formally registered both in Macedonia and in the United States, with operations based in the San Francisco Bay Area, California. Our focus is on capacity building, research collaboration, and creating practical pathways into the space sector, especially for talent coming from non-space bearing nations.”

- Daniela Jović stated: “International collaboration reduces risks by: Providing launch access; Offering technical mentorship; Facilitating knowledge transfer; Enhancing diplomatic visibility; In emerging space nations, these partnerships are not optional—they are structural necessities. CroCube’s trajectory illustrates that overcoming barriers requires strategic partnerships, incremental capability building, and strong project leadership. In this sense, CubeSats are not merely technical artifacts; they function as strategic national capability-building platforms.”
- Tamara Blagojević stated: “When it comes to capacity building, this is one of the key areas of focus of UNOOSA, not always requiring a full membership with COPUOS. If Serbia, and other Balkan states participated in UNOOSA’s projects such as Space4Woman, Space4SDGS, Access to Space for All, and Space Law for New Space Actors, they could gather the necessary best practices and knowledge to further develop their space sectors in an inclusive, sustainable, peaceful and overall, SDG aligned manner. Access to more ESA resources through becoming a member state could also provide additional funding through joint projects, technology transfer or participation in

incubator and accelerator competitions. In practice, and from my own example, I strive to support capacity development by focusing on coaching and mentoring talent from underdeveloped or emerging space sectors, always remembering my past experiences, and trying to prevent that from happening to anyone else, by easing access to connections, crafting tailored professional development and business development plans for clients and mentees, and I do this through Space Court Foundation, Space Career Academy and even, SpaceWatch.Global, by trying to promote and present the underrepresented, motivate the unsure and insecure, and create pipelines to opportunities by sharing my network to young space enthusiasts and early stage startups and spin outs like Argo Robotics, a student organization outgrowing its academic nature, with high potential of becoming a leader in its own making in Serbia, creating the first rover. Whichever event I go to, I strive to connect people with opportunities, and to advocate for inclusive approaches and capacity building. Anyone can do this, it just takes good will and a love to share know-how, best-practices and connections.”

- Valerya Barashkova stated: “Space industry is one of the few industries that requires multiple partnerships with other nations to have an effective space mission that will benefit the citizens of the nation itself and will bring benefits to the whole region or even have a global impact. Emerging nations often lack the substantial funding needed for cutting-edge technology, so they often form international partnerships for realizing big and expensive space missions. The formulation and realization of the emerging space nation’s first CubeSat SC require international collaboration, therefore even before the nation launches its first satellite into orbit, the new partnerships are already made on Earth. This aspect of collaboration resonates with the following SDG’s: “Peace, justice,

and strong institutions” and “Partnerships for the goals. This is also why capacity building and technology transfer related partnerships are relevant”.

- Vladimir Gašić stated: “If the ESA wants to use the talent and the capacity of the Balkan nations to contribute to the space ecosystem, it has to enable participation through allowing project proposals, conference attendance, workshop usage and internships, even if the country is merely a candidate for the EU.”
- Vuk Maksić stated: Emerging and small space nations are currently dependent on the space industry of bigger countries. Balkans can benefit from the further development of the European space sector by being involved in their projects. Balkan is full of great minds that are ready to jump at such opportunities, and I do believe that Europe will also benefit from folding us in. Technological barriers could be important due to the lack of proper tools for engineers to use, which could be easily fixable, the only problem is the lack of finances. A great example of public-private partnerships are NASA and SpaceX. Currently, most rockets in the USA are built by private companies, like SpaceX. NASA lost its original function of being the ones developing the space industry, and now it’s supporting private companies that do that job for them. On the other hand, when it comes to funding, only through government support is the USA so far ahead in the space sector.”

As per Montenegro Space Research analysis and assessments, as well as based on data from reputable space industry reports, a €10 million consortium could support training for approximately 1,000 or more engineers, reducing the 20% STEM emigration (Eurostat, 2023). This could also be facilitated by educating the Balkan talent through initiatives such as UNOOSA’s projects, and funding startups through ESA business incubators and accelerators.

More frequent and consistent Balkan participation in such initiatives would lead to capacity building, and create more space sector related opportunities and jobs, especially for women.

4.7.4 Inclusive Policies for Gender Equality

Policies targeting female participation, like ESA's diversity initiatives, could increase the 20% female space workforce.

- Daniela Jović noted: “The absence of national space strategies, fragmented regulatory frameworks and lack of funding, create barriers. Funding female-led projects like CroCube could inspire more women in STEM. With small satellite missions, socio-economic objectives must be embedded in the beginning. This includes defining the number of students engaged, and STEM programs created, as well as, establishing policy outcomes (national space frameworks initiated). The strategic value lies not only in orbital operations but in entire ecosystem activation.”
- Tamara Blagojević noted: “SDG 5 should be considered at any given workplace. When developing policies, gender equality has to be considered just as much, and this implies for all sectors, not just aerospace. I’m unsure about the exact percentage, but I’m sure that policies targeting more inclusive representation of women could end up with an increase. This is justifiable by behavioral sciences – if we identify proper boosts and nudges, people react. Similarly, if we incentivize properly, we get more results. A good policy acts as an incentive by itself, as it creates a pathway for creating better practices.”
- Martina Dimoska noted: “Mentorship and support networks are essential for navigating invisible barriers. They provide guidance, confidence, and a sense of belonging.”

- Vuk Maksić noted: “From a perspective of a student in STEM, I must say that female students are more dominant and determined to succeed, but I don’t see many female engineers in our industry. By introducing a new branch to our industry, more jobs will open up for young female and male engineers. I would also like to mention that the launch systems and satellite programs are very attractive to all engineers. Even girls can dream of going to space, right? Regarding the SDG 5, we believe that diversity is the key to developing a new industry. We choose our members based on their skills, and that’s the only thing we care about. By increasing the amount of jobs, we will naturally gain more opportunities for women to fill those seats. There are many great female engineers and students in our region that are just waiting for such an opportunity. Argo has over 40% of female members in the organization, and we intend to increase that number in the upcoming academic year. However, for this to happen, inclusive policies, more funding and external partnerships could contribute to creating more opportunities for women.”
- Valerya Barashkova: Regarding equal female access to space opportunities and participation and representation in the “space workplace”, the barriers remain the same as for other SDGs– financial and institutional. Institutional Barriers include the lack of regulatory and legal frameworks – emerging space nations do not have robust national space laws or policies. These affect the subsequent lack of skilled workforce – there's often a shortage of trained engineers, scientists, and policymakers with required expertise, especially women, as they do not have equal access to opportunities. Space entrepreneurship goes together with space education in emerging or small space nations, as more people, organizations and departments should be aware of opportunities that can be gained by the space data and use it effectively. This stands for female and male

individuals alike. To build an ecosystem where you will have educated people working in it, male or female, the space education should reach schoolchildren, students and professionals with an interest in the industry. For this to happen, inclusive policies should exist at higher levels, and SDG 5 should be considered when developing them, which could contribute to a more equal representation of women in the long run.”

4.8. NVivo Node Structure and Coding Matrix Query

The NVivo node structure was developed from the seven semi-structured interviews. As illustrated in Figure 4.6, the hierarchical coding structure is organized around the five core interview questions, supplemented by a cross-cutting themes node. This design enables both vertical depth (within-question analysis) and horizontal integration (cross-question patterns), which proved essential given the exploratory nature of the study.

The top-level nodes (A–F) directly mirror the interview while allowing emergent themes to surface organically. For instance, Node A captures the transformative potential of launch cost reduction and reusability as an entry point for small and emerging nations, while Node B highlights the structural tensions within European space governance — most notably the “ESA paradox” repeatedly referenced by participants. Node C, focused on the Balkan space ecosystem, integrates rich case-specific data (Luča, CroCube, ISA, and Serbian talent dynamics) with SDG-aligned contributions and clearly delineated barrier clusters (technological, institutional, and financial). This tripartite barrier framing proved particularly robust across interviews.

A key analytical strength of the structure is its explicit incorporation of SDG dimensions. Nodes D (SDG 5 – Gender Equality) and the relevant sub-nodes under C and F reveal both systemic under-representation and promising local enablers, such as female-led initiatives and mentorship

networks. The separation of Blagojević’s lived experience as an in-vivo code (D4) preserves the authenticity and emotional weight of individual narratives while maintaining analytical clarity.

The cross-cutting themes node (F) emerged as analytically important. Issues such as brain drain (F2), geopolitical legacies (F3), and the need for mission design with developmental impact embedded from inception (F4) appeared consistently across multiple questions, justifying their elevation beyond single-question categorization. This reflects the interconnected nature of the phenomenon under study.

Sparse coding in certain areas (e.g., certain interviewees skipping specific questions) was transparently retained, allowing subsequent matrix coding queries to reveal coverage patterns and gaps. The color-coded analytical typology (SDG, Sector/Actor, Barrier, Enabler, Policy/Strategy, Case Study) facilitates both within-case and cross-case synthesis.



Figure 4.1. NVivo Node Structure, part 1

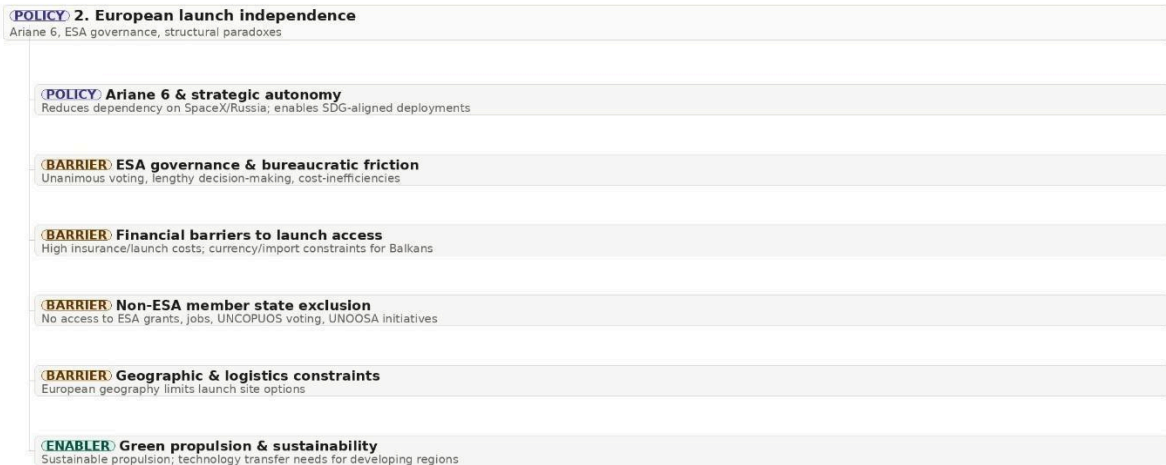


Figure 4.2. NVivo Node Structure, part 2

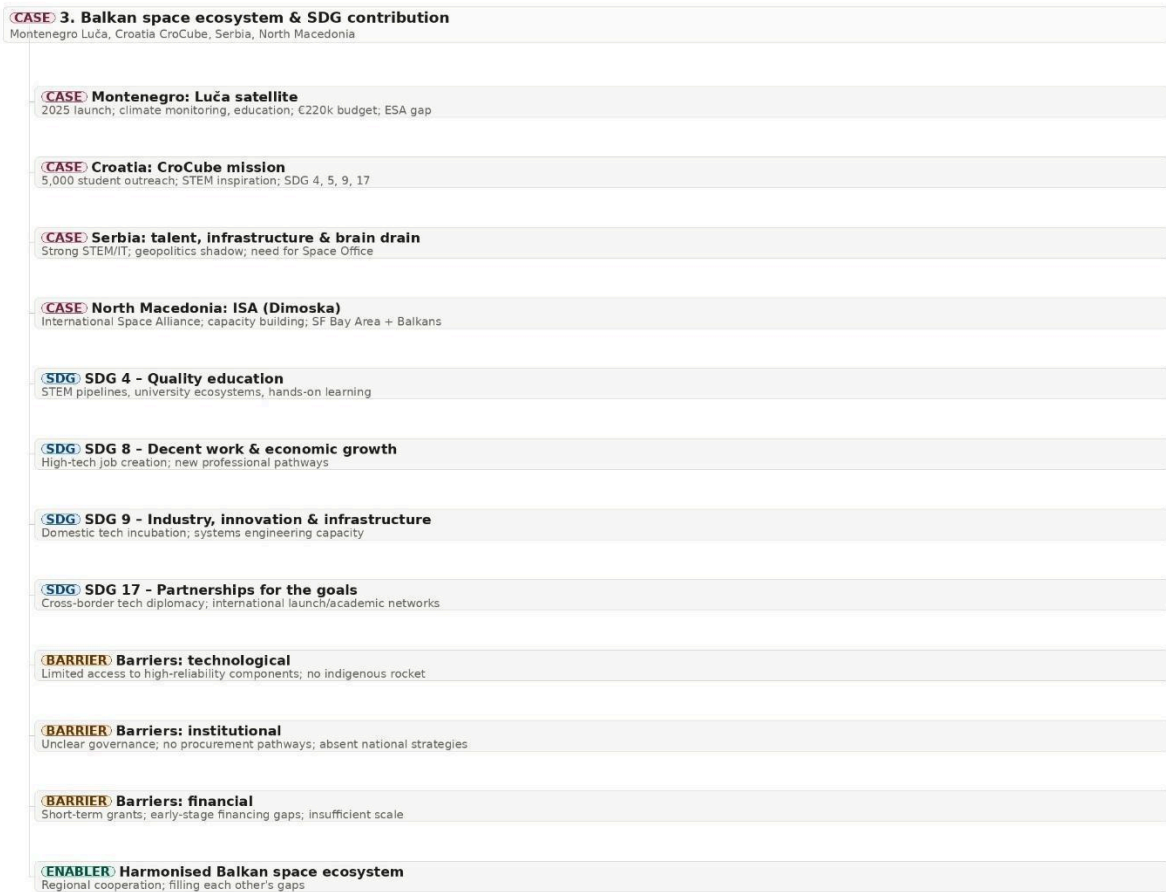


Figure 4.3. NVivo Node Structure, part 3

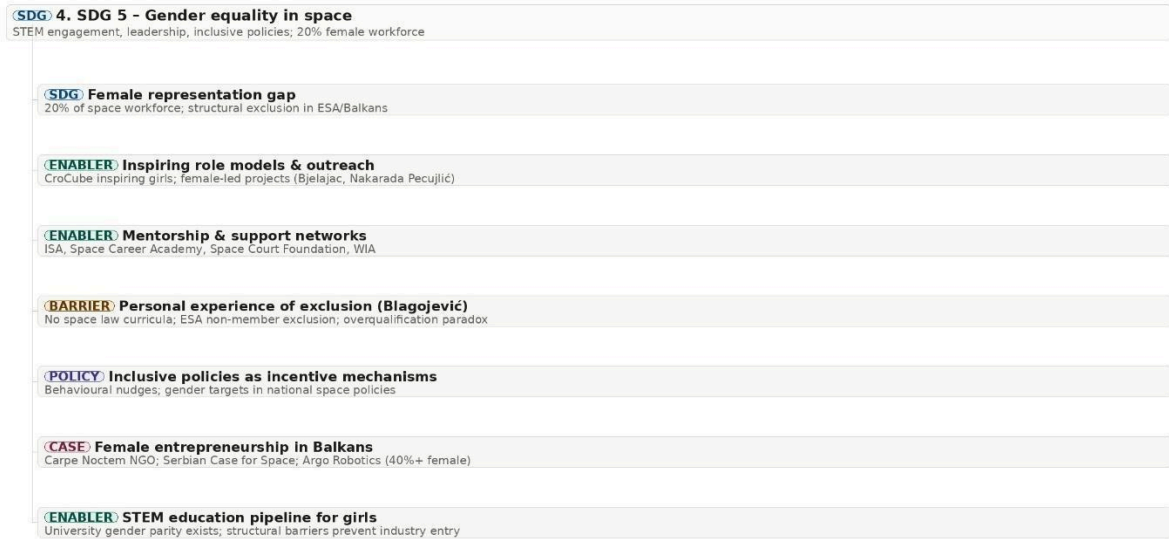


Figure 4.4. NVivo Node Structure, part 4

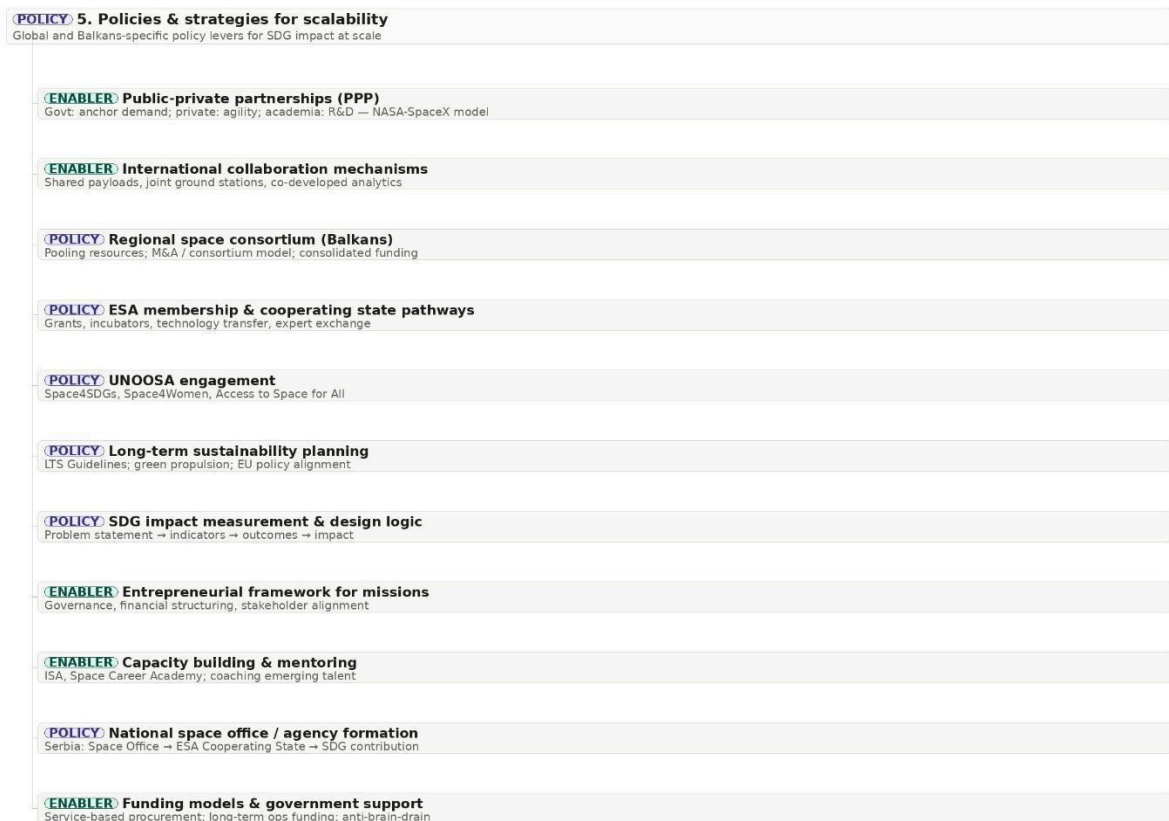


Figure 4.5. NVivo Node Structure, part 5

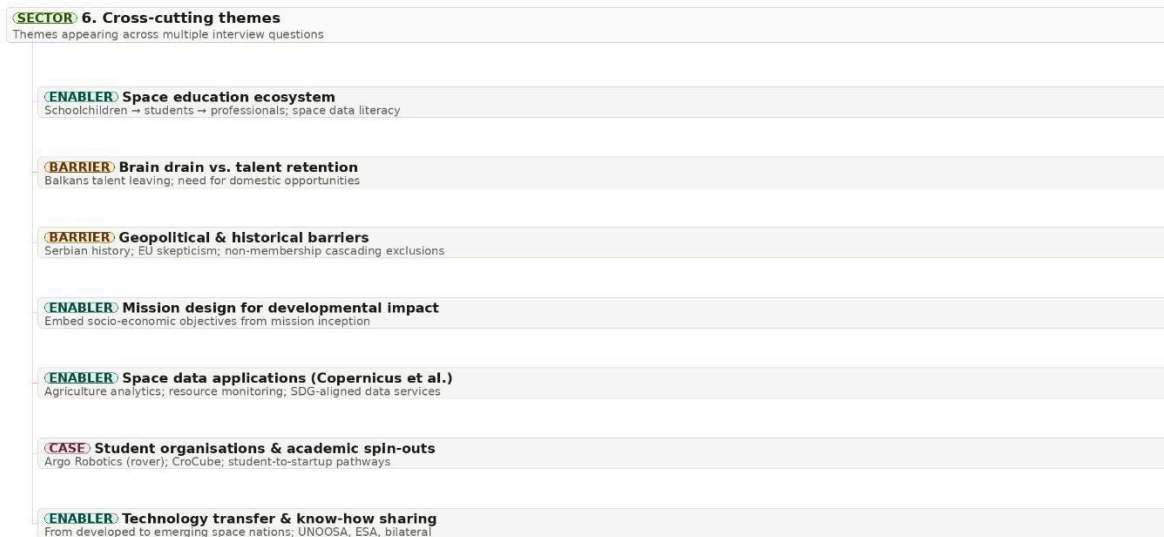


Figure 4.6. NVivo Node Structure, part 6

An output of the NVivo matrix coding query, presented in Figure 4.7., provides a detailed visualization of coding coverage across the seven interviews and twenty-three analytical nodes. This matrix offers both an at-a-glance overview of data saturation and a granular picture of thematic emphasis and omission.

The matrix reveals variation in interviewee engagement across topics. Blagojević (T. Blagojević, SpaceWatch.Global/Serbia) demonstrated the highest overall coverage at 91%, contributing responses across nearly all major themes, particularly governance, barriers, and policy recommendations. In contrast, the ESA Official showed the lowest coverage (13%), as this participant focused primarily on institutional and launch-related topics while skipping questions related to Balkan-specific cases.

Particularly noteworthy patterns emerge when examining SDG-related nodes. High coverage in SDG 9 (Industry, Innovation and Infrastructure – 88%), SDG 4 (Quality Education – 75%), and SDG 17 (Partnerships – 63%) confirms that interviewees consistently linked space

entrepreneurship to these goals. Conversely, lower coverage was observed in areas such as “Green propulsion” (25%) and “Balkan consortium” (25%).

The distinction between substantive (●) and partial (○) coding proved valuable. For example, while several participants mentioned brain drain, only a minority addressed it in depth. Similarly, public-private partnerships and international collaboration received strong substantive attention, reinforcing their centrality to scalable solutions in the Western Balkans context.

This matrix coding output confirmed that the node structure was sufficiently comprehensive while transparently exposing coverage gaps — particularly in certain SDG dimensions and among specific interviewees. These gaps were not treated as methodological weaknesses but as meaningful data points reflecting real differences in expertise, experience, and focus among participants.



Figure 4.7. NVivo matrix coding query

4.9 Discussion and Synthesis

Per the research, the initial impression of the Western Balkans' potential to engage in the space industry and contributing to the SDG values can be compared to the African continent, due to a lack of infrastructure, issues with documentation and a lack of an adequate space policy (Froehlich, Sarang and Siebrits, 2019; Siebrits and van de Heyde, 2019; Asiyanbola *et al.*, 2021). However, it should be noted that the tertiary education, as well as the community of experts in the Western Balkans are capable of participating in New Space, following the models of Hungary, Italy, Scotland and Latin America (Froehlich, Sarang and Siebrits, 2019; Vidmar, 2020; Parragh *et al.*, 2021; Florio, Castelnovo and Lupi, 2022), creating an industry resilient to shocks and capable of enhancing local communities (Oksin and Zubko, 2021).

As mentioned, the reduction of launch costs and improved launch capabilities have lowered the entry barrier for developing countries. This finding is consistent with existing literature, which identifies cost reduction and increased launch capabilities as key drivers of accessibility in the space sector (OECD, 2023; Lamine et al., 2021). These studies emphasize the role of commercial innovation and public-private partnerships in lowering barriers to entry for new actors.

However, these findings not only confirm existing literature but extend it by demonstrating that, in emerging ecosystems such as the Western Balkans, structural constraints significantly moderate the impact of technological advancements. While previous studies emphasize cost reduction as a primary enabler, this research shows that institutional readiness, regulatory alignment, and access to international partnerships are equally critical for enabling meaningful participation in the space sector.

Building on these findings, multiple issues arise immediately for the states of the Western Balkans. The Outer Space Treaty, even though it emphasizes freedom of exploration for all,

doesn't consider the needs and the interests of developing countries (Nahtigal, 2022), making late arrivals to the space industry subject to a serious disadvantage. Additionally, even institutions which have a history of working and understanding the space industry impose formidable barriers for the commercialization of space (Lamine *et al.*, 2021) and it will be equally, if not even more difficult for newly formed space programmes to develop public-private partnerships, attract venture capitalists and develop incubation mechanisms for start-ups. Moreover, the presence of megaconstellations of satellites already creates high risk environments for collisions and progressing into Kessler syndrome (Blom and Mauno, 2021; Abdallah, 2022; Wilson and Vasile, 2023), as well as increasing pollution due to the frequency of launches (Sirieys, 2022; Abdul Majid, 2023) that could exacerbate the already difficult situation for the Western Balkan region. Lastly, a set of reasons why the space industry hasn't developed sufficiently in this region consists of poor awareness, lack of experience and insufficient resources, to name a few (Plugar, Plugar and Stakhno, 2021).

In order to mitigate the numerous issues mentioned, it is essential to develop a space doctrine on basic, strategic and tactical levels (Soroka, 2021), which would lead to the development of a facilitating body for the development of the space market (Robinson and Mazzucato, 2019) and, at the same time, prevent the faults of the US regulatory system (Haggart *et al.*, 2017) and allowing a self-regulated commercialization of space, that follows international guidelines and industry standards (Sandhu, 2023). The emerging commercial companies should incorporate SDGs in their business models (Manotti *et al.*, 2023) and embedding sustainability by employing Space Debris mitigation strategies into their work (El-Shawa *et al.*, 2021), while developing a circular economy and making an industry build-up for own satellites (Paladini, Saha and Pierron, 2021; Maiwald, 2023). Additionally, space industry spillovers could contribute to the generation

of wealth and development of other industry sectors (Lehnert, Karlsson and Giannopapa, 2017; van Burg, Giannopapa and Reymen, 2017; Kerstens *et al.*, 2019; Ferretti, Imhof and Balogh, 2020; Inshakova and Inshakova, 2022; Gonzalez, 2023), contributing to space capacity building (Ferretti, 2020). This might also contribute to the end-user value (Paravano, Locatelli and Trucco, 2023), without benefiting only the wealthiest (Shammas and Holen, 2019) and even reducing pollution and debris (Toivonen, 2017; Oluwafemi and Olubiyi, 2019; Losch, Galli and Schildknecht, 2024). In terms of sustainability, these findings support previous research on space debris and environmental impacts (ESA, 2023; Malinowska *et al.*, 2023). However, this study further emphasizes the need for stronger regulatory frameworks and coordinated international action, particularly for emerging space actors such as those in the Western Balkans. Such a developed market could contribute to policy change (Robinson and Mazzucato, 2019; Tsz Mei Lai, 2024) and create solutions for the commercialization of space (Lages *et al.*, 2023). Of course, such a space industry would still need to be measured by the UN for future sustainability of Earth-space (Wood and Stober, 2018; Alfathimy, 2019; di pippo, 2019; Ferretti, Imhof and Balogh, 2020; Toivonen, 2022; Clegg *et al.*, 2023; Cernev *et al.*, 2024).

There are several reasons to pursue such a complex process. One of them is the contribution of Earth observation to the region (Amr Hany Youssef Abouzahwe, 2022; Ang and St-Pierre, 2022), as well as future sustainability and the post-2030 UN agenda and Space 4.0 (Froehlich, 2018; Bohlmann and Petrovici, 2019; Ferretti, Imhof and Balogh, 2020). Among them is the need to improve human rights (Lovell, 2021), facilitate urban resilience and eliminate “resource wars” (Collins and Autino, 2010; Botezatu *et al.*, 2023). The end goal is to fulfill the promises made by new start-ups (Kreisel and Lee, 2008; Schrogl, Mathieu and Peter, 2008; Al-Ekabi and

Ferretti, 2018) and develop inclusive development and economic growth for the sake of the socio-cultural value and national security of the states of the Western Balkans (Kurkova, 2021).

The findings confirm that rocket programmes and technologies and associated satellite launching projects, through 90% cost reductions and over 1,000 annual launches, enable SDG 2, SDG 4, SDG 10, and SDG 13 applications, fostering connectivity, agriculture, education, and climate monitoring. Europe's launch independence creates 20,500 jobs but faces high costs and delays.

The Balkans, led by Montenegro's Luča and Croatia's CroCube, show potential for SDG 4, SDG 5, SDG 8 and SDG 9 contributions, but are constrained by funding (0.1–0.5% GDP R&D), lack of sufficient external partnerships for technology transfer and knowledge exchange, gaps in regulatory frameworks, lack of memberships and participation in ESA or UNCOPUOS and expertise shortages. Gender inclusion remains limited, with women at 20% of the space workforce, requiring STEM opportunities and mentorship support.

Although the interviews conducted with female individuals such as Daniela, Marta and Tamara focus more on SDGs related to Climate Action, Decent Work and Economic Growth, Reduced Inequalities, and Partnerships for the Goals, they are given by female leaders who pave the way for other young female space enthusiasts to enter the industry, by doing outreach and capacity building. These women have done so in states that lack legal, policy and regulatory frameworks, as much as funding and opportunities for mentorship and space industry engagement on a domestic level. This only serves to prove that the chosen SDGs are inter-dependent and connected – there cannot be visible Gender Equality target achievement if there wasn't Decent Work and Economic Growth; Industry, Innovation and Infrastructure; Reduced Inequalities and if there weren't Partnerships for the Goals; Peace, Justice and Strong Institutions. Similarly to how the launching industry acts as an enabler, it could be said that SDGs 8, 9, 10, 16 and 17,

often act as enablers to other SDG targets. This then proves that taking into consideration SDGs in early stages of one sector development, could lead to creating more just, equal, and inclusive opportunities for all, not just women. Likewise, space powers and more developed space sectors would benefit from resource and talent countries, if they invested more in their development, to fully reap the potential, and at least at a European level, create a cooperative and harmonized space ecosystem. This was also indicated by male individuals such as Vladimir and Vuk, who highlighted the lack of government support, tied that to the lack of funding, the consequent need of external support in a form of partnerships, therefore also tying different SDGs as inter-dependent, and the achievement of their targets, mutually beneficial.

Based on the congruent data from findings, as well as research and analysis from reputable industry reports, policy recommendations for the Balkan region include:

- Creating Balkan Space Consortium, that would consolidate different talents, resources and create a harmonized ecosystem capable of integrating into the European space sector and pooling funding and resources in an efficient manner;
- Creating harmonized policy frameworks in each of the Balkan countries, by sharing know-how, expertise, and having multistakeholder strategic gatherings to align strategies and decision-making power at international fora such as UNCOPUOS;
- Applying for memberships at COPUOS and ESA, to be able to obtain know-how, best practices, share resources and train talent, and get more funding opportunities;
- Implementing sustainability practices and inclusive policies at all levels, as well as, at early stages of mission design, by adopting sustainability by design approach, doing impact assessments throughout the entire lifecycle, and transparent reporting throughout product or project lifecycle;

- Integrating and adopting green propulsion technologies, engaging in external partnerships to enable technology transfer schemes, and implementing inclusive policies to scale SDG contributions.

Table 4.1: Summary of SDG Contributions

SDG	Example	Contributions of Space Entrepreneurship and Technology
SDG 2 Zero Hunger	Serbian agricultural project leveraging Copernicus data. Indian company SatSure	Precision agriculture via satellite imagery for crop monitoring, soil health, and water management.
SDG 4 Quality Education	CroCube (Croatia), North Macedonia and MNE (Montenegro Space Research) initiatives promoting STEM education and youth engagement. UNOOSA with Space4SDGs, Space Law for NewSpace Actors projects	Providing satellite-based internet to remote areas, enabling digital literacy and E-learning.
SDG 5 Gender Equality	Leadership and advocacy by Daniela Jovic in Croatia, Martina Dimoska in North Macedonia, Tamara Blagojevic support of young space professionals through mentoring in Space Court Foundation and coaching in Space Career Academy, UNOOSA with Space4Women project.	Promoting diversity in STEM through space-sector initiatives and connectivity for women in isolated regions.
SDG 9 Industry, Innovation, and Infrastructure	Montenegro's robotics initiatives and the development of the national space sector Tamara Blagojević supported early stage startups globally, Serbia's space ecosystem mapping and engagement, and advised the student spin-out Argo Robotics in Serbia. Marina Dimoska, with leadership through ISA. Daniela Jović through her flagship CroCube project.	Developing resilient communication networks, advanced materials, and regional "NewSpace" ecosystems.

SDG 10 Reduced Inequalities	PLD Space, SpaceX with Starlink.	Bridging the digital divide by offering affordable satellite data and services to developing nations.
SDG 13 Climate Action	The Sentinel-1C mission provides critical radar data for environmental monitoring. UNOOSA's Space4Climate project.	High-resolution Earth observation for monitoring carbon emissions, deforestation, and extreme weather.

Source: Author

4.10 A proposal: The Balkan Space Ecosystem Growth Framework

The proposed framework builds upon the empirical findings of this study and is grounded in existing literature on innovation ecosystems and space sector development. Previous research highlights the importance of institutional support, public-private partnerships, and phased development strategies in emerging space economies (Lamine et al., 2021; OECD, 2023). The findings of this study confirm these patterns within the Western Balkan context, while also revealing region-specific constraints such as limited funding, fragmented institutional capacity, and talent outflow. Therefore, the framework extends existing models by adapting them to the structural realities of smaller and developing space ecosystems.

To ensure practical applicability, the proposed Balkan Space Ecosystem Growth Framework can be used as a structured decision-making tool by policymakers, industry stakeholders, and innovation agencies in emerging space economies. The framework enables stakeholders to assess their current level of ecosystem development, identify key structural gaps (e.g., funding, regulatory frameworks, human capital), and implement targeted interventions aligned with each phase.

In practice, the model functions as both a diagnostic and strategic roadmap, guiding the transition from early-stage capability development to full integration into the European and global space economy.

The Balkan space ecosystem growth depends on the individual Balkan state's space sector development in a synchronized and coordinated manner, through collaboration and joint capacity building efforts. Therefore, each Balkan state has to develop its space sector up to a certain level to be able to collaborate amongst each other, and to then offer their resources and talent in the broader European region, and mature enough to become competitive at the global scale. However, to enable seamless integration into the European space ecosystem, each state should follow certain standardized phases and steps that most frequently reflect the usual development of new space sectors in practice. The framework operates through a phased progression model, where each stage represents a level of ecosystem maturity. Advancement between phases depends on institutional readiness, resource availability, and the degree of regional coordination. While the phases are presented sequentially, their implementation may occur in parallel depending on national context. In that purpose, this thesis offers a Multiphase National Space Ascension Framework (MNSAF), in three phases, detailed with specific steps as follows below:

The structure of the proposed framework is illustrated in Figure 4.8.

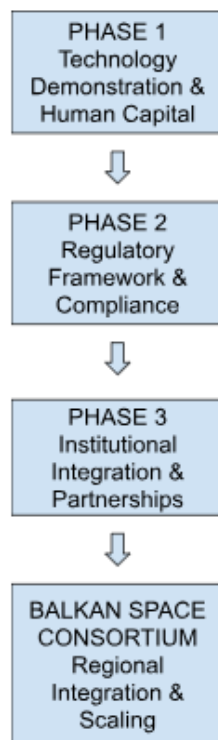


Figure 4.8: Balkan Space Ecosystem Growth Framework

Source: Author

1. Phase 1: Technology Demonstration and Human Capital Investments

- Step 1 – Proof of Concept: Satellite Launch: Launching a first CubeSat (e.g., Luča or CroCube) to demonstrate technical capability and attract talent.
- Step 2 – Capacity Building through Education: Integrating aerospace engineering and Space Law into national university curricula to create a sustainable talent pipeline, or otherwise, collaboration with other foreign universities with space curricula and subject, either for occasional courses and lectures or student exchange programmes.

2. Phase 2: Regulatory Framework Development and Compliance

- Step 1 – International level: Accession to International Space Treaties: Ratifying the OST, Rescue Agreement, Registration, and Liability Convention to establish international legitimacy.
- Step 2 – National level: Enacting specific national space laws to regulate private space activities.

3. Phase 3: Institutional Integration and Partnerships

- Step 1 – UNCOPUOS and ESA Membership: Moving from observer status to full membership at the UNCOPUOS and cooperation agreements with ESA, with the type of membership depending on the readiness level. Collaboration with the UNOOSA on Space4SDGs, Space4Women and similar programmes.
- Step 2 – Technology Transfer and Know-how Exchange: Establishing PPPs with global leaders (e.g., SpaceX) for personnel training and hardware localization.
- Step 3 – Regional Cooperation: Forming a regional space consortium to efficiently pool resources to compete on a European level.

Together, these phases provide a structured pathway for national space sector development, enabling countries to transition from isolated initiatives toward coordinated regional participation. This phased approach reduces fragmentation and enhances scalability by aligning national efforts with regional and European space objectives. The Balkan Space Consortium is envisioned as a regional intergovernmental organization designed to transition Balkan nations from passive observers to active participants in the global space economy. Its primary goals would be resource pooling (aggregating national budgets to fund shared high-cost infrastructure), technological sovereignty (reducing dependence on non-European or major power launch

providers or satellite constellations), and economic scale (creating a unified regional economy that is more attractive to foreign investors and partners).

In order to envision the launching of such a consortium, a Formation Roadmap is proposed as a process consisting of five phases.

1. Phase I – Regional Collaboration Initiation: The Memorandum of Understanding (MoU) would be signed between national ministries of science, technology, economy (or other relevant ministries) to form a regional working group.
2. Phase II – Legal Harmonization: To ensure legal harmonization, the national space laws of member states would have to be aligned to ensure seamless cross-border cooperation, joint capacity building efforts and cross-border technology transfer.
3. Phase III – Entity Creation: To formally establish a legal entity, the founding treaty for the Consortium would have to be brought, signed and ratified in each member state's national parliaments.
4. Phase IV – Financial Capitalization: To be able to plan funding and ensure an initial operational budget, the implementation of a “Weighted Contribution Model”, where member states contribute based on their GDP, is needed.
5. Phase V – Operational Capability: To be able to demonstrate value and contribution potential to the European space sector, proof of concept is needed. This would be possible through launching a first shared regional mission.

The Formation Roadmap provides a practical implementation pathway for policymakers, translating the conceptual framework into actionable steps. It enables governments to move from informal cooperation to formal institutionalization, ensuring long-term sustainability and alignment with international space governance structures.

3. Organizational Structure and Governance:

- The Council would be the decision-making body, responsible for long-term strategy and budget approval, composed of one representative from each member state.
- The Secretariat would be the executive body, led by a Director-General. It would handle day-to-day administration and international diplomacy, liaising with UNOOSA and ESA on behalf of state members.
- Technical Committees would be specialist groups focusing on specific areas, such as: Space Law, Satellite Engineering, and Data Applications (SDG monitoring).
- The Balkan Space Hub, would be formed as a physical or virtual "Innovation Center", functioning as an incubator where startups from all member states can access shared lab equipment and mentors.

4. The "Balkan Fair Return" Principle

To prevent "brain drain" and ensure that individual Balkan states all see direct economic benefits, the Consortium should adopt an adequate Geo-return Industrial Fair Return Policy based on the following principle:

“For every Euro a member state contributes to the BSC, a proportional amount must be returned in the form of industrial contracts to that country’s local companies and researchers.”

By following the steps of each national Balkan state space sector development to the extent feasible, the Balkan states should together pave the way for the Balkan Space Consortium development, and ensure seamless integration into the European Space Sector. By considering the proposed structural and operational proposal for the Consortium, the Balkan region should

ensure strengthening their soft power and gaining more influence, while simultaneously getting more funding, and stronger partnerships at the European and global level.

While similar frameworks have been proposed for more developed spacefaring nations, this model differs by explicitly addressing the constraints of emerging regions and emphasizing regional cooperation as a central mechanism for scalability. This contribution is particularly relevant in the context of the Western Balkans, where individual national capacities are limited, but collective action can create critical mass for participation in the European and global space economy.

From a practical perspective, the proposed framework can be applied by national governments, regional organizations, and innovation agencies as a policy and strategic planning tool. It allows stakeholders to sequence investments, prioritize institutional development, and align national initiatives with broader regional objectives. By doing so, the framework transforms abstract policy recommendations into a structured and implementable model for emerging space ecosystems.

4.11 Conclusion

This chapter synthesizes the key findings of the study, examining the transformative role of rocket programmes as critical enablers of space entrepreneurship and their contributions to the achievement of the Sustainable Development Goals. The analysis highlights how cost reductions, increased launch frequency, and technological advancements have reshaped access to space, enabling new actors—including developing regions—to participate in the global space economy.

The findings demonstrate that rocket programmes are not merely technical infrastructures, but strategic gateways that determine access to space-based resources, data, and economic opportunities. In this context, the emergence of New Space has significantly lowered

barriers to entry; however, access remains uneven, with developing regions such as the Balkans still facing structural constraints related to funding, expertise, and regulatory frameworks. In this context, the Western Balkans, although currently nascent, represent a high-potential emerging space ecosystem that could play a significant role in Europe's pursuit of technological sovereignty and inclusive space development.

Building on these findings, the study contributes to the field by proposing a structured framework for the development of emerging space ecosystems in the Western Balkans. The proposed Balkan Space Ecosystem Growth Framework integrates technological capabilities, institutional development, and regional collaboration mechanisms, offering a practical model for aligning space entrepreneurship with SDG implementation. Unlike existing studies, which predominantly focus on advanced spacefaring nations, this research highlights the unique constraints and opportunities of developing regions, demonstrating how targeted policy interventions, public-private partnerships, and regional coordination can accelerate participation in the global space economy.

From a practical perspective, the findings underline the necessity of coordinated regional strategies to overcome structural barriers such as limited funding, fragmented institutional support, and talent outflow. The research suggests that initiatives such as a Balkan Space Consortium, increased investment in STEM education, and the development of supportive regulatory frameworks could significantly enhance regional competitiveness. Furthermore, improving inclusivity—particularly in terms of gender participation—emerges as a critical factor for sustainable growth. These insights provide actionable guidance for policymakers, industry stakeholders, and academic institutions seeking to leverage space technologies as drivers of economic development and SDG achievement.

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APPENDIX A

INFORMED CONSENT

Thesis Title: The Role of Space Entrepreneurship in Achieving Sustainable Development Goals

Researcher: Filip Jovičević, SSBM Geneva

Purpose: The goal of this research is to explore the intersection of space entrepreneurship and the UN Sustainable Development Goals (SDGs), identifying factors that enable or inhibit the contribution of space ventures to global sustainability.

Participation Procedures: As a participant, you will be asked to answer questions regarding your professional experience in the space sector, your views on satellite applications for the SDGs, and the challenges facing regional space ecosystems (specifically the Balkans).

Confidentiality and Data Security: All data collected during this study will be treated with strict confidentiality. For interviewees, identities will be protected using pseudonyms (e.g., "Interviewee 1") unless explicit written permission is granted to cite specific institutional roles. All data will be stored on a secure, encrypted server.

Voluntary Participation: Your participation is voluntary. You may decline to answer any specific question or withdraw from the study at any time without any negative consequences.

Consent: By signing below for the interview, you acknowledge that:

1. You have read and understood the information provided above.
2. You voluntarily agree to participate in this study.
3. You are at least 18 years of age.

Participant Signature: _____ Date: _____

APPENDIX B

INTERVIEW GUIDE

Project Title: The Role of Space Entrepreneurship in Achieving Sustainable Development Goals

Researcher: Filip Jovičević, DBA Candidate, SSBM Geneva.

I. THE ENABLER: ROCKET TECHNOLOGY AND ECONOMIC DEMOCRATIZATION

This section explores how cost reductions and reusability act as the "foundational layer" for your projects.

Guiding Framework: How do rocket programmes (cost reductions, frequency, sustainable propulsion) enable space entrepreneurship to contribute to SDG 9 (Infrastructure) and SDG 5 (Gender)?

Participant Discussion Points:

- Democratization of Access: In your experience, how has the launch cost reduction affected the feasibility of projects for developing regions?
- Sustainable Operations: How can we ensure that the environmental impact of increased launches (SDG 13) does not negate the socio-economic benefits?
- Mission Design: How must technical mission design change to ensure that socio-economic objectives (like student engagement) are embedded from day one?

II. THE STRATEGIC LANDSCAPE: EUROPEAN INDEPENDENCE AND THE BALKANS

This section analyzes the "Innovation Ecosystem" and how institutional shifts impact regional startups.

Guiding Framework: What are the opportunities and challenges of Europe's pursuit of launch independence for SDG-aligned space ventures, particularly in the Balkans?

Participant Discussion Points:

- Institutional Membership: How does the lack of formal ESA membership (status: Cooperation Agreement vs. ECS) hinder the scalability of projects like Luča?
- Public-Private Partnerships (PPP): How can international collaboration and PPPs reduce the risks for emerging space nations entering the industry?.
- Best Practices: Can the ISRO model (500 private firms generating \$200M annually) be realistically adapted to the Balkan context?

III. THE REGIONAL ECOSYSTEM: LUČA, CROCUBE, AND STEM EDUCATION

A deep dive into the specific "grassroots" initiatives in Montenegro and Croatia.

Guiding Framework: How can the emerging Balkan space ecosystem contribute to SDGs 4, 5, 9, and 17, and what are the key barriers?

Participant Discussion Points:

- Educational Impact (SDG 4): How do CubeSat missions like CroCube stimulate STEM interest in local universities compared to traditional academic programs?.
- The "Luča" Model: How can Montenegro leverage its successful 2025 launch to establish itself as a regional hub for space innovation?
- Structural Barriers: Beyond funding, how do "expertise shortages" and "brain drain" (20% STEM emigration) affect your project's long-term sustainability?

IV. DIVERSITY AND INCLUSION: CLOSING THE 20% GAP

Addressing the specific gender disparities identified in your research.

Guiding Framework: How does space entrepreneurship promote SDG 5 through STEM engagement and leadership, particularly where women constitute only 20% of the workforce?

Participant Discussion Points:

- Leadership Representation: In projects like CroCube, how does female leadership directly influence the participation of girls in your outreach workshops?
- Policy vs. Practice: Are international initiatives like "Space4Women" effectively reaching the Balkan region, or is local advocacy more impactful?
- Inclusive Policies: What specific "inclusive policies" would you recommend for the Balkans, in order for the regional space ecosystem to develop in harmonization with the European space ecosystem? ?

V. POLICY ROADMAP: SCALABILITY & THE BALKAN SPACE CONSORTIUM

Final recommendations for future growth.

Guiding Framework: What policies and strategies can enhance the scalability of space entrepreneurship's contributions to the SDGs globally and in the Balkans?

Participant Discussion Points:

- The Consortium Idea: What would be the primary function of a Balkan Space Consortium—pooling money for launch access or harmonizing regional space laws?
- Measurable Outcomes: How can we better track the "socio-economic spillovers" of these missions to justify government R&D investment (currently at 0.1–0.5% GDP)?