



RESEARCH THEME: “DRIVING INNOVATION IN THE EUROPEAN EARTH OBSERVATION START-UP ECOSYSTEM: INSIGHTS FROM THE SEBS START-UP SURVEY 2021”

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Abstract:The “Driving Innovation in the European Earth Observation Start-Up Ecosystem: ”Insights from the SEBS Start-Up Survey 2021” looks at the trends of EO start-ups in Europe and their use of satellite imagery to solve the problems of the world, including climate change, urbanization, and sustainable resources. This work explains the growth strategies, challenges and potentials of 43 EO start-ups in 16 European countries. It assesses how these enterprises apply government aided satellite information in creating and implementing commercial focused solutions. This survey underpins the extreme reliance on public domain information sources and underlines the necessity for diverse funding and the boosting of the private sector to secure the sustainability and growth of EO solutions. Policy recommendations are offered for government, business, and other stakeholders to build a strong EO start-up sector able to deliver on social and environmental goals.

Keywords:Earth Observation, EO Start-Ups, Satellite Data, European Start-Up Ecosystem, SEBS Survey 2021, Innovation, Sustainable Development, Public Sector Data, Funding Diversification, Policy Recommendations.

1. Introduction

With the SEBS Start-Up Survey 2021, we look at how EO Start-Ups can contribute to the solution of global issues such as climate change, urbanisation, and sustainable utilization of resources. The survey reveals that there are 43 start-ups in 16 European countries, and all of them have to use satellite data which means that this raw information is converted into actionable intelligence (EARSC, 2021). These dynamics conform to Schumpeter’s theory regarding innovation which states that new business companies create new markets by employing new technologies to break conventional industries (Schumpeter, 1942).

The success of EO Start-ups that use data from Copernicus and Sentinel satellites proves that government backed initiatives are the key to innovation. Nevertheless, the resource dependency theory of Pfeffer and Salancik (1978) indicates that the use of public information sources may be problematic in the sense of their long-term availability. The EUR 1.1 million in total revenue associated with Copernicus supports this reliance and emphasises the requirement for policy measures to diversify funding and resource accessibility. This paper analyzes the growth patterns of EO start-ups in light of extant theories and the structural and operational constraints encountered. This is useful in generating recommendations for policy makers, business people and other interested parties who wish to build on the EO ecosystem and tackle social problems.

2. Survey Overview

This paper presents the SEBS Start-Up Survey 2021 that offers an overview of the EO start-up ecosystem in Europe and focuses on the start-ups created after 2015 for commercial applications of satellite EO. The survey data was collected from 43 start-ups in 16 countries and is one of the most globally

representative studies of start-ups (EARSC, 2021). This survey is a follow-on to the 2019 Innovation and Start-ups Survey but provides a more detailed exploration of technology maturity, business models, and concerns. These comparative observations highlight the dynamic and quickly changing nature of the EO landscape.

The method used is systemic, and to enhance data credibility, the data was validated and sorted according to the size, age, and functions of the companies. This is in conformity with the General System Theory formulated by Von Bertalanffy (1968) where system components are interdependent. EO start-ups are an important component of the more extensive innovation system and the development of EO start-ups is determined by a network of relationships between technology suppliers, public institutions and private sector actors. This is evident in the survey's focus, which discusses the EO ecosystem's capacity to address various challenges that define our world today including climate change, rapid urbanization and conservation of resources.

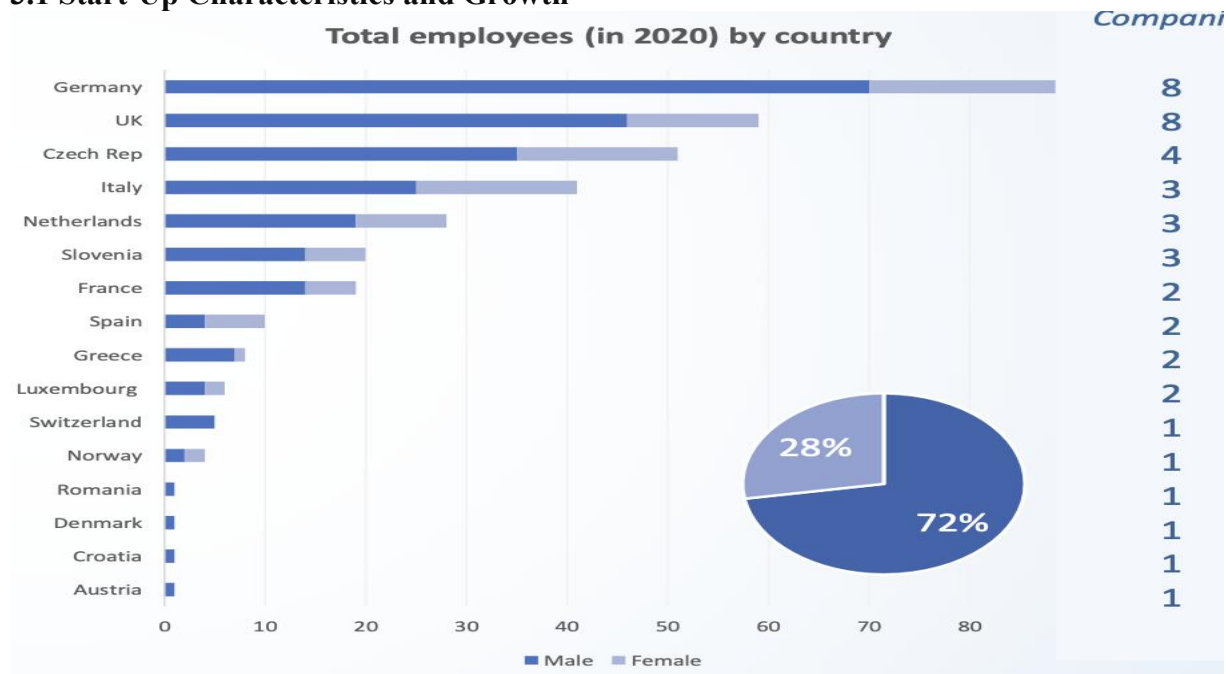
A comparison with the previous survey of 2019 will show the main trends in the development of the sector. Drawing from Greiner's (1972) growth model, the present study's findings can be understood in terms of "evolutionary" and "revolutionary" phases that start-ups go through. For example, although the technological readiness has increased, with 45% of start-ups having advanced solutions ready for the market, further scaling up is limited by operational and market factors. A major problem is that funding has been an issue, with most start-ups seeking finance from public grants and R&D funding to kick start the business. But a drawback of this is that these start-ups are highly dependent on external funding, which can be questionable once they expand and need constant capital.

The survey also investigates market acceptance as another key challenge, cited by 20% of the respondents. Rogers (1962) in the Diffusion of Innovation Theory defined early adopters as important to spreading new innovation and this is the challenge in this study. The results imply that EO start-ups should pay more attention to marketing and customer awareness to change potential users into actual users. Furthermore, the survey reveals that though public resources like Copernicus have provided the initial impetus for start-up, there is a need for enhanced private capital for the sustainable growth of start-ups.

In sum, the results of the survey support the significance of the innovation and market orientation. It calls for ecosystem level changes for instance mentorship, skill development and partnership between the public and private sectors. These are the steps that are necessary for EO start-ups to overcome the challenges of operations, gain the right size to make positive impacts on social and environmental agendas.

3. Key Insights and Graphs

3.1 Start-Up Characteristics and Growth



The SEBS Start-Up Survey 2021 presents the European Earth Observation start-ups community as active and rather young with the majority was launched after 2017. This trend is in response to the growing need for satellite derived information and applications for applications in agriculture, city planning, and environment (EARSC, 2021). According to the survey, start-ups established in 2019 and 2020 have less employment levels than the early start-ups. This finding is consistent with the early development stage theory by Adizes (1979) postulated that new organizations are characterized by resource and operational challenges.

The data gathered from the survey indicates that EO start-ups create employment of about eight persons while the broader EARSC Industry Survey indicates an average employment of 6.7 persons. Nevertheless, the uneven distribution of the workforce across the regions is observed; Germany and the UK represent 37% of total employment in the sector. These countries attract strong entrepreneurial environments, funding opportunities and well-developed technology, which are in accordance with Porter’s Diamond Model of Competitive Advantage (Porter, 1990). On the other hand, although countries such as the Czech Republic also report highly active entrepreneurial environment, their employment rates are comparatively lower, thus suggesting that there could be a need for capacity development at the regional level.

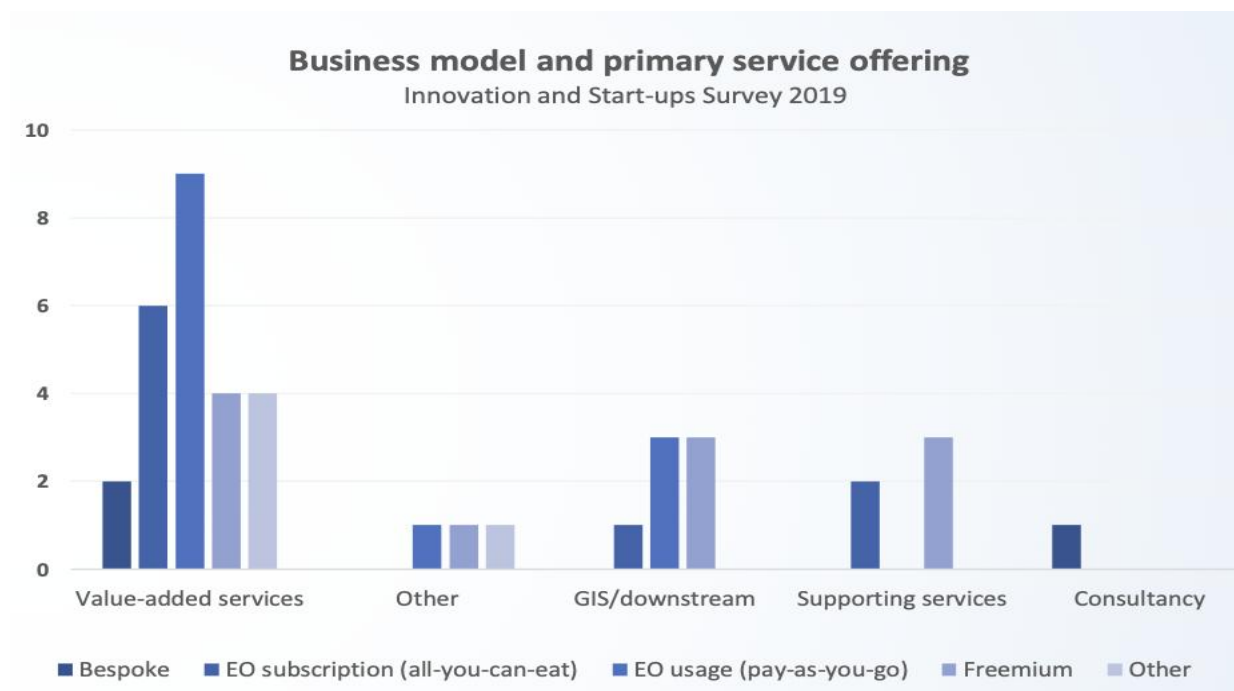
Lack of gender balance is also an important issue within the EO start-up environment because female employees make up only 27.6% of the total. This is not unique to this organization or field, there is a pattern that has been observed regarding women’s involvement in STEM. Diversity theories, for instance, Ely and Thomas’s (2001) Diversity Perspective Model, underlined that inclusive environments are helpful for the innovation and high performance. This gender gap is important to bridge in the EO start-ups as they will require both male and female in the long run in their businesses.

On employment patterns the survey also provides evidence on the effectiveness of specific measures aimed at fostering human capital. Areas such as skills training and development, apprenticeship and leadership training are however essential in order to solve talent gaps and provide solutions for growing start-ups. Besides, the documented differences in employment and gender indicate that there is a policy gap that should be filled in order to ensure that people in different areas of the world have equal chances of getting employment and that women and men are afforded equal opportunities in the workplace.

These findings support other issues related to growing start-ups in high technology industries. Although the

start-up growth of EO business models is primarily fueled by technology advancements, to reach operational sustainability, effort must be directed towards human capital, EO workforce diversity, and regional development. The policymakers and industry participants have to focus on these areas to allow the European EO start-up ecosystem to reach its full potential.

3.2 Business Models and Revenue



The current study is based on SEBS Start-Up Survey 2021, which contains valuable information on revenue streams and services to EO start-ups in Europe. The results reveal that EO value-added products and services are the most critical segment, contributing to about 60% of primary offerings (EARSC, 2021). The widespread use of models based on the “pay per use” concept is the imminent need for more versatile and easily expandable solutions, which are most often used in agriculture, urbanization, and meteorology. These models are consistent with the RBV of the firm (Barney, 1991), which focuses on the identification and building on strengths to overcome competition. This is because start-ups can meet the needs of clients while at the same time the end users do not have to incur costs of acquiring the products.

The survey also reveals changes in revenue generation models than the 2019 Innovation and Start-ups Survey. As earlier defined, the traditional model was the subscription-based model, but the current trend towards usage-based models points to a shift towards customer focus. This change can be explained by Christensen’s (1997) theory of disruptive innovation, where companies use new models of operation in order to attract new clients and to address the needs of the so far underserved customers.

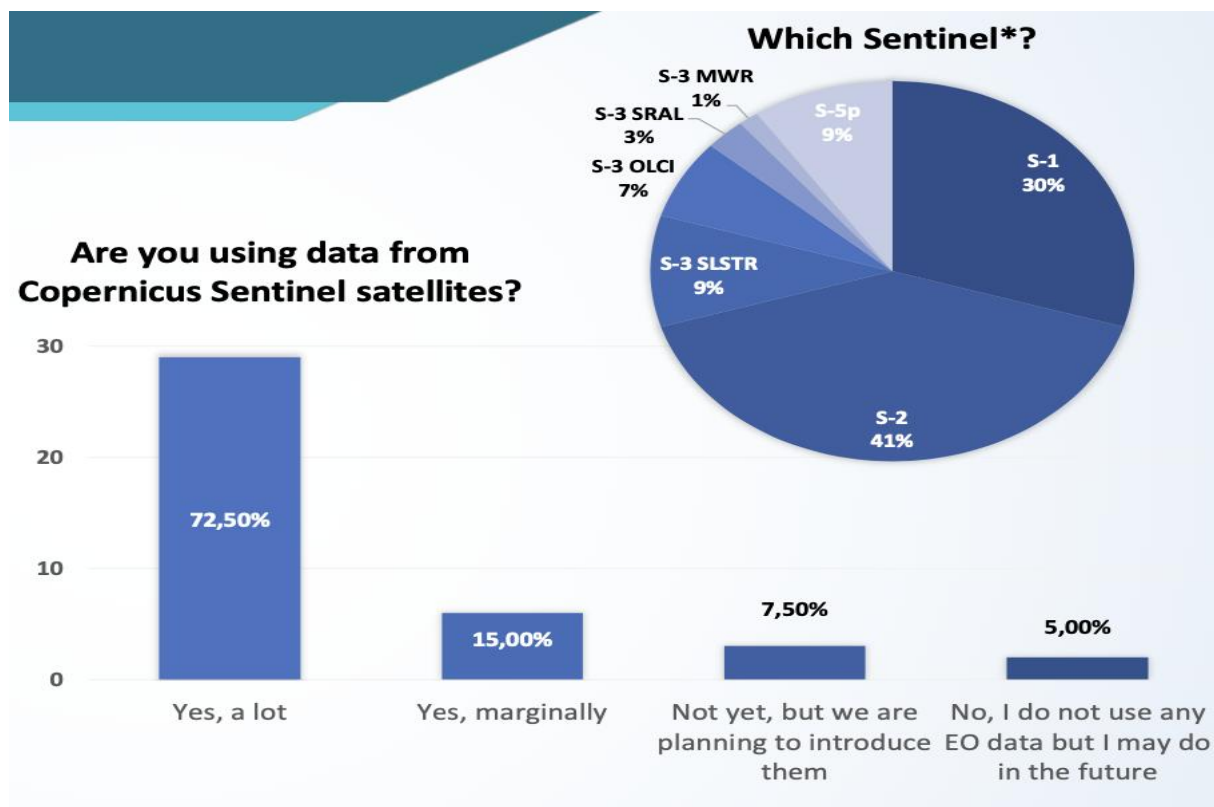
However, the main problem is profitability because it is difficult to turn a profit. According to the survey, 46 percent of start-ups generate annual revenues of less than €50,000, and only 35 percent generate revenues between €101,000 and €1,000,000. Such revenues show the high operational costs of the EO business and the long period it takes to close a sale in the industry. This is a classic problem of financial risk as more than 60% of start-ups depend on public grants and R&D funding for their initial capital. This finding is consistent with agency theory where dependence on external funding sources results in problems of accountability and reduced organizational control (Jensen & Meckling, 1976).

Also, the survey reveals customer acquisition and market acceptance challenges that affect revenue scalability. A major problem experienced by many start-ups is the challenge of moving from the project funding base to sustainable revenue sources, which is an obstacle to growth. This challenge shows that,

there is a general lack of an effective sales approach and customer engagement to explain the benefits of EO services. Drawing from Kotler's (1997) marketing mix model, the marketing focus on promotion and customer relationship will help to overcome these barriers.

The findings have shown that even though EO start-ups have adopted innovative business models, the issue of financial sustainability cannot be overlooked because a diversified revenue model is needed. Decision makers and industrial participants may want to consider establishing opportunities that allow the private sector to invest and minimize reliance on public subsidies. Other programmes including the mentorship programmes and collaborative platforms can also support the growth of sustainable EO ecosystem.

3.3 Role of Copernicus and Sentinel Data



Copernicus and Sentinel satellite data have become essential to European EO start-ups, which use them to create new and unique data-driven products. According to the SEBS Start-Up Survey 2021, 73% of the respondents depend much on the Sentinel data, and 38% state that it is the key to their competitive edge. In addition, according to a study by EARSC (2021), about EUR 1.1 million in total revenue is directly linked with the Copernicus data and services. This has implications on the importance of public-sector programs for innovation and at the same time it creates a problem of resource dependence which is explained by Pfeffer and Salancik (1978) in their resource dependence theory.

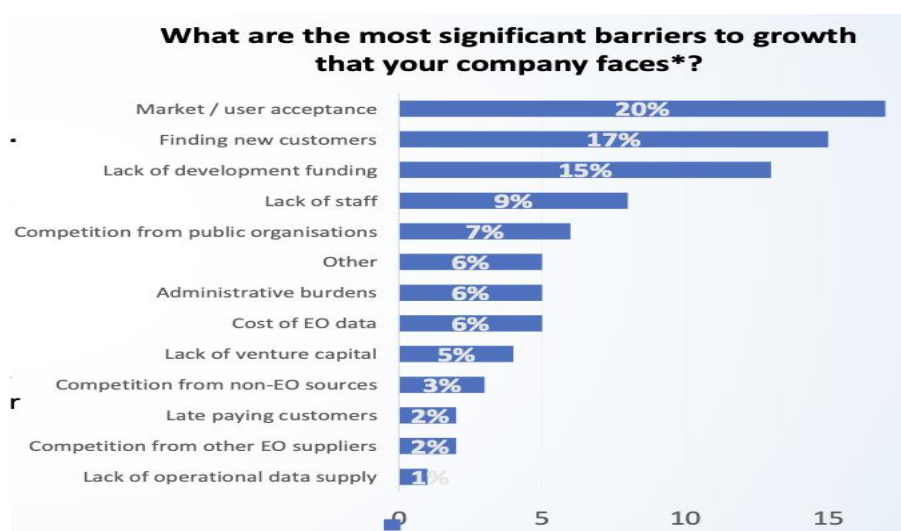
Sentinel data, primarily from the Sentinel-2 and Sentinel-1, informs a diverse range of applications including agricultural, climate, and infrastructure. These databases are offered at a very low or free of charge basis and have the potential of reducing cost on operating expenses for start-up companies and increase their competitiveness in markets that involves high use of data sets. This is in keeping with the theory of public goods which holds that goods that are open to use by anybody can produce great social and economic value (Samuelson, 1954). Nevertheless, as the EO ecosystem grows, the issues related to the commercialization and sustainability of data emerge, which requires a rational approach to the formation of policy to maintain access to data while encouraging the development of the private sector.

The enhanced value of Copernicus and Sentinel data also shows how digital infrastructure supports technological advancement in general. Drawing from Nelson and Winter's (1982) evolutionary theory of economic change, these data resources can be seen as supporting incremental and radical innovations. Through providing accurate and detailed EO datasets, Copernicus enables the creation of advanced analytics and AI which are now key elements for EO services. For instance, the start-ups that are using Sentinel data they have also adopted artificial intelligence in their analysis of the data and in their modelling.

However, the survey identifies a major dependency risk as follows: About two third of the respondents pointed out that they can manage without Sentinel data but their operations will be less effective. This implies that start-ups needs to look for other sources of information to avoid the risks that comes with the overuse of a given source of data. In the strategic management literature, diversification is consistent with Porter's (1980) generic competitive strategies, which help firms to improve their resistance to environmental turbulence.

For such challenges, public and private stakeholders need to come together to increase accessibility and usability of EO data. Among these, investments in data-sharing platforms, training programs, and partnerships can go a long way in enhancing the ecosystem's capacity. Moreover, encouraging private sector contribution to EO data and innovation can help to relieve pressure from public funding and promote a healthier and equitable development of the EO industry.

3.4 Barriers and Opportunities



The SEBS Start-Up Survey 2021 reveals key challenges and possible avenues that define the development path of EO start-ups. Out of the barriers, market and user acceptance was the most common challenge identified with 20% of the respondents. This issue fits in with Rogers' (1962) the Diffusion of Innovation Theory which notes that it is a challenge to move from the early majority to the other masses. The value proposition of many EO technologies may not be well understood by customers given that many industries may not be aware of the potential of satellite data.

Other important issue is customer acquisition, mentioned by 17% of start-ups. Most EO firms face challenges of lengthy sales cycles, intricate processes of purchasing, and relatively nascent markets. These factors are compounded by the fact that the EO market is a complex one, the potential consumers of EO services being drawn from a number of different industries including farming, city planning and even insurance. The challenges that have been highlighted herein can be best addressed by the promotion and

customer relationship management strategies of Kotler's (1997) marketing mix. Illustrative examples and Proof of Concept of EO technology applications as well as marketing strategies aimed at EO technology end-users may go a long way in filling this gap between potential and actual demand.

The lack of funding for development is an enduring problem; 15 percent of respondents pointed to it as a challenge. Surprisingly, according to the survey presented, venture capital is not a major constraint to most start-ups. This points toward a high dependence on grant and R&D monies, which is consistent with earlier sections of this survey. However, as discussed in the agency theory by Jensen and Meckling (1976), this freedom is a source of agency accountability and operational risks. Reliance on such funding sources and private sector financing should be diversified in order to promote financial stability.

However, there are also important opportunities for EO start-ups as revealed by the survey as well. The increasing focus on sustainability and climate change has positioned EO technologies in a good place. The level of awareness of climate change has created the need for information that EO start-ups are well placed to offer. Porter's (1990) value chain model shows how EO firms can realize competitive advantage by internalising upstream (data acquisition) and downstream (customer applications) activities.

To capture these opportunities, start-ups should concentrate on developing alliances and proving the return on investment of the technologies. Government, private sectors and universities can design and implement strategies that will foster innovation and market development. Some of the policy recommendations that may help to improve the future development of the EO sector include providing subsidies for the implementation of EO technologies, or giving tax exemption for investment in start-ups.

Thus, the paper reveals the dual imperative of innovation and market strategy. Recommendations of how to remove hurdles relating to customer, capital, and awareness of the market are crucial for facilitating growth of EO start-ups. Therefore, EO firms need to align their capabilities with the market that is in a state of rapid evolution and expand themselves within supportive ecosystems, so that they can play a vital role in the sustainability of the world.

4. Broader Implications

The results of the SEBS Start-Up Survey 2021 identify EO start-ups as a critical element for the development of the European start-up ecosystem. These companies have a critical role in contributing to the solutions of the world's problems including climate change, urbanization, and resource management. But the survey also reveals the structural and operational constraints that may limit their contribution, which means that a comprehensive strategy to policies and ecosystem is needed.

One significant implication of this study is the need for better financing arrangements suitable to the needs of EO start-ups. Although public grants and R&D funds have helped to kick-start growth, dependence on these sources is problematic as start-ups grow. By the Resource-based view of the firm, Barney (1991) has argued that for a strategic organization to grow sustainably, it has to build firm-specific skills and acquire varied financial assets. Measures that encourage private investment, for instance, tax breaks and co-investment arrangements, could well help to fill these gaps. This is consistent with the entrepreneurial ecosystem model (Isenberg, 2011) which underlines the role of financial capital in the expansion of innovative entrepreneurship.

Just as important as skill-building and mentorship programs are for the development and success of EO start-ups. An examination of employment patterns and dynamics shows that gender and regional dimensions remain critically important in shaping the overall employment situation, with the continued presence of barriers which hinder the achievement of greater employment equity and diversity. Theories of diversity management, including Ely & Thomas' (2001) Diversity Perspective Model, explain why diversity management leads to organizational effectiveness. Strategies that can be used to overcome these inequalities and thus develop a competitive workforce include, special training programs for the under privileged groups and the enhancement of regional capacity.

Another important area which needs intervention is market awareness campaigns. Rogers' (1962) Diffusion

of Innovation Theory suggests that EO technologies will only be adopted by many if the users are informed and shown the benefits. Joint efforts of public and private sectors can help in creation of more efficient and targeted marketing approaches to demonstrate the effectiveness of EO technologies. Through the promotion of market penetration, platforms that link start-ups with customers, investors, and other policy-makers may also be useful.

Finally, the study shows the need for policy measures targeting equal distribution of access to valuable resources such as Sentinel and Copernicus data. These datasets are valuable in supporting innovation as they are public goods whose provision Samuelson (1954) explained. However, the question of how best to sustain their availability and, at the same time, increase the involvement of the private sector is a fine one. Policy makers have to strive for developing structures which encourage cooperation in data sharing and stimulate investments in data related infrastructure.

Thus, these implications can help Europe promote its EO start-up ecosystem as one of the most technologically and environmentally advanced in the world. Greater engagement of public and private partners, in parallel with sound policies, will be pivotal for realising the EO technologies' full potential and fostering sustainable development.

5. Conclusion

The SEBS Start-Up Survey 2021 gives a great overview of the state of the European EO start-ups and the opportunities and threats for its development. It is a list of start-ups that are leading the change and are working to solve some of the world's biggest problems such as climate change, urbanization, and sustainable resource management. Using leading-edge technologies and open sources, EO start-ups provide a clear example of how innovation may foster the common good.

The survey results show that Sentinel data is very valuable as more than 73% of the users reported depend on it for improving operations and competitiveness. This dependence highlights the importance of further public funding for data availability based on the public goods approach introduced by Samuelson (1954). However, the concentration of the sector on grants and R&D funding shows that there is a lack of diversified strategies for financing. From the analysis of the resource dependence theory by Pfeffer and Salancik (1978), it is clear that sustainable growth has to do with decreasing the organization's reliance on outside resources and encourage the private sector.

There are still some operational barriers in this context like market acceptance, customer acquisition, and funding concerns which are still major issues. Such challenges require a more purposeful effort to engage customers, create new forms of value, and target systemic changes throughout the ecosystem. These theories such as Rogers' (1962) Diffusion of Innovation theorize that early adopters of new technology influence the market adoption of those technologies.

To support the development of the EO business in Europe, the governments, industries and investors should work together to build the proper conditions. Better financial schemes, capacity development, and fair distribution of limited resources are key to EO technologies for achieving their full potential. If such structural barriers can be removed and inclusive growth can be supported, EO start-ups will have the potential to define the future of sustainable development.

Hence, besides revealing the accomplishments of the EO start-up sector, the SEBS Start-Up Survey 2021 also captures the future direction of the sector's development. Backing up this thriving environment is an investment in technology, environmental conservation, and people's lives. It remains the responsibility of the stakeholders to ensure that EO start-ups sustain the innovation and add value on the international market.

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