



## WP5 Business model implementation through innovation support services

---

### D5.3 Incubation design and implementation plan

<https://forest40.it/>



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101059985. Views and opinions expressed are, however, those of the author(s) only and do not necessarily reflect those of the European Union or the granting authority. Neither the European Union nor the granting authority can be held responsible for them.



**Grant Agreement No.: 101059985**  
**Deliverable: D5.3 Incubation design and implementation plan**

**Project Start Date:** 01/05/2023  
**Coordinator:** *Vytauto Didžiojo universitetas*

**Duration:** 72 months

<b>Deliverable No:</b>	D5.3
<b>WP No:</b>	5
<b>WP Leader:</b>	Kaunas University of Technology
<b>Due date:</b>	31/04/2025
<b>Delivery date:</b>	31/04/2025

**Dissemination Level:**

PU	Public Use	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	



## DOCUMENT SUMMARY INFORMATION

<b>Project title:</b>	<b>Creation of the centre of excellence in smart forestry</b>
<b>Short project name:</b>	Forest 4.0
<b>Project No:</b>	101059985
<b>Call Identifier:</b>	HORIZON-WIDERA-2022-ACCESS-01-two-stage
<b>Thematic Priority:</b>	HORIZON-WIDERA-2022-ACCESS-01-01-two-stage - Teaming for Excellence
<b>Type of Action:</b>	HORIZON-CSA - HORIZON Coordination and Support Actions
<b>Start date of the project:</b>	01/05/2023
<b>Duration of the project:</b>	72 months
<b>Project website:</b>	<a href="https://forest40.lt/">https://forest40.lt/</a>

### D5.3 Incubation design and implementation plan

<b>Work Package:</b>	WP5 Business model implementation through innovation support services
<b>Deliverable number:</b>	D5.3
<b>Deliverable title:</b>	Incubation design and implementation plan
<b>Due date:</b>	31/04/2025
<b>Actual submission date:</b>	31/04/2025
<b>Editor:</b>	Egidijus Kazanavičius
<b>Authors:</b>	Rytis Maskeliūnas, Robertas Damaševičius
<b>Dissemination Level:</b>	PU
<b>No. pages:</b>	75
<b>Authorized (date):</b>	16/04/2025
<b>Responsible person:</b>	T. Krilavičius
<b>Status:</b>	Working

#### Revision history:

Version	Date	Author	Comment
v.0.1	23/10/2024		First outline
v.0.5	22/12/2024		Contents, including a classification of the related state-of-the-art
v.0.8	08/01/2025		Restructuring, finalization of the model
v.0.8.1	18/01/2025		Proofreading, minor revisions
v.0.9	19/02/2025		First complete version presented, minor revisions
v.1.0	23/02/2025		Pre-final version after internal review, minor revisions
v.1.1	23/04/2025		Final version approved by consortium



### Quality Control:

	<b>Who</b>	<b>Date</b>
<b>Checked by internal reviewer</b>	Egidijus Kazanavičius	18/01/2025
<b>Checked by WP Leader</b>	Kaunas University of Technology	19/02/2025
<b>Checked by CoE Manager</b>	N. Kupstaitis	16/04/2025
<b>Checked by Project Coordinator</b>	T. Krilavičius	16/04/2025



## COPYRIGHT

©Copyright by the **Forest 4.0** consortium, 2023-2029.

This document contains material, which is the copyright of Forest 4.0 consortium members and the European Commission, and may not be reproduced or copied without permission, except as mandated by the European Commission Grant Agreement no. 101059985 for reviewing and dissemination purposes.

## ACKNOWLEDGEMENTS

Forest 4.0 is a project that has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No 101059985. Please see <https://forest40.lt/> for more information.

The partners in the project are Vytauto Dižiojo universitetas, Kauno technologijos universitetas, Linnaeus University, Interior Cluster Sweden, AgroFood . The content of this document is the result of the worked developed by the partners in the context of the project.

## DISCLAIMER

The content of the publication herein is the sole responsibility of the publishers and it does not necessarily represent the views expressed by the European Commission or its services. The information contained in this document is provided by the copyright holders "as is" and any express or implied warranties, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose are disclaimed. In no event shall the members of the Forest 4.0 collaboration, including the copyright holders, or the European Commission be liable for any direct, indirect, incidental, special, exemplary, or consequential damages (including, but not limited to, procurement of substitute goods or services; loss of use, data, or profits; or business interruption) however caused and on any theory of liability, whether in contract, strict liability, or tort (including negligence or otherwise) arising in any way out of the use of the information contained in this document, even if advised of the possibility of such damage.



# Contents

<b>1</b>	<b>Prèámble</b>	<b>7</b>
<b>2</b>	<b>Introduction</b>	<b>8</b>
2.1	Background on forests and environmental challenges in the Baltic Sea Region .	8
2.2	Role of technology (AI, IoT, etc.) in Sustainable Forest management . . . . .	9
<b>3</b>	<b>Strategic Vision for Technology Incubation</b>	<b>11</b>
3.1	Objectives of the incubation program . . . . .	11
3.2	Desired outcomes (environmental, economic, technological) . . . . .	13
3.3	Key stakeholders (government agencies, NGOs, tech companies, etc.) . . . . .	15
<b>4</b>	<b>Ecosystem readiness and existing infrastructure in Lithuania</b>	<b>15</b>
<b>5</b>	<b>Incubation Design and Framework</b>	<b>19</b>
5.1	Structure of the incubation program . . . . .	19
5.2	Criteria for project selection and evaluation . . . . .	21
5.2.1	Diversity, Equity, and Inclusion (DEI) Considerations . . . . .	24
5.3	Stages of incubation . . . . .	25
5.4	Timeline for development and deployment . . . . .	27
5.5	Monitoring, Evaluation, and Feedback . . . . .	29
5.5.1	Key performance indicators (KPIs) for success measurement . . . . .	29
5.5.2	Feedback mechanisms for continuous improvement . . . . .	29
5.5.3	Long-term monitoring strategies and sustainability . . . . .	33
5.6	Mentorship . . . . .	38
5.7	Infrastructure and resource requirements . . . . .	40
<b>6</b>	<b>Overview of Potential Funding sources</b>	<b>42</b>
<b>7</b>	<b>Example Business Models for the Incubation Pipeline</b>	<b>44</b>
7.1	AI and IoT for Forest Health Monitoring . . . . .	44
7.2	Wildlife conservation and habitat protection . . . . .	47
7.3	Forest Wildfire Detection and Prevention . . . . .	51
7.4	Carbon Sequestration Tracking and Reporting . . . . .	55
7.5	Digital Twin for Forest Ecosystems . . . . .	59
7.6	Decentralized Forest Monitoring Using Blockchain and Large Language Models	64
<b>8</b>	<b>Conclusion and Recommendations</b>	<b>70</b>
<b>9</b>	<b>Annex I. Abbreviations used</b>	<b>72</b>



---

# 1 Prèámble

---

The "Forest 4.0 CoE" commits to democracy, sustainability, and technological advancement in the fight against climate change. The pursuit of sustainable forestry is not just an ecological necessity but a moral imperative, reflecting the values of a society where knowledge, innovation, and justice are accessible to all, regardless of background or identity.

This report on "Business model implementation through innovation support services" is shaped by a collective recognition that the climate crisis, economic inequality, and the erosion of democratic norms are interconnected challenges that cannot be addressed in isolation. The leadership of global institutions, such as the World Economic Forum (WEF), and the tireless advocacy of underrepresented communities, including LGBTQ+ activists, have laid the foundation for a more inclusive and just approach to environmental policy. Their work underscores a critical truth: that sustainable commercial developments must be driven by diverse voices, ensuring that climate action, technological innovation, and social equity move forward hand in hand.

One of the most pressing issues addressed in this programme is the accelerating of start-ups that focus on the impact of climate change on forests and biodiversity. As the planet faces unprecedented environmental degradation, the role of sustainable forest management becomes increasingly vital. The Forest 4.0 initiative harnesses the power of AI, IoT, and other emerging technologies to modernize forestry practices, not only to mitigate climate change, but also other issues.

However, addressing these challenges requires more than technological solutions. It demands a paradigm shift in how we view the intersection of climate action, social justice, and democratic governance. The increasing pressure on global institutions to confront inequality, authoritarianism, and environmental collapse requires innovative responses that prioritize sustainability and inclusivity. The Forest 4.0 programme is designed with this complexity in mind, providing a blueprint for how we can integrate cutting-edge technology into sustainable practices while ensuring that marginalized communities are not left behind.

We express our deepest appreciation to educators, activists, and scholars who continue to challenge the status quo, advocating for a future defined by shared prosperity, climate resilience, and democratic values. Their commitment to addressing these interwoven crises serves as a powerful reminder that the fight against climate change is also a fight for human dignity, equity, and freedom.



---

## 2 Introduction

---

### 2.1 Background on forests and environmental challenges in the Baltic Sea Region

The Baltic Sea Region (BSR) is a set of countries surrounding the Baltic Sea, including Sweden, Finland, Denmark, Estonia, Latvia, Lithuania, Poland, Germany, and parts of Russia [1]. The forests in the Baltic region are predominantly boreal and temperate, featuring coniferous and mixed forests that support a variety of plant and animal species, many of which are endemic to the region [2]. Forest ecosystems act as carbon sinks, helping to mitigate the effects of climate change by absorbing and storing carbon dioxide [3]. They support rich biodiversity and provide habitat to species such as elk, lynx, wolves, and numerous species of birds [4]. Our forests play a key role in the regulation of the water cycle and soil conservation, helping to prevent erosion and maintain the water quality in rivers and lakes [5]. Forestry in the BSR is a major industry that contributes significantly to the regional economy [6]. Almost all BSR countries have highly developed timber and paper industries [5]. Forests are also a vital source of livelihood for rural communities, providing employment and resources [7]. Finally, forests also offer recreational opportunities and cultural heritage value, which are important for tourism [2].

Despite their critical role in environmental and economic sustainability, forests in the BSR face significant challenges that threaten their health and long-term survival [8]. The most obvious stressor is climate change [9]. Warming temperatures and altered precipitation patterns stress forest ecosystems [10]. Boreal forests are particularly sensitive to these changes, which shift species distributions, increase vulnerability to pests and diseases, and disrupt ecological balances, already very noticeable in the BSR forests [11]. The increased occurrence of extreme weather events, such as storms and droughts, is causing forest degradation, reducing forest productivity, and increasing the risk of wildfires [12].

The third issue is biodiversity loss. Unsustainable logging practices, pollution, and habitat degradation contribute to a decline in biodiversity, affecting both the species richness within forests and the overall ecological integrity of the region [6]. Some forest species in the Baltic region are at risk of extinction due to habitat loss and environmental pressures [4].

Pest and disease outbreaks have become very noticeable in the last five years [12]. Climate change has exacerbated the spread of pests such as bark beetles, which have caused extensive damage to coniferous forests in Lithuania, Sweden, Finland, and other parts of the region [11]. Warmer winters mean that these pests are no longer limited by cold conditions, allowing for more frequent and widespread infestations, which can lead to large-scale tree die-offs [9].

Finally, increasing temperatures and prolonged dry periods in the summer season have led to more frequent and severe forest fires in the Baltic region, particularly in southern parts of Poland and northern parts of Lithuania, destroying vast areas and releasing large amounts of carbon dioxide, exacerbating climate change [10].

Countries in the Baltic Sea Region are actively working to mitigate these challenges through various conservation and sustainable forest management practices, further to be accelerated by the efforts of Forest 4.0 CoE [8]. National and cross-border policies are being updated



that focus on forest conservation, biodiversity protection, and climate adaptation [1]. Participation in the European Union's Forest Strategy and Biodiversity Strategy promotes sustainable forest management, afforestation, and reforestation initiatives [13]. The implementation of forest certification schemes (FSC and PEFC) encourages responsible forest management practices [14]. However, while these initiatives are steps in the right direction, more robust and adaptive approaches are needed to address the long-term sustainability of forests in the Baltic Sea Region [15]. The integration of emerging technologies, such as those promoted by Forest 4.0, in particular, artificial intelligence (AI), Internet of Things (IoT) and advanced data analytics, could offer new tools to address environmental challenges and support sustainable forest management [16].

## 2.2 Role of technology (AI, IoT, etc.) in Sustainable Forest management

The general idea behind Sustainable Forest Management (SFM) involves balancing the environmental, economic, and social functions of forests to meet the needs of present and future generations [13]. The advanced technologies promoted by Forest 4.0, Artificial Intelligence (AI), the Internet of Things (IoT), and remote sensing play a transformative role in achieving this balance, providing innovative solutions to monitor, manage and protect forests more effectively, making forest management more adaptive, data-driven, and precise [16].

AI can help process large amounts of data from different sources to generate insights that support decision-making in forest management [17]. Its applications include Forest Health Monitoring, where AI algorithms analyze satellite images, drone data, and other sources to detect patterns of degradation, and forest health problems such as disease outbreaks or pest infestations [18]. Machine learning models can identify early signs of these threats and predict their spread, allowing for timely interventions [19]. AI-powered systems use data from sensors, satellites, and historical records to detect forest fires at an early stage and predict their potential paths [19]. By analyzing climate conditions, vegetation types, and topography, AI models can assess the risk of future wildfires and guide firefighting efforts more efficiently [20]. AI also enables automated analysis of audio, video and image data from forest habitats to monitor wildlife and assess biodiversity levels [21]. For example, AI-powered acoustic sensors can identify bird and animal species by their calls, helping to track changes in population dynamics and ecosystem health [21]. AI-powered drones and sensors can gather data on tree species, height, and diameter, and calculate biomass, which helps in sustainable timber harvesting [20]. AI models can also optimize harvest schedules, ensuring that logging is conducted without harming the forest's ability to regenerate [22]. AI can help measure the carbon storage capacity of forests by analyzing data on forest composition, growth rates. This supports carbon credit programs and international climate agreements by providing accurate assessments of forests' role in capturing and storing carbon dioxide [22].

IoT devices can provide near real-time data for monitoring forest ecosystems and supporting sustainable management [16]. Key applications include Environmental Monitoring, where IoT-enabled sensors are deployed in forests to collect continuous data on temperature, humidity, soil moisture, and air quality [23]. These sensors allow forest managers to remotely monitor environmental conditions, which is critical for detecting changes in ecosystem health and responding to potential threats such as droughts or pest outbreaks, as complete physical



surveys are hardly ever feasible considering the landscapes and areas of the BSR forests [24]. IoT sensors, cameras, and acoustic recorders can track animal movements, monitor migration patterns, and assess habitat conditions, which are essential for conserving biodiversity and protecting endangered species in forest ecosystems [25]. IoT technology accelerates precision forestry, where connected devices provide data that enables forest managers to optimize resource use [26]. For example, IoT sensors can measure soil and nutrient levels, ensuring that fertilizers and water are applied in the right amounts, improving tree growth while minimizing environmental impact [27]. IoT devices equipped with smoke and temperature sensors can be placed in forested areas to detect the early signs of wildfires. These sensors provide instant alerts to forest authorities, allowing for rapid response and minimizing the damage caused by fires [28].

Remote sensing, through satellites and drones, provides important data for large-scale forest monitoring and has already revolutionized sustainable forest management by offering detailed, accurate, and frequent observations [29]. Satellite imagery and drone data map forest cover, identify deforested areas, and monitor the expansion of agricultural or urban zones that can invade forests [30]. For example, in Lithuania, such data support the enforcement of forest protection laws and help policymakers develop more effective land use planning strategies [31]. Foresters use satellite imagery and LiDAR (Light Detection and Ranging) technology for mapping forest structure, tree species composition, and biomass, as well as estimating the volume of timber, monitoring forest growth, and assessing the forest's ability to sequester carbon [32]. Remote sensing data can be used to analyze soil degradation and erosion in forested areas, helping in the management of reforestation efforts and the prevention of further land degradation, ensuring that forest ecosystems remain healthy and productive [33].

Data analytics and GIS tools are the other necessary components for synthesizing data collected from various sources (satellites, IoT sensors, remote sensing) into actionable insights for forest management [34]. GIS systems allow forest managers to create detailed maps of forest resources, including species distribution, forest density, and areas affected by deforestation or degradation [35]. These maps are used for land-use planning, conservation efforts, and optimizing resource extraction [36]. Data analytics tools enable the development of predictive models to anticipate future changes in forest ecosystems, such as the impact of climate change, the spread of invasive species, or the likelihood of wildfires [10]. These insights help to proactive forest management and disaster prevention [37]. With advanced data analytics, forest managers can create detailed reports on forest operations sustainability, track carbon sequestration, and monitor compliance with certification schemes such as FSC (Forest Stewardship Council) or PEFC (Programme for the Endorsement of Forest Certification) [14].

Finally, blockchain technology helps improve transparency in forest management and supply chains. Research indicates that blockchain can be used to create transparent and traceable records of timber harvested from certified forests, ensuring that logging operations comply with sustainability standards and helping to reduce illegal logging while ensuring responsible sourcing of forest products [38]. Blockchain technology can also ensure the integrity of carbon credit programs by securely recording transactions and verifying the amount of carbon sequestered by forests, thus reducing fraud and ensuring that carbon credits represent real environmental benefits [39].



## 3 Strategic Vision for Technology Incubation

### 3.1 Objectives of the incubation program

The incubation program for sustainable forest management (SFM) techniques aims to accelerate the development and deployment of innovative technologies and strategies that address the environmental, economic, and social challenges associated with forest management. The program should focus on nurturing ideas, startups, and projects that use advanced technologies such as AI, IoT, drones, data analytics, and sustainable forestry practices to create long-lasting positive impacts on forest ecosystems and communities. The following are the key objectives for the incubation program:

- **Develop Scalable Technology Solutions for Forest Monitoring and Protection.** The idea is to support the development of AI, IoT, and drone-based solutions to improve the monitoring and protection of forests from threats such as illegal logging, wildfires, pests, and diseases. The incubation program will provide mentorship, resources, and funding to teams working on technology-based tools that offer real-time monitoring and early detection of threats, helps to respond more effectively to emerging challenges, ensuring forest health and longevity.
- **Promote Data-Driven Decision-Making** through the creation of data analytics platforms and tools that enable forest managers to make informed, data-driven decisions regarding land use, resource allocation, and conservation strategies. Encourage the development of platforms that integrate satellite imagery, IoT sensor data, and forest inventory information into user-friendly dashboards. These tools will empower decision-makers to monitor deforestation, assess biodiversity, track carbon sequestration, and optimize harvesting plans, contributing to more sustainable forest practices.
- **Enhance Carbon Sequestration through Forest Management** focusing on projects that maximize the carbon sequestration potential of forests by promoting sustainable forestry practices, reforestation, and afforestation initiatives. The incubation program will support innovations aimed at assessing and increasing the carbon storage capacity of forests, including tools to measure carbon in real time, models for optimizing tree planting efforts, and techniques for preserving older, carbon-rich forests. The goal is to contribute to global climate change mitigation efforts while ensuring ecosystem health.
- **Encourage Circular Economy Models in the Forestry Sector** by developing solutions that promote a circular economy in forestry, minimizing waste, and maximizing the value of forest products in sustainable ways. The incubation program will focus on the development of technologies and business models that reduce waste in the forestry supply chain, promote responsible harvesting, and encourage the use of forest by-products. This could involve creating new applications for wood waste, improving recycling technologies, or developing biodegradable materials that can replace unsustainable alternatives like plastic.
- **Support Biodiversity Conservation and Habitat Restoration**, by incubating technologies and strategies that protect and restore biodiversity in forest ecosystems, esp. in areas affected by deforestation, and climate change. This objective focuses on nurturing projects



that deploy technologies such as drones, GIS mapping, and AI-based wildlife tracking to monitor species health, migration patterns, and habitat conditions. It will support efforts that integrate sustainable forest management with biodiversity restoration, such as agroforestry and landscape-level conservation planning.

- **Strengthen Local Communities through Sustainable Forestry Practices** by promoting forest management techniques that create economic opportunities for local communities while ensuring forest conservation and sustainability. Encourage the development of inclusive models for community-based forestry management, agroforestry, and ecotourism. The incubation program will support projects that help communities derive sustainable income from forests, such as the development of non-timber forest products (NTFPs), forest-based enterprises, and partnerships that align local livelihoods with conservation goals.
- **Promote Responsible Timber Harvesting and Supply Chain Transparency** by incubating solutions that ensure the sustainable and traceable harvesting of timber and forest products. Support the creation of tools, such as blockchain-based platforms, that provide transparency in the forest product supply chain, that can track the origin of timber, certify that it has been harvested sustainably, and help companies and consumers make responsible purchasing decisions.
- **Facilitate Reforestation and Ecosystem Restoration** by incubating projects focused on restoring degraded forest ecosystems and increasing forest cover through innovative reforestation techniques. The program will support technologies such as drone-based seed planting systems, AI-powered ecosystem restoration planning, and precision reforestation tools that make large-scale reforestation efforts more efficient and effective, also focusing on restoring native species, improving soil health, and building resilience against climate change.
- **Develop Solutions for Wildfire Prevention and Management**, by supporting innovations in wildfire prevention, early detection, and mitigation, particularly in regions at high risk of forest fires due to climate change. The incubation program will focus on advancing technologies such as IoT-based fire detection systems, AI models that predict fire risk based on environmental data, and drones that monitor and help manage fires. These solutions will be aimed at reducing the incidence and impact of wildfires on forest ecosystems and nearby communities.
- **Foster Collaboration Between Technology Providers and Forest Stakeholders** by aiming to create an ecosystem of collaboration between tech startups, forest managers, environmental NGOs, and government agencies to develop and implement cutting-edge solutions for sustainable forest management. The incubation program itself should serve as a platform for stakeholders to collaborate on projects that bridge the gap between technology innovation and on-the-ground forest management, which includes forming partnerships that enable technology developers to work closely under umbrella of Forest 4.0: foresters, scientists, and policymakers together ensuring that solutions meet practical needs and regulatory requirements.



## 3.2 Desired outcomes (environmental, economic, technological)

The desired outcomes of the incubation program can be grouped into three main categories: environmental, economic, and technological. These outcomes reflect the overarching goal of promoting sustainability, enhancing the resilience of forest ecosystems, and driving innovation in forest management practices.

### Environmental Outcomes:

- Improved Forest Health and Resilience, as the CoE aims to improve forest health and resilience of forests by using innovative technologies to monitor, protect, and manage forest ecosystems. And through incorporation of AI, IoT, and remote sensing tools, the program will facilitate early detection of threats such as pest infestations, diseases, and forest fires, allowing proactive interventions to reduce forest degradation. Healthier forests will be able to regenerate and resist environmental stressors, leading to long-term sustainability.
- Enhanced Carbon Sequestration through promotion of sustainable forestry practices, reforestation, and afforestation to maximize forests' carbon sequestration potential. Tools that measure, monitor, and optimize carbon storage in forests will contribute to climate change mitigation. Increased carbon capture will support national and global climate targets such as the Paris Agreement.
- Reduction in forest fires and environmental damage through the use of AI, IoT and satellite technologies. For example, the development of smart early warning systems for wildfires could enable faster and more effective responses. Advanced tools could help predict fire risks and mitigate damage. As a result, there would be reduced incidence of wildfires and less environmental damage, protecting forest ecosystems, and reducing the release of carbon emissions caused by fires.
- Biodiversity Conservation and Habitat Restoration through technologies that can track wildlife populations, assess habitat quality, and promote healthy ecosystems. Initiatives through precision forestry and sustainable land use planning must help to protect and enhance biodiversity, leading to increased biodiversity, restored ecosystems, and improved habitats for endangered species.

### Economic Outcomes:

- Sustainable Economic Growth in Forest-Dependent Communities could be achieved, for example, by programmes focus on the development of sustainable business models that provide income-generating opportunities for forest-dependent communities, such as eco-tourism, non-timber forest products (NTFPs), and community-based forestry enterprises. By promoting a circular economy in the forestry sector, it can help to ensure that forest resources are used sustainably and contribute to local economic growth. Potential impacts could be improved livelihoods for rural and forest-dependent communities, enhanced job creation, and sustainable use of resources.
- The development of green technologies and business models is another outcome. The program will foster innovation in green technologies, including renewable materials derived from forests, sustainable timber harvesting tools, and resource-efficient forest management techniques. Startups focusing on green solutions would drive new



economic opportunities while promoting environmental stewardship. As a result, an increase in economic value could be achieved from forests through sustainable forest practices, innovative products, and responsible supply chains.

- Reduction in Economic Losses Due to Forest Degradation and Fires is realistic with effective early detection of forest fires, pest outbreaks, and illegal logging, enabled by AI and IoT technologies, helping forest managers mitigate risks and reduce economic losses, also , ensuring long-term economic benefits. Forest degradation leads to decreased timber productivity and loss of ecosystem services, impacting industries and communities.
- Expansion of the Forest-Based Bioeconomy is possible by encouraging sustainable use of forest resources and the development of eco-friendly forest products driven by the circular economy, including innovations in timber, biofuels, biodegradable materials, and other forest-based products. Diversified revenue streams and increased economic resilience in the forest sector, would support a transition to low-carbon, bio-based industries.
- Increased Investment in Sustainable Forestry and Conservation can happen by demonstrating the profitability and long-term sustainability of new technologies and business models in forestry, as the Forest 4.0 program participants would be able to attract increased investment from both public and private sectors in contrast with traditional means of nonspecialized incubation, supporting the expansion and commercialization of these technologies. Capital flow would increase toward sustainable forest initiatives, continuing to drive innovation and enhancing the global market for sustainable forest products.

#### Technological Outcomes:

- Development of Advanced Forest Monitoring and Management Tools as an outcome of encouragement toward the creation of cutting-edge technologies such as AI-driven forest monitoring systems, IoT-enabled sensors for real-time data collection, and drones for precision forestry, all to improve forest management efficiency, allowing smarter and more sustainable decisions and driving a more widespread adoption of high-tech solutions in forest management, leading to improved accuracy and efficiency in monitoring and maintaining forest ecosystems.
- The deployment of predictive analytics for forest health is again possible by incorporating big data analytics and AI, through the use of predictive models that anticipate forest health challenges, including disease outbreaks, pest infestations, and wildfire risks, all to allow forest managers to take preventive measures before major damage occurs. A data-driven approach to forest management will allow for proactive interventions, reducing the risks and costs associated with forest degradation.
- The integration of blockchain for transparent supply chains will help ensure traceability in the timber and forest product supply chain. These systems can allow transparent verification of the sustainability of forest products, reducing illegal logging and encouraging responsible sourcing. Transparent and traceable supply chains can increase consumer trust in sustainable products and reduce illegal forest activities and imports from sanctioned countries.



- Creation of Smart Forests Using IoT and Remote Sensing, where IoT sensors, satellite technology, and remote sensing are fully integrated to provide real-time data on forest conditions, enabling more dynamic and responsive forest management, with precision monitoring of forest ecosystems leading to adaptive management that can respond instantly to changing environmental conditions.

### 3.3 Key stakeholders (government agencies, NGOs, tech companies, etc.)

Tables 1, 2, 3, 4, 5, 6, 7 identify key stakeholders, such as government agencies, NGOs, tech companies operating in the Baltic Sea Region, as potential contributors to the incubation programme, with a key role in the implementation of sustainable forestry practices, the development of technology-driven solutions, and the conservation of forest ecosystems in the Baltic Sea region.

Name	Description
<b>NGOs</b>	
Lithuanian Fund for Nature (Lietuvos Gamtos Fondas)	Focuses on forest conservation, biodiversity, and sustainable resource management.
Baltic Environmental Forum Lithuania	Engages in environmental advocacy, including sustainable forestry practices.
<b>Research Institutions</b>	
Lithuanian Research Centre for Agriculture and Forestry (LAMMC)	Conducts research on sustainable forest management and technology use.
Vytautas Magnus University (VMU)	Researches forestry, ecology, and environmental science.
<b>Tech Companies</b>	
Akvasmart	Provides IoT and remote sensing solutions for environmental monitoring.
Vilniaus Baldai	Involved in sustainable use of forest resources in manufacturing.
UAB Miškų Želdinimo Paslaugos	Provides forest planting and maintenance services.
UAB Ecoman	Specializes in environmental monitoring and forest management solutions.
UAB Lesprema	Offers forestry and wood processing solutions.
UAB Envirotech	Focuses on environmental technologies including forestry applications.
UAB ROVI	Provides forest management software and solutions.
UAB Šiaulių Miškų Įmonė	Engages in sustainable forest management and reforestation.

Table 1: Key Stakeholders in Lithuania

## 4 Ecosystem readiness and existing infrastructure in Lithuania

Lithuania has a well-established ecosystem and infrastructure that supports sustainable forest management, backed up by a strong institutional framework, technological advancements, and a focus on balancing economic, environmental and social sustainability. Lithuania is pushing toward the development of a biobased economy, using forest resources to produce renewable materials and bioenergy.

Lithuanian governmental institutions, led by the Ministry of Environment, have put in place structures to monitor forest health, prevent illegal logging, and enforce regulations. Lithuania has implemented robust policies and strategies to promote sustainable forest management. All are closely aligned with the European Union’s Green Deal and biodiversity strategies, en-



Name	Description
<b>NGOs</b>	
Swedish Society for Nature Conservation (Naturskyddsföreningen)	Advocates for forest conservation and sustainable practices.
WWF Sweden	Focuses on biodiversity protection and forest landscape restoration.
<b>Research Institutions</b>	
Swedish University of Agricultural Sciences (SLU)	Researches forestry, climate change, and sustainable management.
IVL Swedish Environmental Research Institute	Focuses on environmental research, including forestry and climate mitigation.
RISE Research Institutes of Sweden	Conducts applied research in forestry, including technology and innovation.
Skogforsk	Focuses on forestry research and development, including sustainable practices.
Linnaeus University	Conducts research on sustainable forest management and technology use.
<b>Tech Companies</b>	
Sveaskog	Sweden's largest forest owner, involved in sustainable forest management.
SCA (Svenska Cellulosa Aktiebolaget)	Leading in sustainable forestry and innovation in forest resource use.
Holmen	Engaged in sustainable forestry and wood product manufacturing.
BillerudKorsnäs	Focuses on sustainable paper and packaging solutions.
Tetra Pak	Provides solutions for sustainable packaging and resource management.
ÅF Pöyry	Offers consulting services for forest and environmental management.
Metso Outotec	Engages in technologies for the forest industry, including sustainability solutions.
Kinnarps	Specializes in sustainable office furniture and forest product utilization.
Södra	Focuses on forest management and wood product innovation.
Swedwood	Provides solutions for forest product manufacturing and management.

Table 2: Key Stakeholders in Sweden

Name	Description
<b>NGOs</b>	
Finnish Association for Nature Conservation (FANC/SLL)	Focuses on forest protection, climate change mitigation, and biodiversity.
WWF Finland	Engages in sustainable forestry, protection of old-growth forests, and carbon sequestration efforts.
<b>Research Institutions</b>	
Natural Resources Institute Finland (LUKE)	Conducts research on sustainable forest management and biodiversity.
VTT Technical Research Centre of Finland	Engages in technological research including IoT and AI in forestry.
<b>Tech Companies</b>	
Metsä Group	Uses digital tools to manage forests sustainably and improve productivity.
Stora Enso	Applies AI, IoT, and data analytics in forestry operations.
UPM-Kymmene	Specializes in sustainable forestry and wood product manufacturing.
Sampo Forest	Provides forest management and consulting services.
Forest Bioenergy Finland	Focuses on bioenergy solutions and sustainable forest management.
Green Forest Ltd	Offers forest management and conservation services.
Kantele Forest Solutions	Provides forest data management and monitoring solutions.
Forest Industry Research Centre	Specializes in forestry research and technology development.
Metso	Engages in technologies for the forest industry.
Ponsse	Provides forest machinery and technology solutions.

Table 3: Key Stakeholders in Finland

ensuring that national efforts contribute to broader regional goals. Key Government Initiatives are:

- Lithuania's National Forest Strategy, which aims to balance forest conservation with sustainable timber production and biodiversity protection. The government has set clear objectives for sustainable use, reforestation, and climate adaptation.
- Forestry Law (Lietuvos Miškų Įstatymas) regulates forest management, protection, and use, requiring forest owners to adhere to sustainable forestry practices. It also emphasizes reforestation, preservation of biodiversity, and public access to forests.
- State Forest Enterprise (Valstybinė Miškų Urėdija) manages state-owned forests, ensur-



Name	Description
<b>NGOs</b>	
Estonian Fund for Nature (Eestimaa Looduse Fond)	Advocates for forest conservation and sustainable forestry practices.
Pärandkoosluste Kaitse Ühing (Heritage Society)	Focuses on preserving natural habitats including forest ecosystems.
<b>Research Institutions</b>	
Estonian University of Life Sciences	Researches forestry, biodiversity, and ecosystem services.
Tallinn University of Technology (Tal-Tech)	Researches technology and innovation in forestry including IoT and AI.
<b>Tech Companies</b>	
Graanul Invest	Europe's largest pellet producer, focusing on sustainable wood processing.
Timber.ee	Offers digital solutions for timber trading and forest management.
Puidutööstus AS	Specializes in wood processing and sustainable forestry practices.
Fundermax Estonia	Provides sustainable wood-based materials and solutions.
Metsä Group	Involved in forest management and sustainable forestry practices.
Eesti Metsatööstus	Offers forestry and wood processing services.
Ecomatic	Provides environmental monitoring and forest management solutions.
Metsatööstus OÜ	Engages in wood processing and forest management solutions.
Forest Management Ltd	Offers comprehensive forest management and consulting services.

Table 4: Key Stakeholders in Estonia

Name	Description
<b>NGOs</b>	
Latvian Fund for Nature (Latvijas Dabas Fonds)	Works on forest conservation, biodiversity protection, and sustainable development.
Green Liberty (Zaļā Brīvība)	Focuses on environmental protection and sustainable practices including forest conservation.
<b>Research Institutions</b>	
Latvia University of Life Sciences and Technologies	Researches forestry, forest ecosystems, and sustainable resource management.
Latvian State Forest Research Institute (Silava)	Focuses on forest research, conservation, and technology application.
<b>Tech Companies</b>	
Latbio	Provides solutions for forest and biodiversity data management.
Latvijas Finieris	Focuses on sustainable forest practices and innovation in forestry technology.
Forests.lv	Offers forest management and consulting services.
Silva	Specializes in forestry and wood product management.
EkoMežs	Provides environmental and forest management solutions.
Vairas Ltd	Engaged in sustainable forestry and timber production.
Woodwise	Offers solutions for forest health monitoring and management.
Latvia Timber	Provides comprehensive forest management solutions.
Forestry Ltd	Specializes in forest conservation and management.
Biomass Solutions	Focuses on sustainable biomass and forest product management.

Table 5: Key Stakeholders in Latvia

ing compliance with sustainability principles, reforestation initiatives, and environmental conservation.

With strong political support, Lithuania has a growing number of companies and startups that focus on applying advanced technologies in the forestry sector. Innovation Support is a priority coordinated by the Ministry of Economics. The Lithuanian Innovation Agency (IA) run by the state provides support to startups and businesses involved in forest technology, offering project funding, networking opportunities to foster innovation.

Sustainable forest management is supported by strong public awareness and community engagement initiatives. Lithuania's government and NGOs work together to educate the public on the importance of forest conservation, responsible use of resources, and climate action. Notable players are the Lithuanian Fund for Nature (Lietuvos Gamtos Fondas) who focus on raising awareness of forest biodiversity, promoting sustainable forest practices, and involving



Name	Description
<b>NGOs</b>	
Polish Society for Nature Conservation (Polskie Towarzystwo Ochrony Przyrody)	Advocates for forest conservation and biodiversity protection.
WWF Poland	Involved in forest protection, biodiversity, and sustainable forest management.
<b>Research Institutions</b>	
Forest Research Institute (IBL)	Conducts research on sustainable forestry and conservation.
University of Warsaw, Faculty of Biology	Researches forest ecosystems, biodiversity, and conservation efforts.
Institute of Dendrology, Polish Academy of Sciences	Focuses on tree biology and forest ecology.
Warsaw University of Technology	Engages in research on technology applications in forestry.
<b>Tech Companies</b>	
Polish Forest Data Bank	Provides digital solutions for forest management and monitoring.
Dronpol	Uses drones for forest monitoring, including pest detection and health mapping.
ForestGuard	Specializes in forest surveillance and management solutions.
EcoTech Solutions	Provides environmental and forestry technology solutions.
ForestData Ltd	Offers data management and analysis for forestry applications.
Biosfera Ltd	Focuses on sustainable forest management and bioinformatics.
Forestry Innovations	Engages in technology development for forest monitoring and management.
Green Forest Ltd	Provides forest data management and conservation solutions.

Table 6: Key Stakeholders in Poland

Name	Description
<b>NGOs</b>	
Greenpeace Russia	Focuses on protecting old-growth forests and promoting sustainable forestry.
WWF Russia	Active in sustainable forestry, wildlife conservation, and forest restoration.
<b>Research Institutions</b>	
Institute of Geography, Russian Academy of Sciences	Conducts research on forest ecosystems and land-use change.
Saint Petersburg State Forest Technical University	Specializes in forestry research and technology development.
<b>Tech Companies</b>	
Forest Technology Company (LesExpert)	Provides digital tools for forest management, including remote sensing.
GeoScan	Uses drones and geospatial technologies for forest mapping and monitoring.
Timber Invest	Engages in sustainable timber production and forest management.
EcoForest	Focuses on eco-friendly forest management and conservation.
Russian Forest Products	Provides solutions for forest product manufacturing and management.
Forest Control Ltd	Offers forest monitoring and data management services.
Green Tree Ltd	Specializes in reforestation and sustainable forest practices.
RusEco	Provides environmental and forest management solutions.
ForestWatch	Focuses on technology for forest health monitoring.

Table 7: Key Stakeholders in Russia (Kaliningrad region)

local communities in forest conservation activities, Baltic Environmental Forum Lithuania, who engages in public campaigns and environmental education programs, promoting sustainable forestry and climate resilience. The public plays a role in forest management through participatory approaches and consultations. Forest-related policies often involve stakeholders from local communities, ensuring that forest conservation efforts align with societal needs and traditions.

Lithuania has a strong research infrastructure focused on forestry, sustainability, and technological innovation. This ecosystem fosters collaboration between universities, research institutes, and the private sector. There are two key research institutions operating. Vytautas Magnus University (VMU), Faculty of Forest Science and Ecology, works to advance the science of forest ecosystems, biodiversity conservation, and the application of new technologies in forestry. The Lithuanian Research Center for Agriculture and Forestry (LAMMC) also works in sustainable forest management, forest ecology, biodiversity, and adaptation to cli-



mate change. The institute conducts research on reforestation techniques, forest genetics, and the impacts of forestry on carbon sequestration.

Lithuania actively participates in international initiatives and programs that aim to improve forest sustainability and climate resilience. The country is part of various EU and global networks that facilitate knowledge exchange, access to funding and adoption of best practices, namely, the EU's LIFE program, which funds environmental and climate action projects, and Horizon Europe, the EU's research and innovation framework program, with the primary example of our CoE Forest 4.0, which focuses on sustainable forest management and environmental technologies. Lithuania works closely with all neighboring Baltic Sea countries (Sweden, Latvia, Estonia and Finland) on cross-border forestry and biodiversity projects, sharing best practices and encouraging regional solutions to forest conservation and sustainability challenges.

Lithuania has already embraced digital transformation in forest management, with CoE Forest 4.0 established and several other technological solutions already in place to improve forest monitoring, data analysis, and sustainable management practices. Lithuania uses UAV and satellite imagery collection and analysis of forest conditions, supporting decision making to monitor forest cover, detect illegal logging, and assess forest health. Lithuania also continues to grow the use of geographic information systems (GIS) and forest mapping tools helps manage large-scale forest inventories, monitor biodiversity, and predict the impacts of climate change on forest ecosystems. Our CoE Forest 4.0, as led by project partner Kaunas University of Technology, is developing the IoT-enabled Smart forest concept, where sensors are placed to monitor environmental factors such as soil moisture, temperature, and air quality, all to provide information on forest health and potential risks, such as fires or pest infestations. Big Data and Predictive Modeling led by project coordinator Vytautas Magnus University is another concept in place, with AI-powered models being developed to analyze large datasets related to forest health, growth patterns, and climate trends, to predict risks such as fire outbreaks or pest invasions, enabling forest managers to take preemptive measures. CoE researchers are experimenting with blockchain technologies to ensure the traceability of timber products from forest to final use. This technology improves transparency, reduces illegal logging, and ensures compliance with sustainability standards.

## 5 Incubation Design and Framework

### 5.1 Structure of the incubation program

The incubation programme is structured to 6 phases and are summarized in figure 1.

1. *Scoping and Needs Assessment.* The primary objective of this phase is to assess existing challenges in forest management and identify key areas where technology can be effectively applied. Activities will include conducting workshops with forest managers, environmental experts, and technology developers to explore specific pain points and challenges. Technological needs such as advanced forest monitoring, biodiversity conservation, deforestation prevention, and climate adaptation will be mapped out. Key stakeholders, including forestry companies, government agencies, NGOs, and tech firms, will be identified. Technical details will involve creating an inventory of current tech-

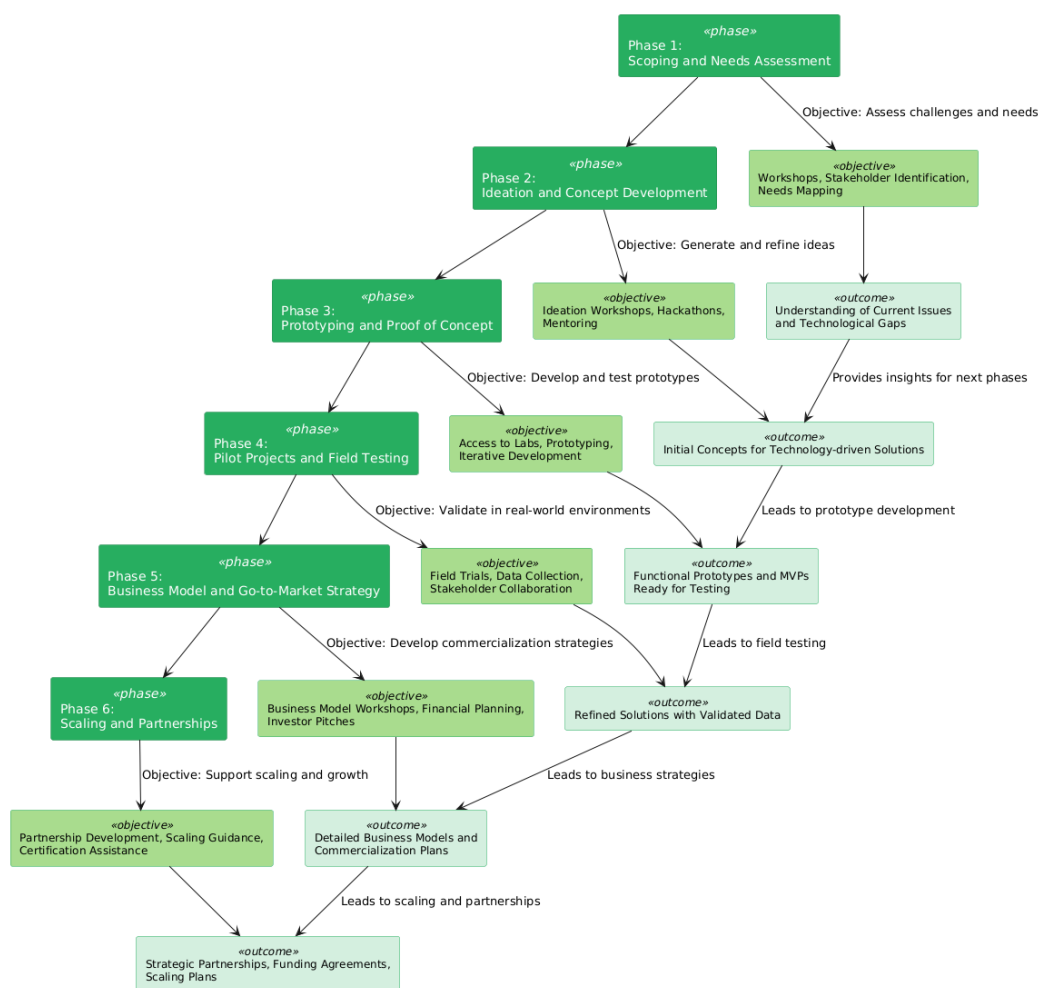


Figure 1: Structure of the incubation programme for CoE Forest 4.0

nologies and evaluating their effectiveness to pinpoint gaps where new solutions can be introduced.

2. *Ideation and Concept Development.* In this phase, the objective is to encourage participants to generate innovative ideas for applying AI, IoT, and other technologies in sustainable forest management. Activities will include ideation workshops, hackathons, and design thinking sessions to stimulate creative solutions. Participants will receive mentoring from forestry experts and tech leaders to refine their ideas. The focus will be on ensuring that solutions address both environmental and economic impacts, such as carbon sequestration, biodiversity enhancement, and smart timber harvesting. Outputs will be initial concepts for potential products, services, or systems aimed at sustainable forestry. Technical details will include the creation of conceptual models and feasibility studies to assess the viability of these concepts.
3. *Prototyping and Proof of Concept (PoC).* The goal here is to develop prototypes and MVPs to validate the most promising ideas. Activities will involve offering access to lab facilities, IoT infrastructure, and pilot forests for initial trials. Resources such as hardware, sensors, and AI platforms will be provided for rapid prototyping. Regular mentorship sessions with forestry specialists, environmental NGOs, and technology experts will



guide the development process. Partnerships with government agencies will ensure regulatory compliance. Outputs will include MVPs of technology-driven solutions for sustainable forest management. Technical aspects will involve iterative development and testing of MVPs to refine their functionality and applicability based on initial feedback and performance data.

4. *Pilot Projects and Field Testing.* The objective of this phase is to test and validate MVPs in real-world forest environments. Activities will include field trials in selected forests or natural reserves to evaluate the effectiveness of the MVPs. Data will be collected on forest health, biodiversity, and carbon capture using sensors, drones, and other IoT devices. Collaboration with local forest owners, NGOs, and government bodies will ensure scalability and adaptability. Feedback from forest managers and other stakeholders will be used to refine the MVPs. Outputs will be validated solutions with data demonstrating their real-world applicability. Technical details will involve detailed analysis of field test data and adjustments based on performance metrics.
5. *Business Model and Go-to-Market Strategy.* This phase focuses on developing viable business models and commercialization strategies. Workshops will cover sustainable business models, industry dynamics, and market opportunities. Mentorship will assist in building financial models, customer acquisition strategies, and identifying funding sources such as venture capital and grants. Participants will be introduced to investors, government funding bodies, and international organizations supporting environmental technologies. Outputs will be detailed business models, commercialization strategies, and funding plans. Technical details will include crafting market entry strategies and financial projections to support the scaling of successful MVPs.
6. *Scaling and Partnerships.* The final phase supports the growth and scaling of successful projects. Activities will include connecting startups with larger forestry companies, governmental organizations, and international NGOs for partnership opportunities. Guidance will be provided on scaling solutions regionally or globally, focusing on expansion across the Baltic Sea region or the EU. Assistance will also be given in obtaining certifications for sustainable practices, such as FSC certification. Outputs will include strategic partnerships, funding agreements, and scaling plans. Technical details will involve developing and implementing scaling strategies, securing necessary certifications, and establishing long-term partnerships for sustained impact.

## 5.2 Criteria for project selection and evaluation

This section presents the detailed criteria as a comprehensive framework for evaluating projects in the incubation program, ensuring that selected projects are not only innovative and technically feasible but also align with environmental, economic, and strategic goals:

- In evaluating *innovative aspects*, the criteria focus on several key aspects. *A an existing prototype will be required to get enrolled in the programme.* **Technological Novelty** assesses whether the technology behind the prototype introduces groundbreaking innovations or significantly improves existing methods. For example, does the project leverage cutting-edge AI algorithms or novel IoT sensors to enhance forest monitoring and management? **Integration of Advanced Technologies** evaluates how well the project



combines multiple advanced technologies, such as AI and IoT, to create a cohesive solution for real-time forest monitoring and decision-making. It is important to assess the interoperability and synergy between these technologies. **Feasibility and Scalability** examines the technical feasibility of deploying the technology at scale. This involves evaluating whether the technology is adaptable to various forest environments and management scenarios, and identifying potential technical challenges and the project's readiness to address them. **Evaluation Metrics** include an **Innovation Score**, which rates the degree of technological advancement and uniqueness on a scale of 1-10. **Technology Integration** is assessed using a scorecard to determine how effectively multiple technologies are combined and their impact on the solution's effectiveness. **Scalability Assessment** involves evaluating potential challenges and solutions for scaling through feasibility studies and pilot results.

- Evaluating the *environmental impact* of forest management technologies involves several criteria. **Sustainability** examines whether the project aligns with sustainable forestry practices and contributes to the long-term health and resilience of forest ecosystems. This includes impacts on biodiversity, soil health, and water resources. **Effectiveness** assesses how well the technology addresses specific environmental issues such as deforestation or carbon sequestration. **Measurement of Impact** evaluates the robustness of methods used to measure and report environmental benefits, including metrics and methodologies for quantifying improvements in forest health and sustainability. **Evaluation Metrics** include a **Sustainability Impact Score**, measuring how well the project promotes sustainable practices using indicators like carbon sequestration rates and biodiversity indices. **Effectiveness Evaluation** involves analyzing performance data from pilot projects or simulations, such as reductions in deforestation rates and improvements in forest health metrics. The **Impact Measurement Framework** reviews the tools used for impact measurement, including remote sensing data and field surveys.
- The *economic viability* of a project is assessed through several criteria. **Market Potential** involves analyzing the demand for the technology in the forestry sector and related industries, including identifying market gaps, market size, growth trends, and customer needs. **Business Model** evaluates the strength of the business model, including revenue streams, cost structure, and value proposition. It examines the sustainability and scalability of the model, considering pricing strategies, customer acquisition channels, and operational costs. **Funding and Financial Projections** review the financial assumptions, including budget, funding requirements, and potential return on investment. It assesses the plan for securing initial and ongoing funding. **Evaluation Metrics** include a **Market Potential Assessment**, analyzing market research data, customer feedback, and competitive analysis. The **Business Model Strength** is evaluated by reviewing revenue projections and profitability analyses. **Financial Projections Review** assesses financial models, funding strategies, and risk management using tools like financial viability scorecards and investor pitch feedback.
- *Technical feasibility and readiness* are essential for successful project implementation. **Development Stage** assesses the current stage of the project, whether it is at the concept, prototype, or pilot stage, and evaluates the maturity of the technology and progress toward commercialization. **Technical Challenges** identifies potential technical issues and assesses the team's ability to address them, including integration difficulties, per-



formance limitations, or data accuracy concerns. **Integration with Existing Systems** evaluates how well the technology integrates with existing forest management systems, including compatibility with current data platforms and operational workflows. **Evaluation Metrics** include a **Development Stage Rating**, which measures the technology's readiness level, such as Technology Readiness Level (TRL). **Technical Challenge Assessment** reviews identified technical risks and mitigation strategies, using tools like risk assessment matrices and challenge resolution plans. **Integration Compatibility** is analyzed through compatibility tests and system compatibility reports.

- The effectiveness of a project is also dependent on the *team* behind it. **Team Composition** evaluates the skills, experience, and expertise of the project team, including relevant backgrounds in forestry, technology, business, and environmental science. **Track Record** considers the team's previous achievements and experience in similar projects or sectors, evaluating their success in developing and commercializing similar technologies. **Advisory and Support Network** assesses the involvement of advisors, partners, or collaborators and their strategic value to the project, including partnerships with experts or organizations providing additional support and validation. **Evaluation Metrics** include **Team Expertise Assessment**, which reviews team members' qualifications and experience. **Track Record Analysis** evaluates previous project outcomes and achievements. **Advisory Network Strength** assesses the relevance and influence of advisors and partners, using tools like advisory board composition and partnership agreements.
- Ensuring *alignment with Forest 4.0 program goals* is mandatory. **Alignment with Objectives** assesses whether the project aligns with the specific goals of the incubation program, such as promoting innovative forest management techniques and addressing environmental challenges. **Impact on Regional Goals** considers how the project contributes to regional or national forest management goals, policies, and sustainability targets, and whether it supports broader environmental and policy objectives. **Evaluation Metrics** include **Objective Alignment Score**, which rates the alignment with program objectives using an alignment scorecard or objective fit analysis. **Regional Impact Assessment** evaluates the project's contribution to regional goals and policies through policy alignment reports and regional impact studies.
- Effective *stakeholder engagement* and collaboration are vital for project success. **Partnerships** evaluate the quality and strategic value of partnerships with key stakeholders such as forestry organizations, government agencies, NGOs, and technology providers. It assesses whether these partnerships are essential for the project's success. **Community Involvement** considers how the project engages with local communities and forest users, including meaningful involvement of community stakeholders in the development and implementation of the solution. **Evaluation Metrics** include **Partnership Value Assessment**, which reviews the strength and relevance of partnerships using partnership agreements and stakeholder engagement plans. **Community Engagement Metrics** measure the level of community involvement and feedback through community consultation reports and stakeholder engagement activities.
- The implementation and *risk management* aspects are critical for project execution. **Implementation Plan** reviews the project's detailed plan, including timelines, milestones, resource allocation, and deliverables, assessing whether it is comprehensive and realis-



tic. **Risk Management** assesses the project's approach to risk identification, assessment, and mitigation, ensuring that strategies are in place to handle potential risks and uncertainties. **Evaluation Metrics** include **Implementation Plan Review**, which analyzes the completeness and feasibility of the implementation plan using Gantt charts and milestone tracking. **Risk Management Evaluation** reviews risk management strategies and contingency plans, including risk registers and mitigation plans.

### 5.2.1 Diversity, Equity, and Inclusion (DEI) Considerations

The "Forest 4.0 Incubation Programme" emphasizes not only the technological and environmental impact of selected projects but also the importance of Diversity, Equity, and Inclusion (DEI) as core principles in fostering innovation, sustainability, and societal progress. In the context of forestry, the programme recognizes that sustainable forest management and environmental solutions cannot succeed without equitable access, diverse perspectives, and inclusive practices that benefit all stakeholders, including forest-dependent communities. We believe that embedding DEI into the evaluation framework will align with key goals of CoE Forest 4.0, to ensure that forest management innovations selected for incubation are inclusive and just. In the following, we outline the DEI framework used in evaluating projects, promoting equal opportunities and representation within the programme:

- *Diversity in Team Composition* is vital for fostering a wide range of perspectives in forest management projects. The programme encourages project teams to include individuals from diverse backgrounds, such as forestry experts, environmental scientists, technologists, and representatives of local communities. The inclusion of people from different genders, ethnicities, and regions ensures that forest management approaches are innovative and holistic. **Evaluation Metrics** include a **Diversity Index**, which measures the team's representation across various dimensions, and a **Forest Sector Inclusivity Score**, which evaluates the team's expertise in forestry and ecosystem management from a diversity perspective.
- *Equity in Project Access and Resources* ensures that forest management innovations are accessible to all, regardless of socioeconomic status, geographic location, or technological resources. Projects that provide equal access to tools, data, and knowledge-sharing opportunities are prioritized, ensuring that marginalized communities have the same opportunities as larger industry players. **Evaluation Metrics** include an **Equity in Access Score**, which measures how well projects facilitate access to forest technologies, and a **Resource Equity Assessment**, evaluating whether resources such as funding and data infrastructure are distributed fairly.
- *Social Impact and Community Benefits* are key indicators of a project's ability to improve the lives of those who depend on forests for their livelihoods. Projects are evaluated based on their potential to create job opportunities, support local economies, and enhance the social well-being of forest-dependent populations. For instance, a project that introduces sustainable logging practices should also consider how it empowers local communities to manage forest resources autonomously. **Evaluation Metrics** include a **Community Benefit Index**, which tracks the social and economic impact of the project on local populations, and a **Forest Livelihoods Impact Score**, which measures the project's long-term contribution to local prosperity.



- *Equitable Environmental Impact* evaluates whether the benefits of forest management technologies are distributed fairly across communities. Projects must demonstrate how they will prevent negative environmental impacts, such as deforestation or land degradation, from disproportionately affecting vulnerable populations. For example, projects should consider how to minimize carbon footprints while ensuring that local communities benefit from carbon sequestration initiatives. **Evaluation Metrics** include an **Environmental Justice Index**, which assesses the project's ability to balance ecological benefits with community needs, and a **Fair Impact Distribution Score**, which measures how equitably the environmental benefits, such as improved biodiversity, are shared.
- *Cultural Sensitivity and Awareness* is critical in forestry projects that operate in diverse cultural contexts. Many forest regions are home to communities with deep cultural and spiritual ties to the land. The programme encourages projects to engage with these cultural aspects respectfully and inclusively, ensuring that forestry innovations do not disrupt traditional practices. **Evaluation Metrics** include a **Cultural Sensitivity Score**, which measures how well projects adapt to local customs, and a **Cultural Impact Assessment**, which evaluates the potential cultural consequences of project activities on forest communities.
- *Promoting Gender Equity in Forestry* is a core objective, as women and non-binary individuals often face barriers in accessing opportunities within forest-related fields. Projects that empower these groups to take leadership roles in forestry, conservation, and environmental governance are highly valued. Additionally, projects that address gender-specific impacts, such as ensuring equitable access to forest resources, are prioritized. **Evaluation Metrics** include a **Gender Equity Score**, which measures gender representation within project teams and leadership, and a **Gender Impact Assessment**, which evaluates how the project contributes to advancing gender equity in forest management.
- *Ongoing DEI Monitoring and Reporting* ensures that projects maintain their commitment to DEI throughout their lifecycle. Regular assessments of team diversity, community engagement, and equitable resource distribution are required, with feedback mechanisms to allow local communities to voice concerns or suggestions. **Evaluation Metrics** include a **DEI Monitoring Score**, which tracks the project's progress in meeting DEI objectives, and a **Stakeholder Feedback Index**, which measures the effectiveness of community engagement and responsiveness to diverse stakeholder input.

## 5.3 Stages of incubation

This section details the incubation process for forest sustainable management techniques through several stages, each designed to address different aspects of project development and ensure successful implementation and scaling as is explained in figure ??.

1. *Ideation*. The primary objective of the ideation phase is to generate and refine innovative ideas for applying advanced technologies, such as AI and IoT, to sustainable forest management. This phase involves several key activities. First, challenge identification is conducted through workshops and interviews with stakeholders to pinpoint major forest management issues that can be addressed with technology, including deforestation, bio-

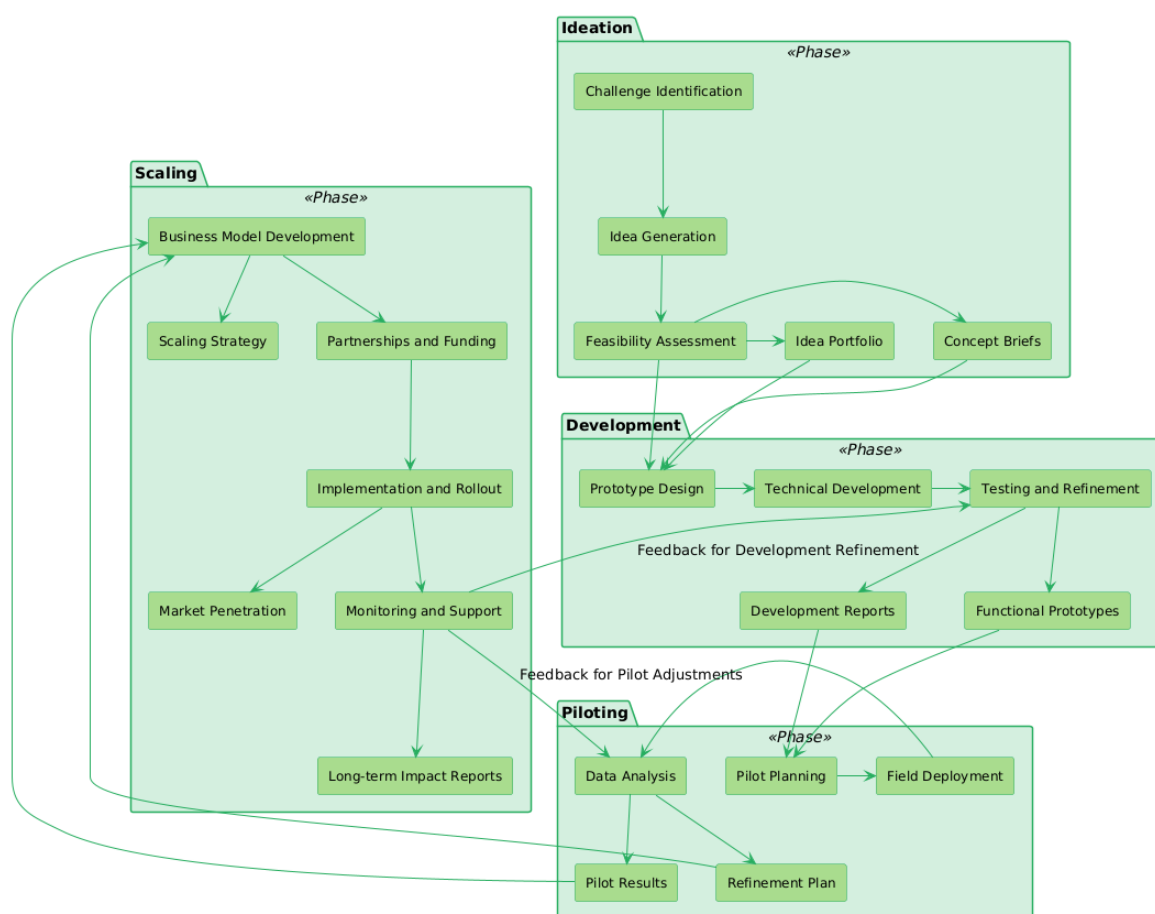


Figure 2: Incubation process explained

diversity loss, and climate change. Following this, idea generation is facilitated through brainstorming sessions, hackathons, and design thinking workshops, using methods like scenario planning and trend analysis to stimulate creative solutions. Finally, a feasibility assessment is performed to evaluate the practicality of proposed ideas, including their technical feasibility, potential impact, and alignment with sustainability goals. The outputs of this phase include an idea portfolio—a collection of potential projects and technologies that address the identified challenges—and concept briefs, which provide detailed descriptions of promising ideas, including their proposed solutions, target problems, and expected impacts.

2. *Development.* The development phase aims to create functional models and proof-of-concept solutions from the chosen ideas. Key activities include prototype design, where initial models or prototypes of the proposed solutions are developed, involving the creation of physical or digital mockups, software prototypes, or early-stage technology implementations. This is followed by technical development, which involves coding, hardware integration, and system design to build functional prototypes that can be tested in controlled environments. Testing and refinement are then conducted iteratively, gathering feedback from users and stakeholders to identify improvements and address technical challenges. The outputs from this phase are functional prototypes that demonstrate the core functionality and potential of the ideas, along with development



reports that document the process, including technical specifications, testing results, and feedback received.

3. *Piloting*. The piloting phase focuses on testing prototypes in real-world environments to validate their effectiveness and gather performance data. It begins with pilot planning, where pilot projects are designed to test prototypes in actual forest settings, defining objectives, scope, and performance metrics. This is followed by field deployment, where the pilot projects are implemented in selected forest areas to monitor and collect data on the technology's performance, usability, and impact. Data analysis is then performed to assess the effectiveness of the solution, evaluating key performance indicators such as accuracy, reliability, and user satisfaction. The outputs of this phase include pilot results, which provide a detailed analysis of performance, effectiveness, and user feedback, and a refinement plan with recommendations for improving the technology based on the findings, including adjustments to design, functionality, or deployment strategies.
4. *Scaling*. The scaling phase aims to expand successful solutions to broader applications and markets, ensuring widespread adoption and long-term sustainability. This phase involves several critical activities. Business model development includes refining and validating the model for scaling, developing a clear value proposition, revenue model, and market strategy. Partnerships and funding are then secured with key stakeholders such as forestry organizations, government agencies, and technology providers, with efforts to identify and obtain funding to support scaling. The implementation and roll-out involve developing a detailed scaling plan, including timelines, resource allocation, and market entry strategies, and applying the solution across larger regions or multiple sites. Finally, monitoring and support systems are established to ensure successful adoption, providing training, technical support, and user assistance as needed. Outputs from this phase include a comprehensive scaling strategy, evidence of market penetration into new regions or markets, and long-term impact reports documenting the technology's impact at scale, including environmental benefits, economic outcomes, and user feedback.

## 5.4 Timeline for development and deployment

We plan that each incubated company should start with existing prototype, showcasing their idea, allowing a rapid 12-month incubation cycle through a stage gate based a structured approach, validated in KTU's project development modules by prof. E. Kazanavicius, emphasizing speed in validation, development, and deployment while ensuring all key aspects of a startup's growth are addressed (see Figure 3). Each stage gate ensures that resources are efficiently used, the product remains on track, and the startup is primed for success as it progresses through incubation:

1. *Ideation and Validation (Months 1-2)*. In the first stage, startups focus on generating, refining, and validating their ideas. This involves market research, developing a business model, and working on improving an initial prototype, with which they are enrolled into the incubation. Stage Gate 1 occurs at the end of this period, where progress is reviewed based on customer feedback, market validation, and the viability of the technology. If key criteria are met, the startup moves to the next phase. Key Milestones for Stage Gate 1 are:

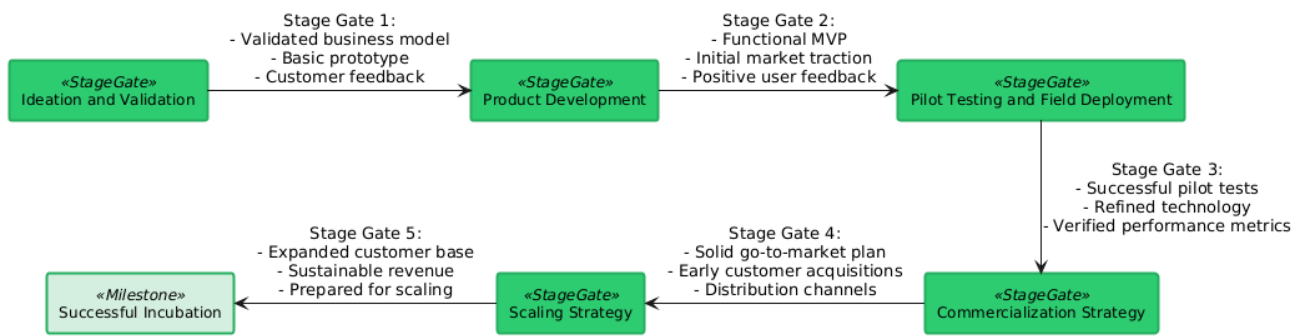


Figure 3: Timeline for development and deployment

- Validated business model
  - Basic prototype or MVP
  - Customer feedback indicating demand
2. *Product Development (Months 3-4)*. After passing the first stage gate, the startup focuses on refining its MVP into a more robust version of the product. This includes developing core features and ensuring the technology works as intended in its target environment. Technical testing and adjustments should happen here. Stage Gate 2 reviews the readiness of the MVP, product-market fit, and technical feasibility before moving to pilot testing. Key Milestones for Stage Gate 2 are:
    - Functional MVP with key features
    - Initial market traction
    - Positive user engagement and feedback
  3. *Pilot Testing and Field Deployment (Months 5-8)*. This is a critical phase where the product is tested in a real-world environment. Startups should deploy their solutions to collect performance data, address bugs, and improve product functionality based on actual use. Stage Gate 3 occurs after pilot testing to evaluate product performance, customer satisfaction, and market readiness before launching a full-scale commercialization. Key Milestones for Stage Gate 3 are:
    - Successful pilot tests
    - Refined technology based on real-world feedback
    - Verified performance and reliability metrics
  4. *Commercialization strategy (Months 9-10)*. Once the product has proven its value in field tests, the focus must shift to commercialization. This step includes preparing for market entry, finalizing planning of distribution channels, and a go-to-market strategy. Stage Gate 4 assesses the startup's readiness for a larger-scale rollout, including funding, marketing, and partnerships. Key Milestones for Stage Gate 4 are:
    - Solid go-to-market plan



- Early customer acquisitions or partnerships
  - Distribution and sales channels set up
5. *Scaling strategy (Months 11-12)*. In the final phase, the startup develops a plan how to scales its product to reach a broader audience. This involves ramping up production, expanding into new markets, and refining operations for efficiency. The final Stage Gate 5 reviews long-term viability, customer satisfaction, and business growth, ensuring the startup is positioned for sustained success. Key Milestones for Stage Gate 5 are:
- Expanded customer base
  - Sustainable revenue generation
  - Preparedness for long-term scaling

## 5.5 Monitoring, Evaluation, and Feedback

### 5.5.1 Key performance indicators (KPIs) for success measurement

During the Product Development phase, the goal is to have a Minimum Viable Product (MVP) ready within 2-4 months, completing approximately 80% of core features by the mid-point of the incubation. For Customer Engagement, the target is to acquire 5-10 pilot customers, maintain a customer retention rate above 70%, and achieve a strong Net Promoter Score (NPS) between 30-50.

In terms of Financial Metrics, a good target is to keep the burn rate under EUR10,000 per month, aim for a 10% revenue growth post-commercialization, and ensure a runway of at least 12 months. For Market Penetration, the objective is to secure 2-3 distribution channels and capture an initial market share of 1%-3%.

On the Operational Efficiency side, development costs should remain within 10% of the budget, with team growth of 10%-20% to support scaling. Lastly, during Pilot Testing, aim for a user feedback score of at least 4.0 out of 5.0, with minimal critical issues, and a solution adoption rate of 50%-60% among pilot users.

Table 8 outlines Key Performance Indicators (KPIs) for startups involved in a 12-month incubation program. These KPIs help measure success in areas such as product development, customer engagement, financial performance, and operational efficiency. The table includes metrics and suggested goals for each KPI.

### 5.5.2 Feedback mechanisms for continuous improvement

Effective feedback mechanisms must be embedded at various stages of development, deployment, and commercialization to maintain continuous improvement in a startup in the incubation program, providing actionable insights, helping to refine processes, and supporting iterative improvements of both products and strategies.

#### *Customer Feedback Loop*

Regular interaction with customers and end-users is traditional part in refining the product. After launching a Minimum Viable Product (MVP), feedback from early adopters is be



Task / Month	1	2	3	4	5	6	7	8	9	10	11	12
<b>1. Ideation and Validation</b>	■	■										
- <i>Activities:</i>												
• Generating, refining, and validating ideas	■	■										
• Market research	■	■										
• Developing a business model	■	■										
• Improving initial prototype	■	■										
<b>Stage Gate 1 (End of Month 2)</b>		◆										
- <i>Key Milestones:</i>												
• Validated business model		▲										
• Basic prototype or MVP		▲										
• Customer feedback indicating demand		▲										
<b>2. Product Development</b>			■	■								
- <i>Activities:</i>												
• Refining MVP into a robust product			■	■								
• Developing core features			■	■								
• Technical testing and adjustments			■	■								
<b>Stage Gate 2 (End of Month 4)</b>				◆								
- <i>Key Milestones:</i>												
• Functional MVP with key features				▲								
• Initial market traction				▲								
• Positive user engagement and feedback				▲								
<b>3. Pilot Testing and Field Deployment</b>					■	■	■	■				
- <i>Activities:</i>												
• Testing in real-world environment					■	■	■	■				
• Collecting performance data and addressing bugs					■	■	■	■				
• Improving product functionality					■	■	■	■				
<b>Stage Gate 3 (End of Month 8)</b>								◆				
- <i>Key Milestones:</i>												
• Successful pilot tests								▲				
• Refined technology based on feedback								▲				
• Verified performance and reliability metrics								▲				
<b>4. Commercialization Strategy</b>									■	■		
- <i>Activities:</i>												
• Preparing for market entry									■	■		
• Finalizing distribution channels									■	■		
• Developing go-to-market strategy									■	■		
<b>Stage Gate 4 (End of Month 10)</b>										◆		
- <i>Key Milestones:</i>												
• Solid go-to-market plan										▲		
• Early customer acquisitions or partnerships										▲		
• Distribution and sales channels set up										▲		
<b>5. Scaling Strategy</b>											■	■
- <i>Activities:</i>												
• Ramping up production											■	■
• Expanding into new markets											■	■
• Refining operations for efficiency											■	■
<b>Stage Gate 5 (End of Month 12)</b>												◆
- <i>Key Milestones:</i>												
• Expanded customer base												▲
• Sustainable revenue generation												▲
• Preparedness for long-term scaling												▲

gathered through surveys, interviews, and usage analytics. This data informs which features are working well, which need adjustments, and if there are gaps in the solution's functionality. User satisfaction metrics such as Net Promoter Score (NPS) or Customer Satisfaction (CSAT) scores help gauge overall experience. For more actionable input, focus groups or beta testing programs should also be established to collect detailed insights about user behavior and preferences. The primary methodologies recommended for the incubated startups are defined below:

- Startups will be recommended to deploy structured *surveys* to collect quantitative data



KPI Category	Metric	Suggested Goal
1. Product Development	Time to MVP Completion	2-4 months
	Percentage of Product Features Implemented	80% of core features
	Product Iteration Rate	1-2 iterations per month
2. Customer Engagement	Customer Acquisition Cost (CAC)	Under \$500 per customer
	Number of Pilot Customers	5-10 customers
	User Retention Rate (Post-pilot phase)	70%-80% retention
3. Financial Metrics	Net Promoter Score (NPS)	30-50 (high satisfaction)
	Burn Rate (Monthly cash usage)	Less than EUR 10,000 / month
	Revenue Growth Rate (Post-commercialization)	10% monthly increase
	Gross Profit Margin	40%-60%
4. Market Penetration	Runway (Months of funding left)	At least 12 months
	Number of Distribution Channels Secured	2-3 channels
	Market Share (Initial phase, niche markets)	1%-3%
5. Operational Efficiency	Development Cost vs Budget	Within 10% of budget
	Team Size Growth (based on operational needs)	10%-20% increase in team size
	Time to Market (Launch readiness)	8-10 months
6. Pilot Testing Results	User Feedback Score	4.0/5.0 or higher
	Number of Bugs/Technical Issues	Less than 5 critical issues
	Solution Adoption Rate (among pilot users)	50%-60%

Table 8: KPIs for Small-Scale Startup Success Measurement

on user satisfaction and feature effectiveness. Aim for a response rate of at least 20% of pilot users should be set to ensure representative feedback. Target a Net Promoter Score (NPS) of 30-50 and Customer Satisfaction (CSAT) scores above 70% is another target to assess the overall user experience.

- Startups should conduct one-on-one *interviews* with a subset of users to gain qualitative insights into their experiences, challenges, and suggestions. Recommended target is in-depth interviews with at least 10-15 users to gather comprehensive feedback.
- Startup teams should organize *focus groups* with diverse user profiles to discuss their experiences and gather feedback on specific aspects of the product. Startups should target at least 3-4 focus groups, each consisting of 5-8 participants, to ensure a range of perspectives.

#### Internal Feedback through Team Retrospectives

Within the startup team, regular retrospectives should be conducted after significant milestones, such as product sprints, pilot testing phases, or business development efforts, allowing team members to reflect on what went well, what didn't, and what could be improved. With methodologies such as Scrum's Sprint Retrospective, team members can openly discuss roadblocks and brainstorm ways to streamline processes or enhance efficiency, which helps to improve workflows, fosters collaboration, and addresses any operational inefficiencies before they become larger issues.

Recommended methodologies are:

- *Reflect* with team members to discuss what went well, what challenges were faced, and areas for improvement. Aim to cover 80-90% of the identified issues during the retrospective.
- *Roadblock Identification*. Identify and document specific *roadblocks* or issues that slowed down the progress, targeting resolution for at least 70% of these issues within the next sprint or phase.



- Collaboratively propose and document *brainstorming* solutions. Set a target for implementing at least 75% of actionable solutions within the next cycle.
- Collect *structured feedback* from all team members using feedback forms or discussion guides. Aim for a participation rate of 90% or higher to ensure comprehensive input.
- Develop and assign *actionable items* based on feedback. Set a target to complete 85% of these items within the next review cycle.
- Implement *process adjustments* and monitor their impact. Aim to reduce identified inefficiencies by at least 30% within the next quarter.
- Regularly *follow up on action plans* and assess their effectiveness. Schedule follow-up reviews within 2-4 weeks to ensure timely implementation.

*Mentorship and Expert Guidance.* Feedback from CoE Forest 4.0 mentors and AgroFood and other industry experts is invaluable for course correction and strategic alignment. Regular mentorship sessions should be scheduled to review key business areas such as market positioning, financial management, and technological development. Experts can provide insights on trends, emerging technologies, and industry standards that can be integrated into the startup's strategy. Advisors will help startups avoid common pitfalls by offering feedback on past decisions, which startups can use to adjust their approach. Startups should implement a structured approach to mentorship and expert engagement:

- Schedule *regular mentorship* sessions, ideally bi-weekly or monthly, to review key business areas to ensure ongoing support and timely advice. Review critical aspects such as market positioning, financial management, and technological development. Aim to cover all these areas in each session to ensure comprehensive guidance.
- Experts can provide insights on current *industry trends and emerging technologies* relevant to the startup's field. Set a target to integrate at least one new trend or technology into the strategic plan every quarter.
- Advisors can offer guidance on industry standards and best practices. Aim to align startup processes and products with these standards, targeting compliance with at least 80% of applicable standards.
- Mentors can offer *feedback on past decisions* to identify successes and areas for improvement. Conduct a review of key decisions with mentors at least once per quarter to refine strategies and approaches.
  - Startups should use mentor feedback to adjust strategies and avoid common pitfalls and set a goal to address and correct at least 70% of identified issues from past decisions within the next cycle. They should also develop actionable plans based on mentor and expert feedback and aim to implement at least 75% of actionable recommendations within the next review period.

*Market Performance Metrics* Once the product is set to market, the startup should also rely on market feedback, derived from metrics such as sales performance, market penetration, and competitor analysis. Such an understanding how the product is performing in the market relative to customer expectations helps identify opportunities for scaling or modifying the



offering. Reviewing analytics such as user acquisition rates, churn rates, and customer lifetime value (CLV) provides quantitative feedback, provide insights into how the product is performing relative to customer expectations and market conditions. Startups should regularly:

- Monitor *sales revenue* to assess product demand and financial health. Set a target for monthly or quarterly revenue growth, such as a 5% increase in revenue per quarter.
- Track *conversion rates* from leads to customers. Aim to achieve a conversion rate of 5-10% from marketing leads.
- Measure the startup's *market share* to evaluate its position relative to competitors. Set a target to capture an initial market share of 0.3-1% within the first 12 months.
- Track the number and effectiveness of *distribution channels*. Aim to secure 2-3 distribution channels and monitor their contribution to sales.
- Regularly *compare product features, pricing, and performance against key competitors*. Aim to identify and address at least 2-3 competitive gaps or advantages per quarter. Assess how the product is positioned relative to competitors. Target improvements in positioning based on competitor benchmarks.
- Track the rate of *new user acquisition*. Set a target for acquiring 5-10 new users per month or a similar metric based on the startup's goals.
- Monitor the *churn rate* at which customers discontinue use of the product. Aim to maintain a churn rate below 10% annually.
- *Calculate Customer Lifetime Value (CLV)* to understand the long-term value of customers. Set a target for increasing CLV by 15-20% through improved retention strategies.
- Collect and analyze *user satisfaction metrics* such as Net Promoter Score (NPS) and Customer Satisfaction (CSAT) scores. Target an NPS of 30-50 and CSAT scores above 70%. Monitor which features are most used and valued by customers. Aim to enhance or expand features that receive high usage and positive feedback.

### 5.5.3 Long-term monitoring strategies and sustainability

Monitoring and adjusting these KPIs over 6 months, 1 year, and 2 years allows the startup to stay flexible and responsive to changes while ensuring growth and sustainability. Each milestone should be tied to specific goals that are realistic for a small-scale startup with limited resources. To ensure a sustainable approach to the long-term success of small-scale startups, particularly those emerging from incubation in the forest technology sector, the following integrated values and goals should be realistically achievable over defined timeframes. Each value addresses key aspects of startup survival, health, and growth:

1. Financial Sustainability and Revenue Growth strategy has a goal to maintain financial stability while building towards profitability.
  - 6 months. Achieve first revenue through pilot projects or early-stage customers. Cash flow should be managed tightly, keeping burn rate below 30% of initial capital, allowing room for reinvestment.

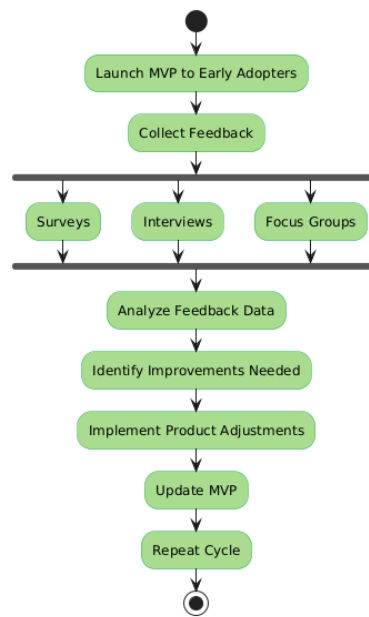


Figure 4: Customer Feedback Loop

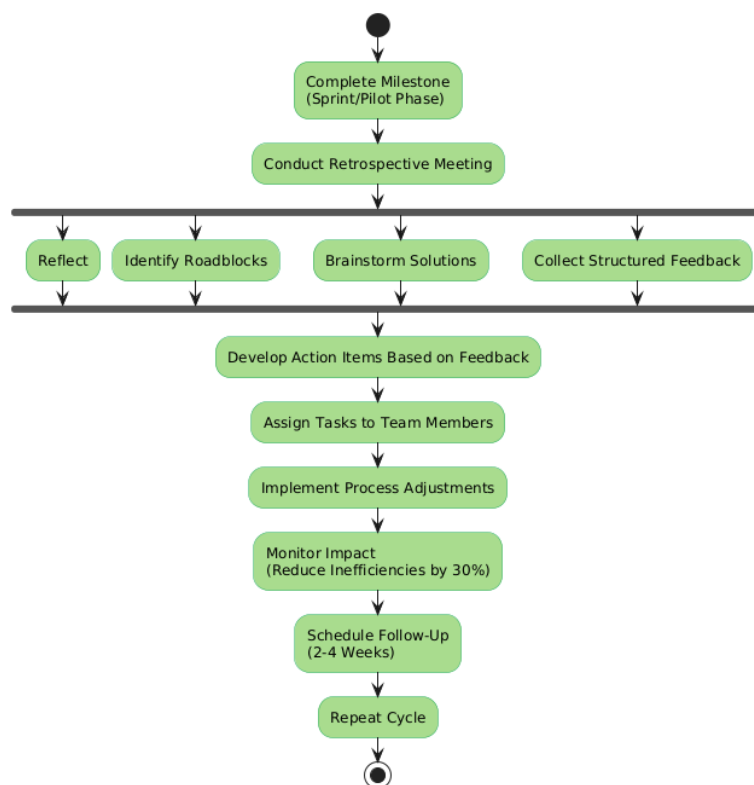


Figure 5: Internal Feedback through Team Retrospectives

- 1 year. Break-even point with a positive net margin of at least 5-10%. Secure steady cash flow from clients or partnerships, covering operational costs and basic salaries.
- 2 years. Reach profitability with a 15-20% profit margin. Consider expansion, rein-

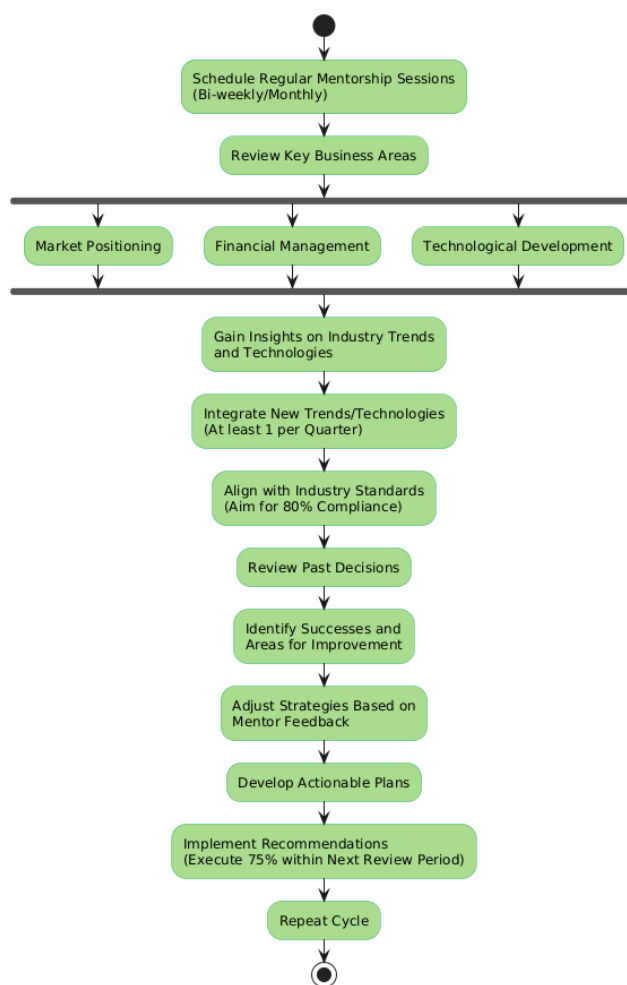


Figure 6: Mentorship and Expert Guidance

vesting into technology improvements or exploring new market segments without compromising financial sustainability.

2. Customer Acquisition and Retention strategy has a goal of building a solid customer base through targeted marketing and personalized solutions.

- 6 months. Secure at least one to two pilot projects with clear milestones. The goal should be to validate the product with real customer feedback and use these insights for further development.
- 1 year. Have 3-5 long-term clients onboard, contributing to at least 40-50% of the revenue. Customer retention should be a priority, aiming for a retention rate of over 70
- 2 years. Scale up to 10+ clients, with at least 25% of them being recurring customers. Strive for a retention rate above 80%, focusing on delivering excellent customer support and personalized services.

3. Show measurable positive impact on forest ecosystems and operational efficiency.

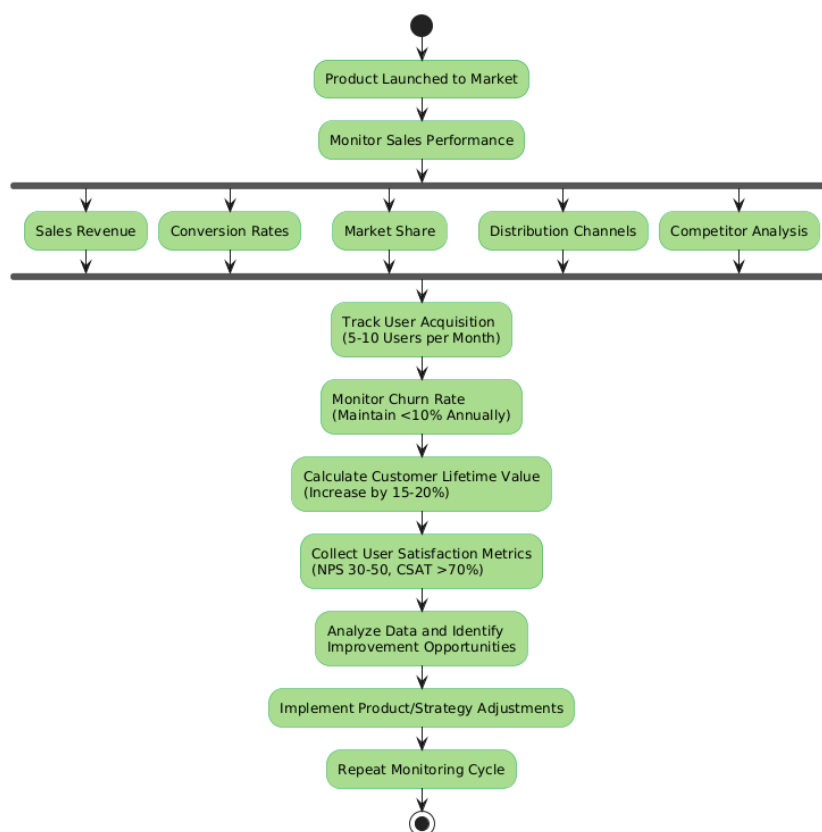


Figure 7: Market Performance Metrics

- 6 months. Begin collecting initial data from pilot projects. Establish baseline metrics for environmental KPIs like forest health monitoring, soil regeneration, or carbon sequestration.
- 1 year. Achieve measurable environmental improvements in pilot areas, such as a 10-15% increase in forest health or 5-10% more efficient resource use through AI and IoT integration.
- 2 years. Demonstrate long-term benefits, such as a 20-25% reduction in deforestation risks or a 15% improvement in carbon capture for partners using your technology. Publish case studies to attract new customers and investors.

#### 4. Develop efficient operations that can support scaling efforts.

- 6 months. Streamline internal processes, ensuring that product development, customer management, and field operations are cost-efficient. Use automated tools to reduce operational overheads by 10-15%.
- 1 year. Introduce scalable technologies and standardized processes, ensuring that operational efficiency can grow in tandem with market expansion. Operations should handle a 50% increase in clients without requiring significant additional resources.
- 2 years. Achieve a 30-40% improvement in operational efficiency through advanced



automation and optimized workflows. Expansion should allow for increased revenue without proportional increases in costs.

5. Continuously refine and improve technology through research and development.
  - 6 months. Complete the first iteration of your core product or service, with a clear understanding of the required improvements. Allocate at least 10% of funds to R&D.
  - 1 year. Begin version 2.0 of the product, incorporating customer feedback and new technology innovations. Demonstrate at least one breakthrough improvement, such as increased AI precision in monitoring or more efficient data processing.
  - 2 years. Have a well-established R&D cycle that enables regular product updates. Allocate at least 15-20% of revenue towards ongoing development, ensuring your technology remains competitive and forward-looking.
6. Build a small but highly capable and motivated team with a clear growth path.
  - 6 months. Hire key personnel necessary for operational needs, keeping the team small (5-10 people) but specialized. Focus on fostering a collaborative and flexible work environment.
  - 1 year. Increase team size by 20-30%, adding talent in critical areas like sales, customer service, and technical support. Establish strong communication and leadership structures.
  - 2 years. Double the team size (if needed for scaling) but maintain the agile, startup-friendly culture. Offer employee development opportunities to ensure long-term team loyalty and performance.
7. Establish strong industry partnerships to support growth and credibility.
  - 6 months. Secure at least one strategic partnership with a key player in the forestry sector. Use this relationship to gain credibility and access to a larger network.
  - 1 year. Build 3-4 additional partnerships, including government agencies, NGOs, or environmental organizations. Leverage these relationships for field trials, market entry, or product validation.
  - 2 years. Expand your partnership network globally or across the Baltic region, aiming for at least 25-30% of your clients or revenue to be derived from strategic collaborations.
8. Define potential paths for long-term growth, acquisition, or exit strategy.
  - 6 months. Begin early discussions about potential exit options, whether through acquisition, scaling through investors, or partnerships.
  - 1 year. Have a clear roadmap for 3-5 years of growth, including potential avenues for merger or acquisition by a larger forestry tech company or venture capital backing.



- 2 years. Be in a position to either pursue rapid scaling through external funding or entertain acquisition offers. Aim to have a company valuation 2-3 times initial investments.

## 5.6 Mentorship

Vytautas Magnus University (VMU), Kaunas University of Technology (KTU) and Linnaeus University (LU) are key institutions from the Forest 4.0 consortium, offering a range of academic expertise in their respective fields and resources that can significantly benefit incubated startups in forest-related fields. Agrofood, another partner of the consortium, is a commercialization specialist and will provide support in that area.

*Vytautas Magnus University's* Faculty of Natural Sciences offer experience in advancing knowledge related to sustainable forest management, ecology, and environmental science. Faculty members are actively engaged in research that explores biodiversity conservation, ecosystem services, and sustainable forestry practices. Their work contributes to a deeper understanding of how forest ecosystems function and how they can be managed in a way that balances ecological health with human needs. By leveraging this research expertise, VMU can offer valuable guidance for the development of technology solutions aimed at forest management. The faculty's insights into ecological processes, species diversity, and forest dynamics are essential for ensuring that technological innovations align with sustainability principles. VMU's Faculty of Informatics has experience in artificial intelligence (AI). Faculty members focus on the development and application of the advanced technologies across various domains.

VMU's experienced professors and researchers are well-positioned to provide mentorship to startups and innovators working on forest technologies. They bring a wealth of knowledge in research methodologies, environmental impact assessments, and the application of scientific principles to real-world challenges. Their mentorship can help ensure that technology solutions are not only innovative but also backed by rigorous scientific research. This support can extend to assisting in the development of environmentally sound approaches, ensuring that any technological intervention in forest ecosystems is both sustainable and scalable.

Involving VMU students in research and development projects is a strategic goal of the university. On the one hand, students gain hands-on experience by working on projects that align with their academic pursuits. On the other hand, startups and innovators benefit from the fresh perspectives and research capabilities that students bring. VMU's strong emphasis on collaboration extends to both academic and industry partnerships, creating opportunities for joint research projects that advance forest management technologies. The coordinator of Forest 4.0, professor president T. Krilavičius is also a dean in the faculty of Informatics and is the head of the largest IT company association - Infobalt, overlapping a variety of focus areas, from studying the environmental impact of new technologies to developing novel IT methodologies. VMU's institutional knowledge in securing research grants and funding opportunities is another significant resource for incubating forest technologies. The university can assist in identifying and applying for financial support from both national sources and European Union programs, such as Horizon Europe and LIFE, which focus on environmental sustainability and innovation.



*Kaunas University of Technology (KTU)* and its StartupSpace incubator can significantly contribute to the incubation of forest technologies through several key areas. First, KTU's research capabilities offer strong support for the development of innovative IoT and AI applications. The university's research facilities and academic expertise are leading in Lithuania and can provide essential technical backing during the incubation process. KTU's academic staff, skilled in artificial intelligence, the Internet of Things, and environmental science, can be attracted to guide applications. Access to advanced research laboratories, such as MLAB, center of Artificial Intelligence, Cyber Security Center, Environmental Institute, allows for the development and testing of prototypes, while collaborative research projects with startups can explore new technologies and sustainable methodologies for managing forests. The faculty of Economics provides insights into market trends, customer needs, and competitive analysis, which enables startups to better position their technologies in the market. KTU coordinates field trials and pilot testing in partnership with industry players, validating the effectiveness of the technologies in real-world environments.

The StartupSpace incubator established by KTU is one of the strongest in Kaunas region and can also offer mentorship through their tailored incubation and acceleration programs, where experienced mentors from StartupSpace provide strategic advice, technical assistance, and business guidance. Workshops and training sessions can be organized on topics ranging from technology commercialization to business model development and market entry strategies. In addition, startups gain access to resources such as office space, legal and financial advice, and networking opportunities, required for their growth. KTU collaborates with the MIT, so the best startups have the chance to go the USA for further training. StartupSpace assists startups in accessing funding by connecting them with potential investors and helping them secure venture capital, grants, and public funding programs. KTU's international connections being a member of ECIU network, allow startups to collaborate with universities and research institutions worldwide, broadening the scope and impact of the forest technologies they are developing.

*Linnaeus University's* contributions to forest technology incubation are deepened by leveraging its strong academic and research expertise, particularly in wood technology, sustainable materials, bioenergy, and the application of AI and IoT in forestry. The university's Faculty of Technology conducts cutting-edge research on bio-based innovations, focusing on sustainable development. Their work on bioenergy and circular economy principles aligns directly with sustainable forest management.

Linnaeus University's Faculty of Health and Life Sciences plays a key role in advancing knowledge in biodiversity, ecosystem conservation, and environmental sustainability, which is essential for forest management innovations. The faculty's focus on forestry ecosystems and biodiversity protection can guide technological development aimed at addressing the challenges of deforestation, species loss, and ecosystem degradation. This expertise can support startups in developing solutions that align with environmental goals while maintaining forest health.

Linnaeus University offers extensive mentorship opportunities. Faculty members with expertise in environmental science, bioenergy, and wood technology can provide targeted support for startups in areas like sustainable material development, ecosystem management, and



environmental impact assessment. The university encourages student involvement through research projects, thesis work, and internships, particularly in areas related to bio-based materials and wood innovation. This student engagement can generate fresh perspectives and ideas, fostering innovation in forest management technologies. The university's established industry partnerships are an asset in technology development. Through collaborations with forestry companies, bioenergy industries, and government agencies, Linnaeus University provides access to real-world testing environments, enabling startups to validate their technologies in forestry operations and wood production. These partnerships also offer commercial insights and opportunities for pilot testing in live environments. The university participates in various EU research projects, offering access to international research networks and funding opportunities, helping to scale projects and enhance their global impact, particularly within the European context of sustainable development. Linnaeus University's innovation support infrastructure includes its business incubation and accelerator programs, which nurture startups by offering mentorship, funding guidance, and access to research facilities. Startups focusing on forest management technologies can benefit from the university's resources, which include labs dedicated to wood technology, bioenergy development, and environmental science research.

Forest 4.0 partner, a leading *AgroFood* company in Lithuania, will have a role to bridge the gap between research and commercialization, by supporting the commercialization and market entry of innovative forest management technologies to be incubated at the CoE Forest 4.0. Collaboration will enable the incubation program to refine and scale advanced technologies like AI and IoT for real-world applications, particularly in sustainable forestry, by utilizing the *AgroFood* company's established commercialization pathways, market access, and operational expertise. The *AgroFood* company will provide strategic financing guidance on product development, market validation, and scaling strategies. Sharing insights into market dynamics, regulatory requirements, and industry trends, the company would help startups within the incubator navigate the complexities of bringing technological solutions from development to market. They will provide direct mentorship, access to pilot testing environments, and assistance with creating viable business models tailored to the forestry sector. The *AgroFood*'s expertise in financial R&D supply chain management and sustainability is invaluable for the incubator. The company's experience in optimizing resource efficiency and improving sustainability in its operations will be applied to adapt forest management technologies for commercial use. Through this partnership, the company will help to ensure that the technological solutions developed within the incubator not only meet market demand but also align with industry best practices and environmental standards. This will include defining clear go-to-market strategies, conducting thorough market research, and identifying potential customers or collaborators within the broader agricultural and environmental sectors. By leveraging its extensive networks, the *AgroFood* company will open doors to potential investors, stakeholders, and additional partners who could facilitate the widespread adoption of these forest management technologies.

## 5.7 Infrastructure and resource requirements

Incubated startups will be able to utilize the infrastructure offered by the Forest 4.0 Centre of Excellence (CoE), with combined state-of-the-art physical infrastructure of key consortium



partners: VMU (Lithuania), KTU (Lithuania) and Linnaeus (Sweden) laboratories equipped for AI model development (VMU), IoT device testing (KTU), and Forest related data analysis (LU). The main facilities of the CoE are established in the Akademija, Kaunas region, with KTU and Linnaeus supporting within their locations. CoE can provide dedicated collaboration spaces that serve as vibrant cross-functional hubs and initial startup facilities, inspired by the Swedish model developed by Daniel Söderberg (KTH, Sweden) running a wood processing incubator Treearch [40], see Figure 8).

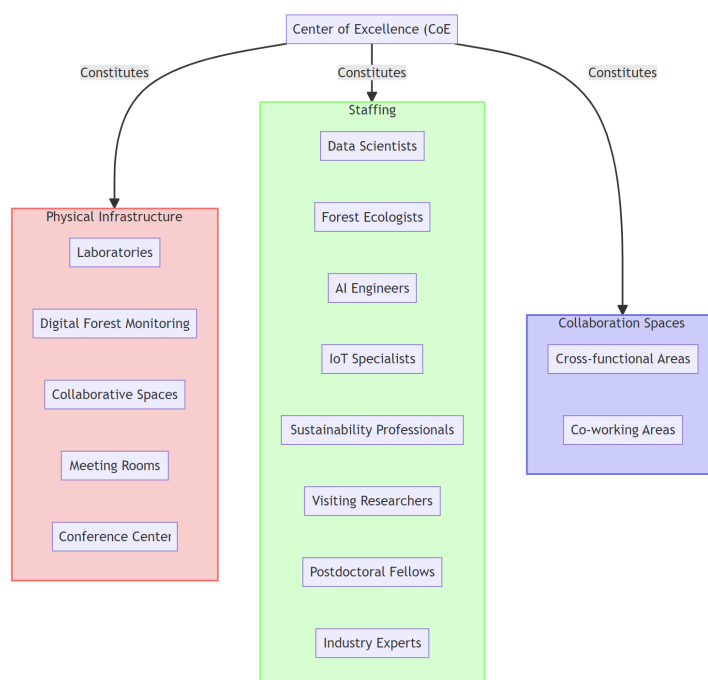


Figure 8: Structure of the CoE within the context of the acceleration programme



## 6 Overview of Potential Funding sources

In the Baltic Sea region, startups have access to a variety of funding sources and support programs designed to foster innovation and business growth, including national initiatives, local government programs, and venture capital firms that provide essential financial backing and business development support. The following tables provide an overview of the most important funding sources and support programs in each BSR country.

Table 9: Funding Sources in Lithuania

Website	Description	Funding Types
Enterprise Lithuania	Government agency supporting entrepreneurship and innovation.	Grants, subsidies, and other financial aids.
Startup Lithuania	National initiative offering resources to entrepreneurs, including funding opportunities.	Grants, seed funding, and other financial resources.
Lithuanian Business Support Agency (LBSA)	Supports SMEs and startups through financial instruments.	Grants, co-financing, and other financial aids.
Invenga	State-owned financial institution providing various financial instruments.	Loans, guarantees, and equity investments.
Practica Capital	Provides venture capital for early-stage startups across various sectors.	Equity investment.
Trigon Capital	Focuses on investments in growth-stage companies.	Equity investment and growth capital.
Change Ventures	Invests in early-stage tech startups in the Baltic region.	Seed funding and early-stage equity investment.

Table 10: Funding Sources in Sweden

Website	Description	Funding Types
Vinnova	Swedish innovation agency supporting research and innovation projects.	Grants for innovation projects, research, and development.
Almi Företagsutveckling	Provides financial support, business advice, and services to startups and SMEs.	Loans, grants, and advisory services.
Swedish Energy Agency	Focuses on funding projects related to energy innovation and sustainability.	Grants for energy efficiency, renewable energy, and tech innovations.
STING (Stockholm Innovation & Growth)	Offers support for early-stage tech startups, including funding and mentoring.	Seed funding, mentoring, and business development resources.
Northzone	Venture capital firm investing in early-stage and growth-stage startups.	Equity investment.
Creandum	Focuses on early-stage investments in technology startups.	Seed and Series A funding.
Industrifonden	Provides venture capital for innovative startups and scale-ups.	Equity investment and growth capital.

Table 11: Funding Sources in Estonia

Website	Description	Funding Types
Enterprise Estonia	Provides support for business development, including financial aid for startups.	Grants, subsidies, and loans.
Startup Estonia	A government initiative to boost Estonia's startup ecosystem with various resources.	Grants, seed funding, and mentoring.
Estonian Credit and Export Guarantee Fund (EKGF)	Offers financial support and guarantees for SMEs and startups.	Guarantees, loans, and export support.
Tuule Capital	Venture capital firm focusing on early-stage investments in innovative startups.	Equity investment.
Funderbeam	Provides funding through a unique platform connecting startups with investors.	Equity crowdfunding and venture capital.



Table 12: Funding Sources in Latvia

Website	Description	Funding Types
Latvian Investment and Development Agency (LIAA)	Supports startups and businesses with various financial and advisory services.	Grants, subsidies, and loans.
Startup Latvia	Initiative to foster the startup ecosystem in Latvia with resources and funding opportunities.	Seed funding, grants, and networking.
Latvian Venture Capital Association (LVCA)	Connects startups with venture capital firms and investment opportunities.	Equity investment and venture capital.
eFunder	Platform offering funding solutions for startups and small businesses.	Equity crowdfunding and loans.

Table 13: Funding Sources in Denmark

Website	Description	Funding Types
Virk	Danish government platform offering information on funding and support for businesses.	Grants, subsidies, and loans.
Innovation Fund Denmark	Provides financial support for innovation projects and startups.	Grants, loans, and co-financing.
Startup Denmark	Supports international startups looking to establish in Denmark with various resources.	Grants, seed funding, and advisory services.
Seed Capital	Venture capital firm investing in early-stage startups with high growth potential.	Equity investment.
Equity	Focuses on venture capital investments in innovative startups.	Equity investment.

Table 14: Funding Sources in Finland

Website	Description	Funding Types
Teknologiategollisuus	Provides support for tech companies and startups in Finland.	Grants, subsidies, and loans.
Sitra	The Finnish Innovation Fund supports sustainability and innovation projects.	Grants, investments, and advisory services.
Business Finland	Offers various funding options for innovation, research, and internationalization.	Grants, loans, and equity funding.
Icecap	Venture capital firm focusing on early-stage investments in tech startups.	Equity investment.
Nordea	Provides financing and investment solutions for startups.	Loans and equity financing.

Table 15: Funding Sources in Germany

Website	Description	Funding Types
Gründerszene	Provides information on startup funding, including grants and investment opportunities.	Grants, venture capital, and seed funding.
EXIST	German government initiative supporting innovative startups with financial aid and resources.	Grants and subsidies.
KfW Bank	Offers various financial products to support startups and small businesses.	Loans, grants, and guarantees.
High-Tech Gründerfonds	Provides seed financing for high-tech startups in Germany.	Seed capital and equity investment.
Eureka	Provides international funding opportunities for innovative startups.	Grants and international co-funding.

## 7 Example Business Models for the Incubation Pipeline



Table 16: Funding Sources in Russia

Website	Description	Funding Types
RosStartup	A national initiative supporting startups across Russia, including St. Petersburg and Kaliningrad.	Grants, subsidies, and seed funding.
St. Petersburg Tech Park	Provides comprehensive support for tech startups in St. Petersburg, including financial aid and mentorship.	Grants, seed funding, and business development resources.
Skolkovo Capital	Offers venture capital for innovative startups throughout Russia, including St. Petersburg and Kaliningrad.	Equity investment and venture capital.
Business Petersburg	Local government initiative offering support and funding to startups in St. Petersburg.	Grants, subsidies, and business development support.
Angels of St. Petersburg	An angel investor network providing early-stage funding to startups in St. Petersburg and Kaliningrad.	Angel investments and seed funding.
InvestKaliningrad	Regional investment promotion agency supporting startups in Kaliningrad with investment and business resources.	Grants, investment support, and business development services.

## 7.1 AI and IoT for Forest Health Monitoring

A startup aims to commercialize an online platform that provides subscription-based access to forest health monitoring services, while customer feedback mechanisms are used to continuously improve the system. The key activities involve the development of an IoT sensor network capable of collecting real-time data, the integration of AI algorithms for predictive modeling, and the continuous monitoring of forest health indicators such as soil moisture, tree growth, and wildlife activity. The system employs predictive analytics to identify early signs of risks, such as pest infestations or fire outbreaks, enabling proactive management.

The business model canvas described in 17 includes providing customer support, user training services, and conducting ongoing research to improve the platform's capabilities. Key providers in this model include IoT sensor manufacturers, AI and data analytics firms, environmental NGOs, government forestry agencies, research institutions, and cloud service providers. The key resources that CoE Forest 4.0 aims to provide include a network of IoT sensors for real-time data collection, AI and machine learning algorithms for data processing and analysis, and a cloud infrastructure to store and manage large datasets.

Table 17: Business Model Canvas of Forest Health Monitoring Product

Key Partners	Key Activities	Value Proposition	Customer Relationships
--------------	----------------	-------------------	------------------------



<ul style="list-style-type: none"> <li>IoT Sensor Manufacturers</li> <li>AI and Data Analytics Firms</li> <li>Environmental NGOs</li> <li>Government Forestry Agencies</li> <li>Research Institutions</li> <li>Cloud Service Providers</li> </ul>	<ul style="list-style-type: none"> <li>Development of IoT Sensor Network</li> <li>Integration of AI for Data Analysis</li> <li>Real-Time Data Collection and Monitoring</li> <li>Predictive Modeling for Forest Health</li> <li>Customer Support and Training Services</li> <li>Continuous Research and Improvement</li> </ul>	<ul style="list-style-type: none"> <li>Real-Time Forest Health Monitoring</li> <li>Predictive Analytics for Early Detection of Risks</li> <li>Energy-Efficient Data Collection and Processing</li> <li>Data-Driven Decision Support for Forest Managers</li> <li>Scalable Solutions for Various Forest Ecosystems</li> </ul>	<ul style="list-style-type: none"> <li>Dedicated Support for Key Clients</li> <li>Online Platform for User Interaction</li> <li>Customer Feedback for Platform Enhancement</li> <li>Educational Workshops and Webinars</li> </ul>
<b>Key Resources</b>	<b>Channels</b>	<b>Customer Segments</b>	<b>Cost Structure</b>
<ul style="list-style-type: none"> <li>IoT Sensor Networks</li> <li>AI and Machine Learning Algorithms</li> <li>Cloud Infrastructure for Data Storage and Processing</li> <li>Technical Team (Data Scientists, AI Experts, IoT Engineers)</li> <li>Data Sources (Remote Sensing, Satellite Imagery)</li> </ul>	<ul style="list-style-type: none"> <li>Direct Sales to Forestry Agencies and NGOs</li> <li>Online Platform for Subscription Services</li> <li>Partnerships with Environmental Organizations</li> <li>Participation in Environmental Conferences</li> </ul>	<ul style="list-style-type: none"> <li>Forest Management Agencies</li> <li>Environmental NGOs and Conservation Groups</li> <li>Research Institutions and Universities</li> <li>Timber and Paper Industries</li> <li>Insurance and Risk Assessment Firms</li> </ul>	<ul style="list-style-type: none"> <li>R&amp;D Costs (AI, IoT Integration)</li> <li>Infrastructure Costs (Cloud Storage, Data Processing)</li> <li>Personnel Costs (Developers, Data Scientists)</li> <li>Marketing and Sales Expenses</li> <li>Customer Support and Training Costs</li> </ul>
<b>Revenue Streams</b>		<b>Unique Selling Points (USPs)</b>	
<ul style="list-style-type: none"> <li>Subscription-Based Access to Monitoring Platform</li> <li>Data Licensing for Research and Industry Use</li> <li>Consulting Services for Forest Management</li> <li>Premium Features (Real-Time Alerts, Advanced Predictive Analytics)</li> <li>Grants and Funding for Conservation Initiatives</li> </ul>		<ul style="list-style-type: none"> <li>Real-Time Monitoring using AI-Driven IoT Networks</li> <li>Predictive Analysis for Early Detection of Forest Health Issues</li> <li>Scalable Solutions for Diverse Forest Environments</li> <li>Energy-Efficient Data Collection with AI-Optimized Sensors</li> <li>Data-Driven Support for Sustainable Forestry Practices</li> </ul>	

The SWOT analysis for AI and IoT for Forest Health Monitoring is offered in Table 18.

**Example Business Case** The startup, incubated within CoE Forest 4.0, specializes in real-time forest health monitoring through a platform that integrates IoT sensors and AI-based data analytics. During the incubation phase, the startup benefits from CoE Forest 4.0's resources: AI expertise, infrastructure, training, and laboratory facilities in exchange for a 20% revenue share. Anticipating 10–15 new customers annually, the company aims to reach 50 customers in year 1, 60 customers in year 2, and 70 customers in year 3. The startup projects



Table 18: SWOT Analysis for AI and IoT for Forest Health Monitoring

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> <li>• Real-time forest health monitoring using IoT sensors.</li> <li>• AI-driven predictive analytics for early detection of risks.</li> <li>• Scalable solutions adaptable to various forest ecosystems.</li> <li>• Energy-efficient data collection and processing using AI-optimized systems.</li> <li>• Data-driven decision-making support for forest managers.</li> </ul>	<ul style="list-style-type: none"> <li>• High R&amp;D and infrastructure costs for IoT and AI integration.</li> <li>• Initial customer base may be limited to forestry and conservation agencies.</li> <li>• Dependence on partnerships for cloud infrastructure and data processing.</li> <li>• Technological challenges in maintaining IoT sensors in remote areas.</li> <li>• High costs of data storage and management for large datasets.</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• Growing demand for forest health monitoring solutions due to climate change.</li> <li>• Expansion into new regions with diverse ecosystems.</li> <li>• Revenue generation from subscription services, data licensing, and consulting.</li> <li>• Partnerships with environmental NGOs and government forestry agencies.</li> <li>• Increased public awareness of sustainable forest management practices.</li> </ul>	<ul style="list-style-type: none"> <li>• Competition from other forest monitoring platforms using similar technologies.</li> <li>• Regulatory challenges that may affect data collection from protected areas.</li> <li>• Cybersecurity risks to sensitive environmental and forest data.</li> <li>• Technological limitations in predictive analytics accuracy for diverse ecosystems.</li> <li>• Dependence on weather conditions affecting IoT sensor accuracy and performance.</li> </ul>

to break even by the end of year 2 and achieve profitability in year 3 by improving service offerings and operational efficiencies (see table 19).

The Profit & Loss dashboard based on the projected business case data for the Forest Health Monitoring start-up is given in Figure 9.

Figure 10 illustrates the profit distribution for the startup's financial projections across the first three years, based on Monte Carlo simulations. Each plot shows a range of possible profit outcomes with an orange dashed line marking the Value at Risk (VaR) at the 90% confidence level, meaning there is a 10% chance that losses will exceed this value. In Year 1, the VaR indicates a potential loss of €75,237, increasing to €83,569 in Year 2, before improving to €54,323 in Year 3. This reflects the startup's increasing likelihood of profitability by Year 3 as operational efficiencies and customer base grow, although there remains a notable risk of financial loss in earlier years.



Table 19: Financial Projections for Forest Health Monitoring Startup (in euros)

Item	Year 1	Year 2	Year 3
<b>Total Customers</b>	50	60	70
<b>Revenue Streams</b>			
Subscription-Based Access (60%)	€150,000	€180,000	€210,000
Data Licensing (15%)	€37,500	€45,000	€52,500
Consulting Services (10%)	€25,000	€30,000	€35,000
Premium Features (5%)	€12,500	€15,000	€17,500
Grants/Funding (10%)	€25,000	€30,000	€35,000
<b>Total Revenue</b>	<b>€250,000</b>	<b>€300,000</b>	<b>€350,000</b>
<b>Cost Structure</b>			
R&D Costs (30%)	€75,000	€90,000	€80,000
Infrastructure Costs (20%)	€50,000	€60,000	€60,000
Personnel Costs (25%)	€62,500	€75,000	€80,000
Marketing and Sales (10%)	€25,000	€30,000	€35,000
Customer Support (5%)	€12,500	€15,000	€15,000
CoE Forest 4.0 Revenue Share (20%)	€50,000	€60,000	€70,000
<b>Total Costs</b>	<b>€275,000</b>	<b>€330,000</b>	<b>€340,000</b>
<b>Net Profit</b>	<b>-€25,000</b>	<b>-€30,000</b>	<b>€10,000</b>

## 7.2 Wildlife conservation and habitat protection

Wildlife conservation and habitat protection actions are required to maintain biodiversity and ecosystem health, particularly as climate change and human activities continue to threaten forest ecosystems. A new start-up company develops a platform, leveraging AI, IoT, and blockchain technologies, for real-time wildlife monitoring and habitat protection to enhance conservation efforts. The platform monitors various IoT devices like camera traps, GPS trackers, and acoustic sensors enabling continuous tracking of animal behaviors, movements, and environmental changes. AI processes the collected data, offering actionable insights on population dynamics, migration patterns, and threats such as poaching. Blockchain ensures data transparency and trust between stakeholders, including conservationists, environmental NGOs, and local communities. This data-driven approach supports early identification of risks, enabling swift and proactive conservation actions, while also fostering local participation in wildlife protection efforts.

The business model (see Table 20) focuses on providing conservation agencies, government wildlife departments, and environmental NGOs with real-time monitoring, data analysis, and decision-making support for wildlife management. The platform's key activities involve the integration of IoT and AI to monitor wildlife movements and behaviors, while blockchain secures data integrity. Revenue is generated through subscription-based access to the platform, data licensing, consulting services, and premium features like advanced predictive analytics. Partnerships with environmental organizations and local communities play a critical role in expanding the reach of the platform and fostering collaboration in wildlife conservation. Through continuous research and innovation, the platform offers a scalable, efficient solution to address a variety of conservation challenges in diverse ecosystems.

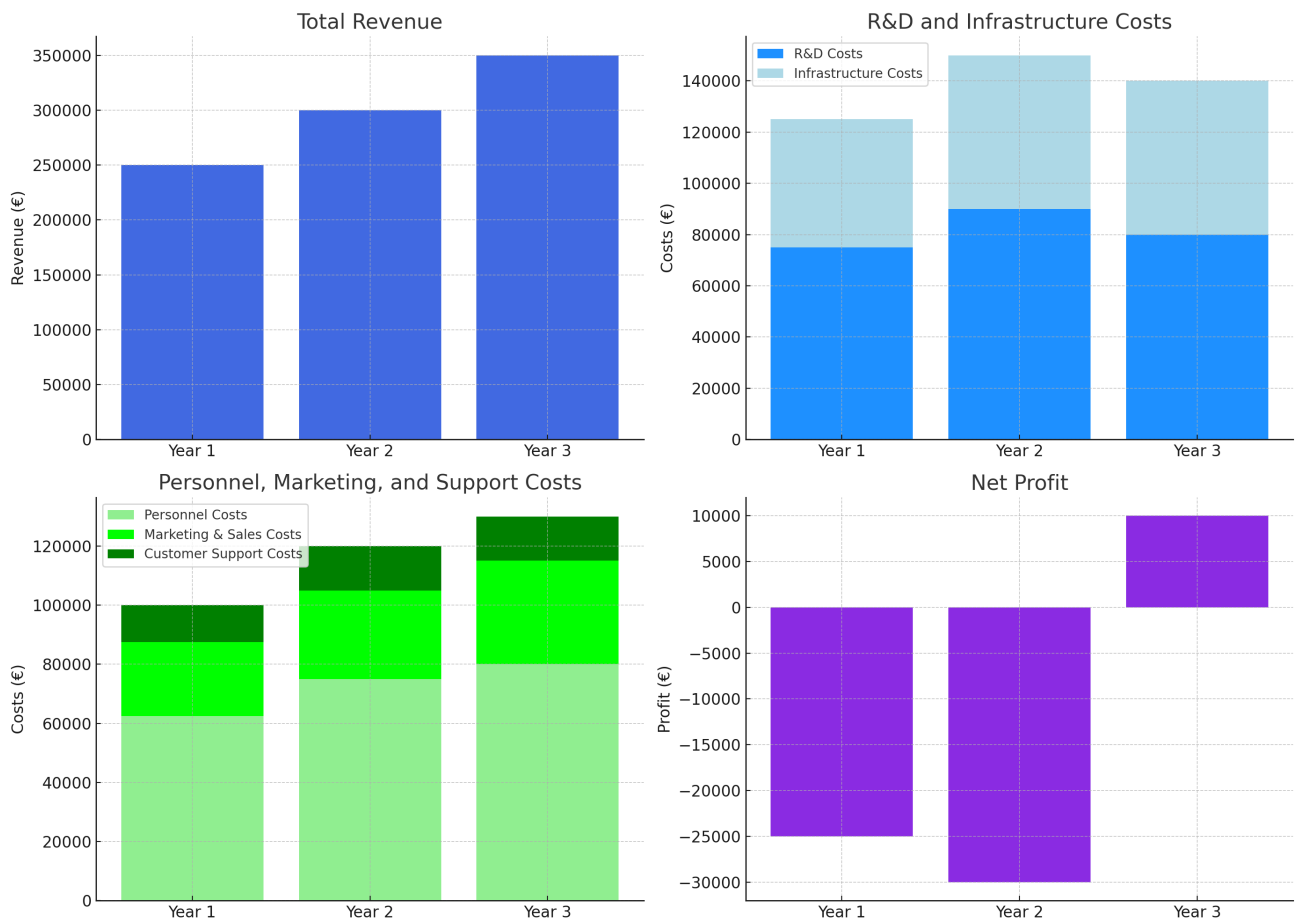


Figure 9: Profit & Loss dashboard based on the projected business case data for the Forest Health Monitoring startup

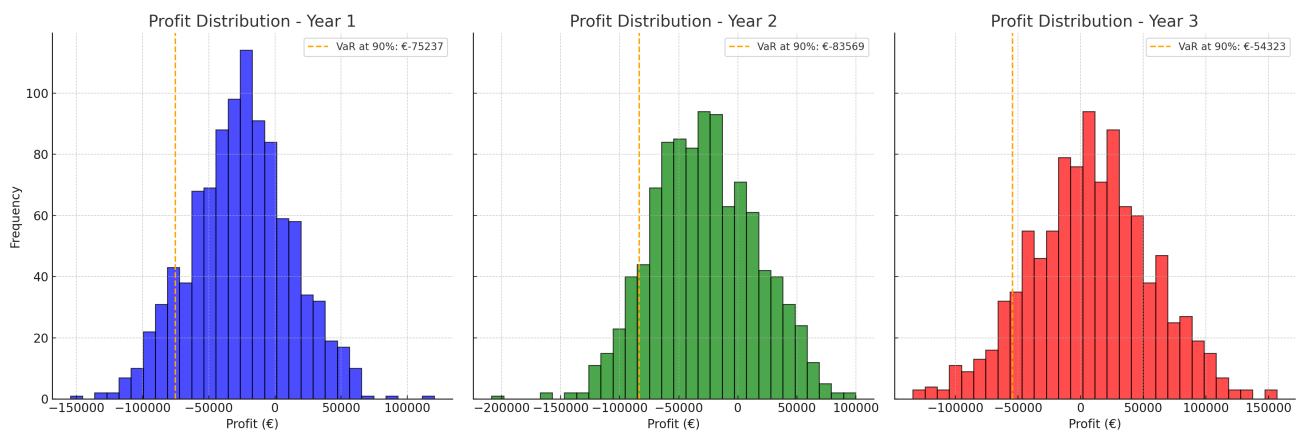


Figure 10: Monte Carlo Simulation Results of Forest Health Monitoring start-up

Table 20: Business Model Canvas of Wildlife conservation and habitat protection Product



Key Partners	Key Activities	Value Proposition	Customer Relationships
<ul style="list-style-type: none"> <li>• Environmental NGOs</li> <li>• Government Wildlife Agencies</li> <li>• IoT Sensor Manufacturers</li> <li>• AI and Data Analytics Firms</li> <li>• Blockchain Technology Providers</li> <li>• Research Institutions</li> <li>• Local Communities</li> </ul>	<ul style="list-style-type: none"> <li>• Development of IoT-Enabled Wildlife Monitoring Systems</li> <li>• Integration of AI for Species Identification and Data Analysis</li> <li>• Real-Time Data Collection and Threat Detection</li> <li>• Blockchain Implementation for Data Integrity and Transparency</li> <li>• Community Engagement and Training Services</li> <li>• Continuous Research for Habitat Protection Strategies</li> </ul>	<ul style="list-style-type: none"> <li>• Real-Time Wildlife Monitoring and Tracking</li> <li>• Data-Driven Decision Support for Conservation Efforts</li> <li>• Enhanced Data Integrity through Blockchain Technology</li> <li>• AI-Based Analysis for Early Risk Detection</li> <li>• Collaborative Platforms for Community Engagement in Conservation</li> </ul>	<ul style="list-style-type: none"> <li>• Dedicated Support for Conservation Groups and Agencies</li> <li>• Online Platform for Data Access and Reports</li> <li>• Community Involvement Programs</li> <li>• User Training and Educational Webinars</li> </ul>
Key Resources	Channels	Customer Segments	Cost Structure
<ul style="list-style-type: none"> <li>• IoT Sensor Networks and Tracking Devices</li> <li>• AI and Machine Learning Algorithms</li> <li>• Blockchain Infrastructure</li> <li>• Data Sources (Camera Traps, Acoustic Sensors, GPS Tracking)</li> <li>• Skilled Technical Team (Data Scientists, Blockchain Developers, IoT Engineers)</li> <li>• Partnerships with Environmental Organizations</li> </ul>	<ul style="list-style-type: none"> <li>• Direct Sales to Wildlife Conservation Agencies and NGOs</li> <li>• Online Platform for Data Access and Subscription Services</li> <li>• Partnerships with Environmental and Governmental Organizations</li> <li>• Environmental Conferences and Workshops</li> </ul>	<ul style="list-style-type: none"> <li>• Wildlife Conservation Agencies</li> <li>• Environmental NGOs</li> <li>• Government Forestry and Wildlife Departments</li> <li>• Research Institutions and Universities</li> <li>• Local Communities Engaged in Conservation</li> </ul>	<ul style="list-style-type: none"> <li>• R&amp;D Costs (AI, IoT Integration, Blockchain Implementation)</li> <li>• Infrastructure Costs (IoT Sensors, Cloud Storage, Blockchain Maintenance)</li> <li>• Personnel Costs (Developers, Data Scientists, Conservation Specialists)</li> <li>• Marketing and Community Engagement Expenses</li> <li>• Customer Support and Training Costs</li> </ul>
Revenue Streams		Unique Selling Points (USPs)	
<ul style="list-style-type: none"> <li>• Subscription-Based Access to Wildlife Monitoring Platform</li> <li>• Data Licensing to Research and Conservation Groups</li> <li>• Consulting Services for Wildlife and Habitat Management</li> <li>• Grants and Funding for Conservation Initiatives</li> <li>• Premium Features (Real-Time Alerts, Advanced Predictive Analytics)</li> </ul>		<ul style="list-style-type: none"> <li>• Real-Time Wildlife Monitoring using AI-Driven IoT Networks</li> <li>• Blockchain-Enabled Data Integrity and Transparency</li> <li>• AI-Based Analysis for Early Detection of Risks to Wildlife</li> <li>• Collaborative Platforms for Community Engagement</li> <li>• Scalable Solutions Tailored to Diverse Ecosystems and Conservation Needs</li> </ul>	



The SWOT analysis for wildlife conservation and habitat protection is shown in Table .

Table 21: SWOT Analysis for Wildlife Conservation and Habitat Protection

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> <li>• Real-time wildlife monitoring and tracking using IoT.</li> <li>• AI-based analysis for early risk detection and insights.</li> <li>• Blockchain ensures data integrity and transparency.</li> <li>• Collaborative platforms for community engagement.</li> <li>• Scalable solution adaptable to diverse ecosystems.</li> </ul>	<ul style="list-style-type: none"> <li>• High R&amp;D and infrastructure costs for AI, IoT, and blockchain integration.</li> <li>• Dependence on partnerships with local communities for data collection.</li> <li>• Complex coordination needed for large-scale wildlife tracking.</li> <li>• Initial customer base may be limited to conservation organizations.</li> <li>• High costs of IoT sensor deployment in remote areas.</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• Growing demand for wildlife conservation and habitat protection solutions.</li> <li>• Partnerships with government wildlife agencies and environmental NGOs.</li> <li>• Revenue generation through subscription services and data licensing.</li> <li>• Expanding to new regions with diverse wildlife ecosystems.</li> <li>• Increased public interest in conservation efforts due to climate change.</li> </ul>	<ul style="list-style-type: none"> <li>• Competition from other conservation and wildlife monitoring platforms.</li> <li>• Regulatory changes affecting data collection and wildlife tracking.</li> <li>• Technological challenges in maintaining accurate wildlife tracking.</li> <li>• Cybersecurity risks to the integrity of wildlife data.</li> <li>• Environmental factors potentially causing IoT sensor failures.</li> </ul>

**Example Business Case** The wildlife conservation and habitat protection startup, in its early stages, anticipates a gradual growth in customers of approximately 10% annually, with the expectation of reaching 50 customers in year 1, 55 in year 2, and 60 in Year 3. Although the startup incurs significant R&D and infrastructure costs due to its technology-driven approach, it is strategically balancing these expenses with community engagement and conservation-focused grants. The company projects to break even by the end of year 2 and achieve a net positive position by year 3. The financial strategy emphasizes sustainable growth, focusing on improving service offerings and operational efficiency to improve its financial stability and support its mission to conserve wildlife (see table 22).

The Profit & Loss dashboard based on the projected business case data for the wildlife conservation and habitat protection startup is given in Figure 11.

Figure 12 presents the Monte Carlo simulation results for the wildlife conservation startup's profit distribution over three years. The orange dashed lines indicate the Value at Risk (VaR) at the 90% confidence level, showing the potential loss threshold with a 10% probability of being exceeded. In Year 1, the VaR is €-94,292, meaning there is a 10% chance of losing more



Table 22: Revised Financial Projections for Wildlife Conservation and Habitat Protection Startup (in euros)

Item	Year 1	Year 2	Year 3
<b>Total Customers</b>	50	55	60
<b>Revenue Streams</b>			
Subscription-Based Access (60%)	€300,000	€330,000	€363,000
Data Licensing (20%)	€100,000	€110,000	€121,000
Consulting Services (10%)	€50,000	€55,000	€60,500
Grants/Funding (5%)	€25,000	€27,500	€30,000
Premium Features (5%)	€25,000	€27,500	€30,000
<b>Total Revenue</b>	<b>€500,000</b>	<b>€550,000</b>	<b>€615,500</b>
<b>Cost Structure</b>			
R&D Costs (AI, IoT, Blockchain) (30%)	€150,000	€165,000	€180,000
Infrastructure Costs (25%)	€125,000	€137,500	€150,000
Personnel Costs (25%)	€125,000	€137,500	€150,000
Marketing and Community Engagement (10%)	€50,000	€55,000	€60,000
Customer Support and Training (10%)	€50,000	€55,000	€60,000
<b>Total Costs</b>	<b>€500,000</b>	<b>€570,000</b>	<b>€600,000</b>
<b>Net Profit</b>	<b>€0</b>	<b>-€20,000</b>	<b>€15,500</b>

than this amount. The risk increases in Year 2 with a VaR of €-118,967, reflecting the startup's continued financial challenges. However, by Year 3, the VaR improves to €-98,350, suggesting the company is progressing toward financial stability as customer growth and operational efficiencies start to pay off.

### 7.3 Forest Wildfire Detection and Prevention

Forest wildfires pose a significant threat to ecosystems and human settlements, necessitating the development of advanced technologies for early detection and prevention. The business case is for an incubated startup focusing on wildfire detection using AI, IoT and computer vision to monitor environmental conditions and identify fire hazards. The key to this solution is the deployment of IoT sensors throughout forest areas, which continuously gather critical data on temperature, humidity, and soil moisture. Integrated with AI algorithms, this system analyzes the data to detect patterns associated with fire risks. Additionally, the platform employs predictive models to assess fire risk and suggest proactive measures, such as controlled burns or clearing vegetation. In emergencies, real-time data can automatically alert authorities and deploy drones for detailed assessments, while blockchain technology ensures the integrity and transparency of the collected data.

The business model canvas (see Table 23) for the wildfire detection and prevention system outlines a comprehensive strategy to provide forest managers, government agencies, NGOs and local communities with actionable information to mitigate wildfire risk. Key partners include IoT sensor manufacturers, AI firms, satellite imagery providers, and environmental NGOs, all contributing essential resources to create a robust platform. The startup's value proposition centers on delivering real-time wildfire detection and early warning systems, supported by predictive analytics for risk assessment and operational decision-making. Customer relationships are enhanced through dedicated support, an online monitoring platform, and community engagement initiatives to promote fire prevention. Revenue is generated pri-

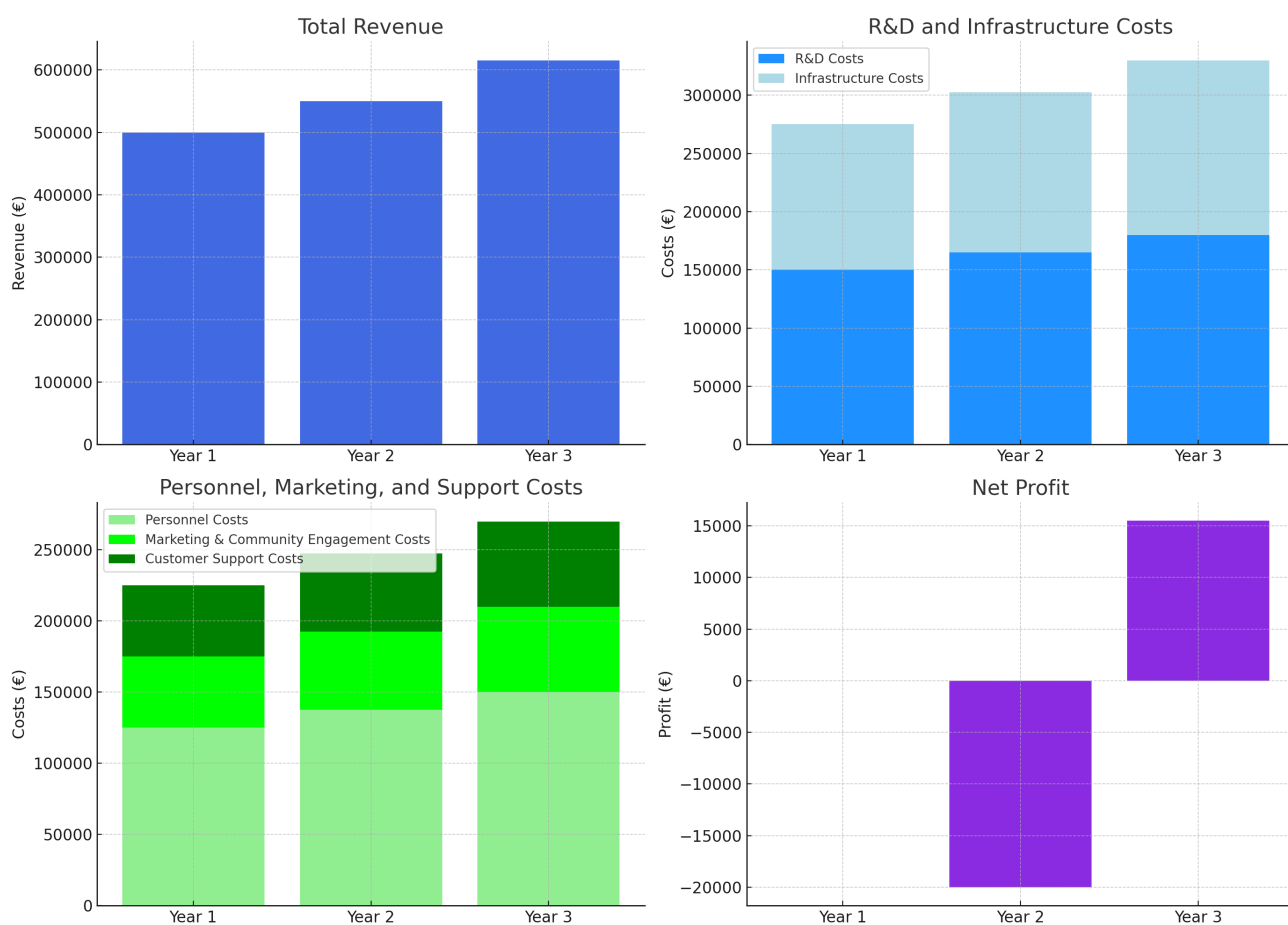


Figure 11: Profit & Loss dashboard based on the projected business case data for the wildlife conservation and habitat protection startup

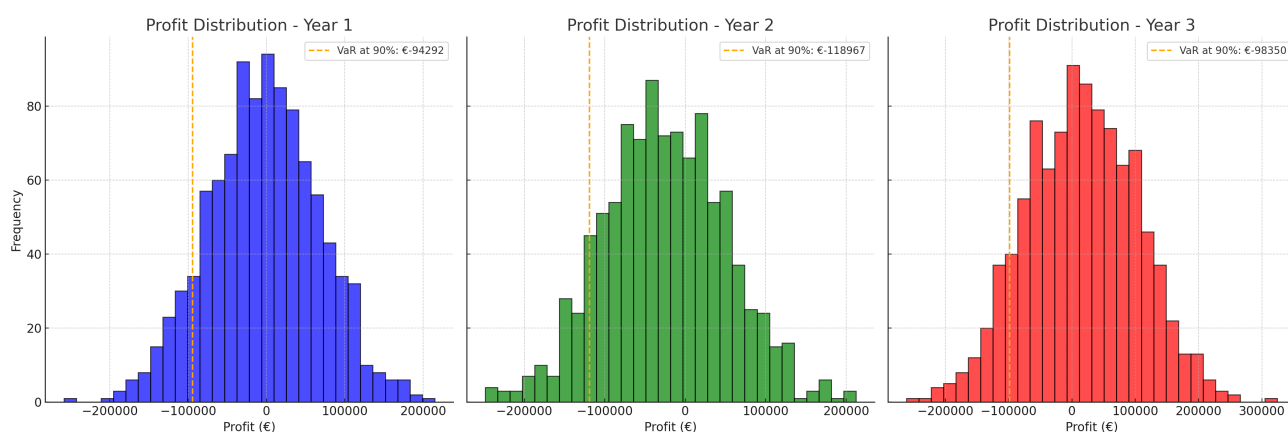


Figure 12: Monte Carlo Simulation Results of Wildlife Conservation start-up

marily through subscription-based access, supplemented by data licensing, consulting services, and grants. The unique selling points of the platform include real-time detection ca-



pabilities, predictive analytics, and a transparent, data-driven approach to wildfire management, ensuring scalability and applicability in various forest ecosystems.

Table 23: Business Model Canvas of Incubated Forest Wildfire Detection and Prevention Product

Key Partners	Key Activities	Value Proposition	Customer Relationships
<ul style="list-style-type: none"> <li>IoT Sensor Manufacturers</li> <li>AI and Data Analytics Firms</li> <li>Satellite Imagery Providers</li> <li>Government Forestry and Fire Departments</li> <li>Environmental NGOs</li> <li>Research Institutions</li> <li>Local Communities and Firefighting Units</li> </ul>	<ul style="list-style-type: none"> <li>Development of IoT-Enabled Wildfire Monitoring Systems</li> <li>Integration of AI for Predictive Analysis and Risk Assessment</li> <li>Real-Time Data Collection and Fire Detection</li> <li>AI-Powered Risk Modeling and Early Warning Systems</li> <li>Blockchain Implementation for Data Integrity and Transparency</li> <li>Community Engagement and Training for Fire Prevention</li> </ul>	<ul style="list-style-type: none"> <li>Real-Time Forest Fire Detection and Early Warning</li> <li>Predictive Analytics for Fire Risk Assessment</li> <li>Data Integrity through Blockchain for Transparent Monitoring</li> <li>Actionable Insights for Preventive Measures</li> <li>Rapid Response Coordination during Fire Incidents</li> </ul>	<ul style="list-style-type: none"> <li>Dedicated Support for Forest Management Agencies</li> <li>Online Platform for Real-Time Monitoring and Alerts</li> <li>Community Awareness Programs and Engagement</li> <li>User Training and Workshops on Fire Prevention</li> </ul>
Key Resources	Channels	Customer Segments	Cost Structure
<ul style="list-style-type: none"> <li>IoT Sensor Networks and Environmental Monitoring Devices</li> <li>AI and Machine Learning Algorithms</li> <li>Satellite Imagery and Remote Sensing Data</li> <li>Blockchain Infrastructure for Data Management</li> <li>Skilled Technical Team (Data Scientists, AI Experts, IoT Engineers)</li> <li>Partnerships with Environmental and Fire Safety Organizations</li> </ul>	<ul style="list-style-type: none"> <li>Direct Sales to Forestry Departments, NGOs, and Firefighting Agencies</li> <li>Online Platform for Subscription-Based Access to Monitoring Services</li> <li>Partnerships with Environmental NGOs and Governmental Agencies</li> <li>Participation in Environmental and Fire Safety Conferences</li> </ul>	<ul style="list-style-type: none"> <li>Forest Management Agencies</li> <li>Government Forestry and Fire Departments</li> <li>Environmental NGOs and Conservation Groups</li> <li>Local Communities in Fire-Prone Areas</li> <li>Insurance and Risk Assessment Firms</li> </ul>	<ul style="list-style-type: none"> <li>R&amp;D Costs (AI, IoT Integration, Blockchain Implementation)</li> <li>Infrastructure Costs (IoT Sensors, Satellite Data, Cloud Storage)</li> <li>Personnel Costs (Developers, Data Scientists, Fire Management Experts)</li> <li>Marketing and Community Engagement Expenses</li> <li>Customer Support and Training Costs</li> </ul>
Revenue Streams		Unique Selling Points (USPs)	



<ul style="list-style-type: none"> <li>• Subscription-Based Access to Wildfire Monitoring Platform</li> <li>• Data Licensing for Research and Insurance Purposes</li> <li>• Consulting Services for Wildfire Risk Assessment and Prevention</li> <li>• Grants and Funding for Environmental and Fire Safety Initiatives</li> <li>• Premium Features (Real-Time Alerts, Advanced Predictive Analytics)</li> </ul>	<ul style="list-style-type: none"> <li>• Real-Time Wildfire Detection using AI-Enabled IoT Networks</li> <li>• Predictive Analysis for Proactive Fire Risk Management</li> <li>• Data Integrity and Transparency through Blockchain</li> <li>• Rapid Response Coordination During Fire Incidents</li> <li>• Scalable Solutions Tailored to Diverse Forest Ecosystems</li> </ul>
--	---

The SWOT analysis for forest fire detection and prevention is available in Table 24.

Table 24: SWOT Analysis for Forest Wildfire Detection and Prevention

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> <li>• Real-time wildfire detection using AI and IoT.</li> <li>• Predictive analytics for proactive fire risk management.</li> <li>• Blockchain ensures transparent and immutable data records.</li> <li>• Scalable solutions adaptable to different forest ecosystems.</li> <li>• Rapid response coordination during fire incidents.</li> </ul>	<ul style="list-style-type: none"> <li>• High R&amp;D and infrastructure costs for IoT and AI integration.</li> <li>• Dependence on external satellite imagery and data sources.</li> <li>• Complex coordination between forest management agencies and local communities.</li> <li>• Initial customer base may be limited to fire-prone regions.</li> <li>• High cost of sensor deployment and maintenance.</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• Growing demand for wildfire prevention solutions due to climate change.</li> <li>• Partnerships with government agencies and environmental NGOs.</li> <li>• Potential to expand into global markets with diverse ecosystems.</li> <li>• Revenue generation from subscription services and data licensing.</li> <li>• Increasing awareness and focus on fire risk mitigation.</li> </ul>	<ul style="list-style-type: none"> <li>• Competition from other wildfire detection technologies.</li> <li>• Technological challenges in ensuring sensor accuracy in extreme conditions.</li> <li>• Regulatory changes that might affect IoT and drone usage in forest areas.</li> <li>• Cybersecurity risks to the integrity of data collected from IoT devices.</li> <li>• Environmental factors causing sensor malfunction, leading to inaccurate data.</li> </ul>

**Example Business Case** The Forest Wildfire Detection and Prevention startup generates revenue focused on subscription-based access to real-time monitoring platforms, consulting services for wildfire risk management, and data licensing for research and insurance purposes. With initial investments directed toward R&D and infrastructure development, the



company expects to achieve a break-even point by the end of Year 2. As customer growth accelerates and scalable premium features are introduced, the startup aims to achieve profitability in year 3, driven by a projected increase in total revenue and controlled cost management.

Table 25: Financial Projections for Forest Wildfire Detection and Prevention Startup (in euros)

Item	Year 1	Year 2	Year 3
<b>Total Customers</b>	40	48	60
<b>Revenue Streams</b>			
Subscription-Based Access (55%)	€110,000	€120,000	€200,000
Data Licensing (20%)	€40,000	€44,000	€75,000
Consulting Services (10%)	€20,000	€22,000	€35,000
Grants/Funding (10%)	€20,000	€22,000	€25,000
Premium Features (5%)	€10,000	€11,000	€15,000
<b>Total Revenue</b>	<b>€300,000</b>	<b>€319,000</b>	<b>€350,000</b>
<b>Cost Structure</b>			
R&D Costs (AI, IoT, Blockchain) (30%)	€90,000	€95,000	€80,000
Infrastructure Costs (30%)	€90,000	€95,000	€80,000
Personnel Costs (20%)	€60,000	€66,000	€70,000
Marketing and Community Engagement (10%)	€30,000	€32,000	€35,000
Customer Support and Training (10%)	€30,000	€32,000	€35,000
<b>Total Costs</b>	<b>€300,000</b>	<b>€320,000</b>	<b>€300,000</b>
<b>Net Profit</b>	<b>€0</b>	<b>€-1,000</b>	<b>€50,000</b>

The Profit & Loss dashboard based on the projected business case data for the Forest Wildfire Detection and Prevention startup is given in Figure 13.

Figure 14 presents the Monte Carlo simulation results for the Forest Wildfire Detection and Prevention startup's financial projections over three years. The orange dashed lines indicate the Value at Risk (VaR) at the 90% confidence level, which represents the maximum potential loss with a 10% probability of being exceeded. In Year 1, the VaR is €-52,239, highlighting a significant risk of loss as the company focuses on R&D and infrastructure investments. This risk increases slightly in Year 2, with a VaR of €-60,013, as the company approaches its break-even point. By Year 3, the VaR improves considerably to €-11,111, signaling the startup's move towards profitability as customer growth and revenue stabilize, reducing financial risk.

## 7.4 Carbon Sequestration Tracking and Reporting

Carbon sequestration plays a pivotal role in mitigating climate change, and forests serve as vital carbon sinks. Accurate tracking of this process is essential for assessing forest contributions to climate goals and supporting carbon credit programs. A new startup is established that uses advanced technologies such as IoT, AI, remote sensing, and blockchain, and the incubated products provide comprehensive real-time monitoring and transparent reporting for effective forest management. IoT sensors deployed in forests collect data on key environmental factors such as soil moisture, tree growth, and canopy density. These data, combined with AI-driven analysis, help estimate carbon absorption rates and predict future sequestration potential, enabling informed decision-making.

The business model (see table 26) based on blockchain technology ensures data integrity and transparency, recording carbon measurements securely for verifiable carbon credits and com-

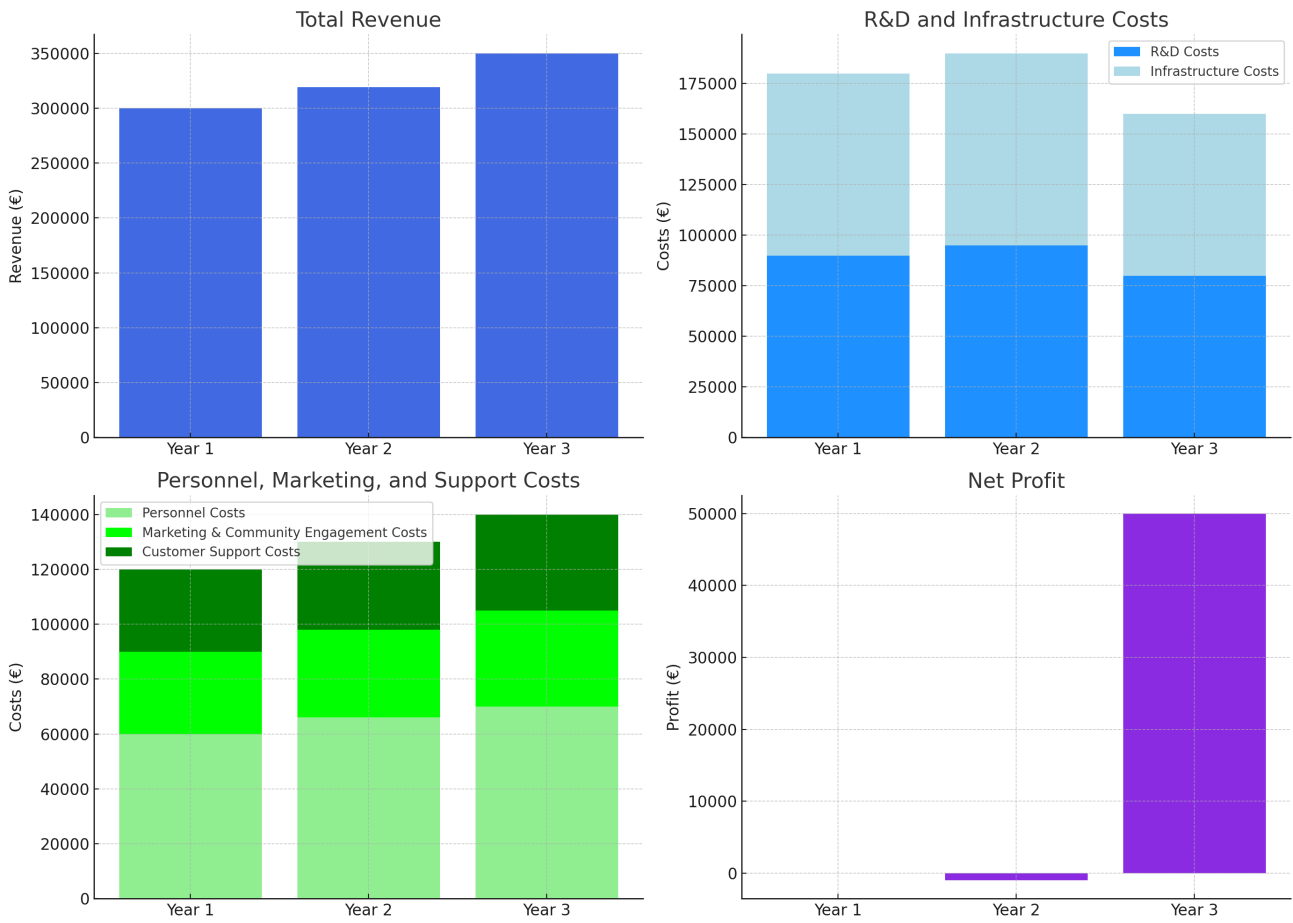


Figure 13: Profit & Loss dashboard based on the projected business case data for the Forest Wildfire Detection and Prevention startup

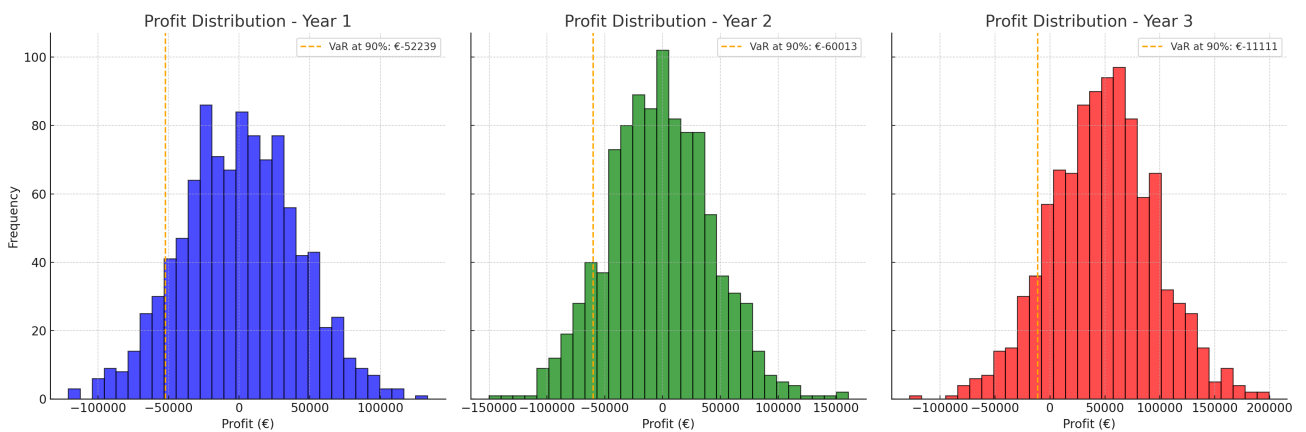


Figure 14: Monte Carlo Simulation Results of Forest Wildfire Detection and Prevention Start-up

pliance with climate regulations. Satellite imagery and AI-powered analysis offer large-scale



insights into forest cover and biomass, improving the accuracy of carbon stock assessments. Engaging local communities through mobile applications enhances data collection and fosters a collaborative approach to forest conservation and by integrating these technologies, these products support forest managers, policymakers, and carbon market participants in optimizing forest practices, promoting sustainable forestry, and achieving climate action goals.

Table 26: Business Model Canvas of Incubated Carbon Sequestration Tracking and Reporting Product

Key Partners	Key Activities	Value Proposition	Customer Relationships
<ul style="list-style-type: none"> <li>IoT Sensor Manufacturers</li> <li>AI and Data Analytics Firms</li> <li>Satellite Imagery Providers</li> <li>Government Climate and Forestry Agencies</li> <li>Environmental NGOs</li> <li>Carbon Credit Market Participants</li> <li>Blockchain Technology Providers</li> <li>Local Communities and Landowners</li> </ul>	<ul style="list-style-type: none"> <li>Development of IoT-Enabled Carbon Monitoring Systems</li> <li>Integration of AI for Carbon Sequestration Modeling</li> <li>Remote Sensing and Satellite Imagery Analysis</li> <li>Blockchain Implementation for Data Integrity and Carbon Credit Verification</li> <li>Real-Time Data Collection and Reporting</li> <li>Community Engagement for Data Contribution and Monitoring</li> </ul>	<ul style="list-style-type: none"> <li>Real-Time Carbon Sequestration Tracking and Analysis</li> <li>Accurate Estimation of Carbon Stock and Future Sequestration Potential</li> <li>Transparent and Immutable Data Records through Blockchain</li> <li>Data-Driven Support for Carbon Credit Programs</li> <li>Community Involvement in Carbon Management and Reporting</li> </ul>	<ul style="list-style-type: none"> <li>Dedicated Support for Forest Managers and Climate Agencies</li> <li>Online Platform for Real-Time Carbon Tracking and Reports</li> <li>Community Engagement Tools for Monitoring and Data Sharing</li> <li>Educational Programs on Carbon Management and Sustainability</li> </ul>
Key Resources	Channels	Customer Segments	Cost Structure
<ul style="list-style-type: none"> <li>IoT Sensor Networks and Environmental Monitoring Devices</li> <li>AI and Machine Learning Algorithms</li> <li>Satellite Imagery and Remote Sensing Data</li> <li>Blockchain Infrastructure for Data Management</li> <li>Skilled Technical Team (Data Scientists, AI Experts, Blockchain Developers)</li> <li>Partnerships with Environmental NGOs, Government Agencies, and Carbon Market Entities</li> </ul>	<ul style="list-style-type: none"> <li>Direct Sales to Forestry Departments, NGOs, and Carbon Market Participants</li> <li>Online Platform for Subscription-Based Access to Carbon Tracking Services</li> <li>Partnerships with Environmental and Climate Organizations</li> <li>Participation in Climate Conferences and Carbon Markets</li> </ul>	<ul style="list-style-type: none"> <li>Forest Management Agencies</li> <li>Government Climate and Forestry Departments</li> <li>Environmental NGOs and Conservation Groups</li> <li>Carbon Credit Market Participants</li> <li>Research Institutions and Universities</li> <li>Local Communities and Landowners</li> </ul>	<ul style="list-style-type: none"> <li>R&amp;D Costs (AI, IoT Integration, Blockchain Implementation)</li> <li>Infrastructure Costs (IoT Sensors, Satellite Data, Cloud Storage)</li> <li>Personnel Costs (Developers, Data Scientists, Climate Specialists)</li> <li>Marketing and Community Engagement Expenses</li> <li>Customer Support and Training Costs</li> </ul>
Revenue Streams		Unique Selling Points (USPs)	



<ul style="list-style-type: none"> <li>• Subscription-Based Access to Carbon Tracking Platform</li> <li>• Data Licensing for Research and Carbon Market Verification</li> <li>• Consulting Services for Carbon Management Strategies</li> <li>• Grants and Funding for Climate and Sustainability Initiatives</li> <li>• Premium Features (Detailed Reporting, Advanced Predictive Modeling)</li> </ul>	<ul style="list-style-type: none"> <li>• Real-Time Carbon Sequestration Tracking using AI and IoT</li> <li>• Accurate Carbon Stock Estimation and Future Sequestration Predictions</li> <li>• Transparent, Immutable Data Records through Blockchain</li> <li>• Support for Carbon Credit Programs and Market Verification</li> <li>• Scalable Solutions for Different Forest Types and Ecosystems</li> </ul>
---	---

SWOT Analysis for Carbon Sequestration Tracking and Reporting is shown in table 27.

Table 27: SWOT Analysis for Carbon Sequestration Tracking and Reporting

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> <li>• Real-time carbon sequestration tracking using IoT sensors.</li> <li>• Blockchain ensures transparent, immutable data for carbon credit verification.</li> <li>• AI-powered predictive modeling for future sequestration potential.</li> <li>• Large-scale insights using satellite imagery and remote sensing.</li> <li>• Collaboration with local communities through mobile apps.</li> </ul>	<ul style="list-style-type: none"> <li>• High infrastructure and R&amp;D costs for IoT and blockchain integration.</li> <li>• Dependence on external partners for satellite imagery and data processing.</li> <li>• Requires substantial technical expertise in AI, blockchain, and environmental science.</li> <li>• Initial deployment may be limited to regions with strong IoT infrastructure.</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• Growing demand for carbon credit programs and compliance with climate regulations.</li> <li>• Partnerships with government agencies, NGOs, and the carbon market for broader adoption.</li> <li>• Potential for expansion into other ecosystem types and geographic regions.</li> <li>• Increased public interest in sustainable forestry and carbon management.</li> <li>• Licensing data to research institutions and industries for carbon credit verification.</li> </ul>	<ul style="list-style-type: none"> <li>• Regulatory changes that could impact carbon credit markets.</li> <li>• Technological challenges in scaling the platform for large ecosystems.</li> <li>• Competition from other carbon tracking solutions using alternative technologies.</li> <li>• Potential cybersecurity threats to sensitive environmental data.</li> </ul>

**Example Business Case** The Carbon Sequestration Tracking and Reporting startup, incubated at CoE Forest 4.0, provides real-time tracking and analysis of carbon sequestration ef-



forts in forest ecosystems (see table 28). Although initial costs are primarily focused on R&D and infrastructure for AI integration and blockchain development, the startup aims to break even by the end of year 2. With an anticipated growth in customer base and scalable service offerings, the startup projects a net profit of €30,000 in year 3, positioning itself to meet the increasing demand for carbon sequestration monitoring and reporting solutions.

Table 28: Financial Projections for Carbon Sequestration Tracking Startup (in euros)

Item	Year 1	Year 2	Year 3
<b>Total Customers</b>	20	32	45
<b>Revenue Streams</b>			
Subscription-Based Access (50%)	€50,000	€80,000	€120,000
Data Licensing (20%)	€20,000	€32,000	€50,000
Consulting Services (15%)	€15,000	€24,000	€36,000
Grants/Funding (10%)	€10,000	€16,000	€24,000
Premium Features (Advanced Modeling) (5%)	€5,000	€8,000	€12,000
<b>Total Revenue</b>	<b>€100,000</b>	<b>€160,000</b>	<b>€242,000</b>
<b>Cost Structure</b>			
R&D Costs (AI, IoT, Blockchain) (40%)	€40,000	€64,000	€80,000
Infrastructure Costs (30%)	€30,000	€48,000	€60,000
Personnel Costs (15%)	€15,000	€24,000	€36,000
Marketing and Community Engagement (10%)	€10,000	€16,000	€24,000
Customer Support and Training (5%)	€5,000	€8,000	€12,000
<b>Total Costs</b>	<b>€100,000</b>	<b>€160,000</b>	<b>€212,000</b>
<b>Net Profit</b>	<b>€0</b>	<b>€0</b>	<b>€30,000</b>

The Profit & Loss dashboard based on the projected business case data for the Carbon Sequestration Tracking startup is given in Figure 15.

Figure 16 depicts the profit distributions for the Carbon Sequestration Tracking startup over three years, based on Monte Carlo simulations. Each plot includes a Value at Risk (VaR) at 90%, represented by an orange dashed line, indicating the potential loss threshold that has a 10% chance of being exceeded. In Year 1, the VaR is €-18,271, reflecting moderate financial risk during the startup's early phase. The risk increases in Year 2, with a VaR of €-30,568, due to ongoing R&D and infrastructure investments. By Year 3, the VaR improves to €-9,293, signaling the startup's growing financial stability as its customer base and revenues expand, positioning the company to reach profitability. The results show a steady reduction in financial risk as the business scales.

## 7.5 Digital Twin for Forest Ecosystems

The startup focuses on a concept of digital twins (DT) for forest ecosystems, enhanced by reinforcement learning (RL), which represents a groundbreaking approach to real-time monitoring, analysis, and resource management. In this adaptive model, IoT sensors continuously collect data on key forest parameters such as soil moisture, tree growth, wildlife activity, and climatic conditions. This data feeds into the digital twin, creating a dynamic virtual forest representation that adjusts in real-time. Using RL, the system adapts to changing conditions, optimizing the balance between model accuracy and energy-efficient operation. Spatio-temporal graph modeling is used to capture complex forest interactions, enabling the system to provide precise insights into ecosystem dynamics and resource use.

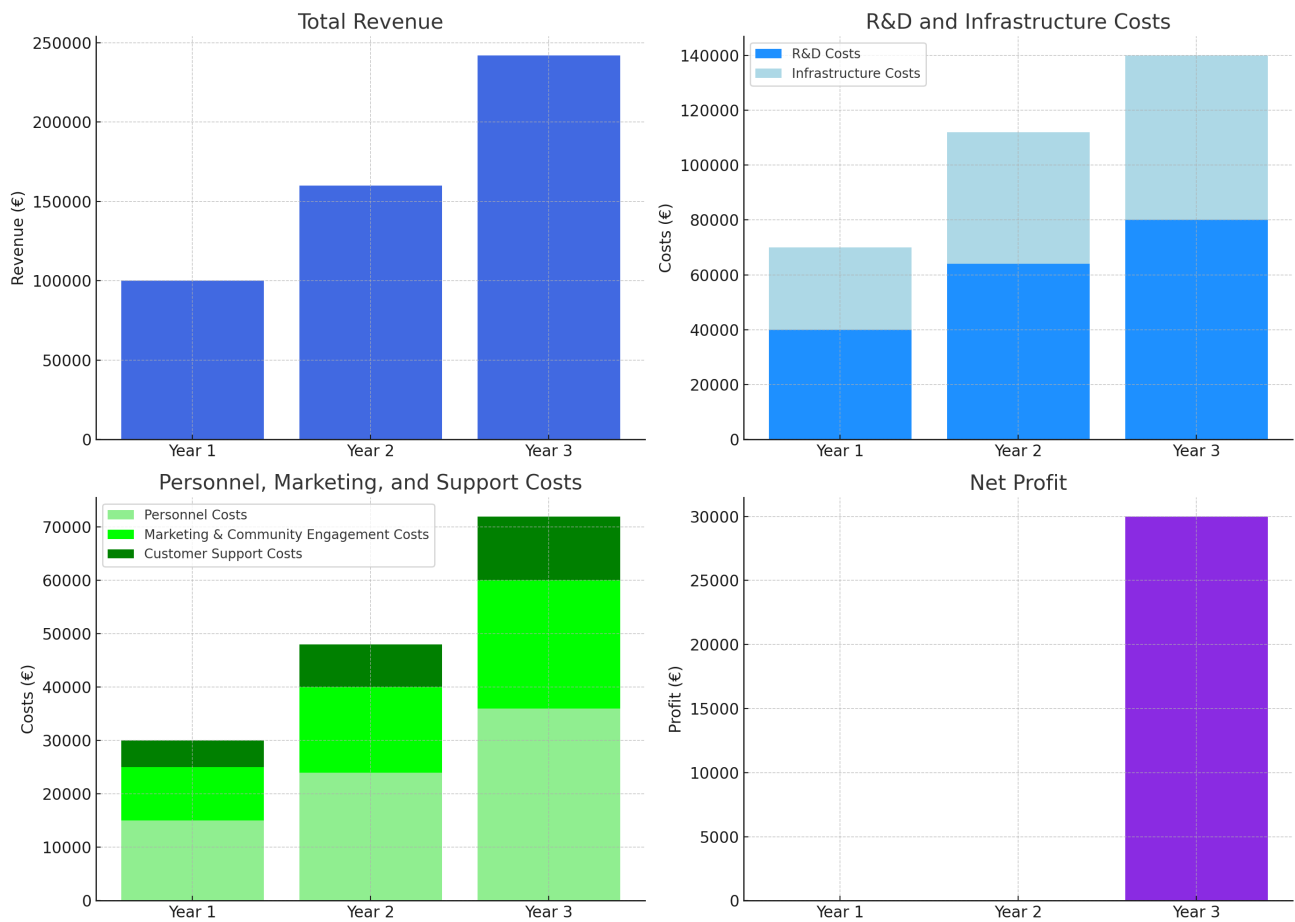


Figure 15: Profit & Loss dashboard based on the projected business case data for the Carbon Sequestration Tracking startup

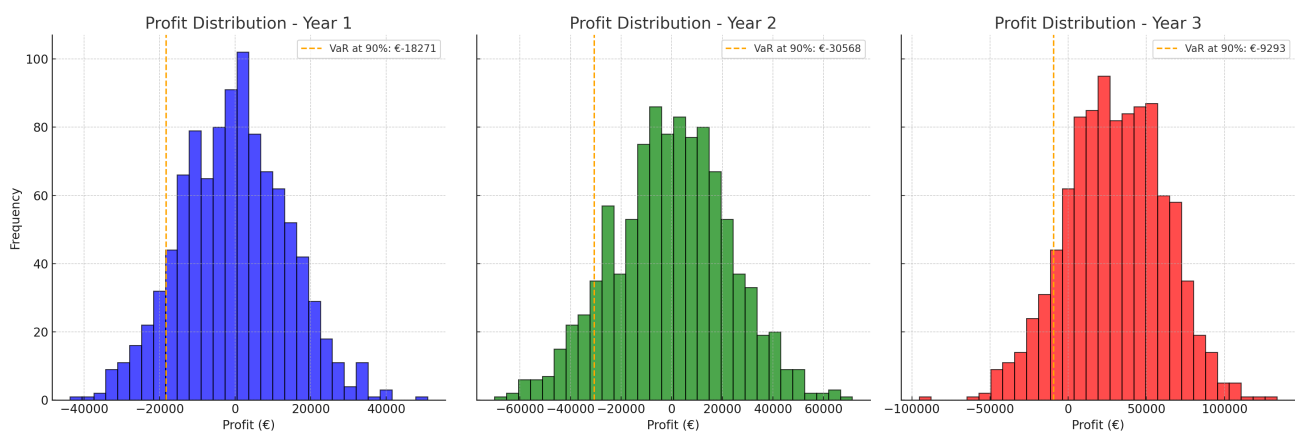


Figure 16: Monte Carlo Simulation Results of Carbon Sequestration Tracking Start-up

The business model (see Table 29) offers significant value for large-scale forest monitoring, allowing forest managers to predict the outcomes of interventions such as thinning or pest



control, thus promoting sustainable forest practices. The business model focuses on offering real-time forest health monitoring, predictive analysis, and resource optimization to various customers, including forestry agencies, conservation NGOs, research institutions, timber industries, and insurers. Key innovations include RL-driven adaptability, scalable ecosystem modeling, and energy-efficient operations, making the platform suitable for a wide range of ecosystems and sustainability goals. Revenue streams will come from subscriptions, data licensing, consulting services, and premium features, while costs focus on R&D, cloud infrastructure, personnel, and customer support.

Table 29: Business Model Canvas of Incubated Digital Twin Product

Key Partners	Key Activities	Value Proposition	Customer Relationships
<ul style="list-style-type: none"> <li>IoT Hardware Providers</li> <li>Research Institutions</li> <li>Government Agencies</li> <li>Environmental NGOs</li> <li>Technology Firms</li> </ul>	<ul style="list-style-type: none"> <li>Product Development and Enhancement</li> <li>Data Collection and Management</li> <li>Customer Support and Training</li> <li>Partnership Building</li> <li>Research and Innovation in Ecosystem Modeling</li> </ul>	<ul style="list-style-type: none"> <li>Real-time forest monitoring using IoT sensors</li> <li>Predictive analysis using reinforcement learning</li> <li>Resource optimization and energy-efficient operations</li> <li>Support for sustainable forest management practices</li> </ul>	<ul style="list-style-type: none"> <li>Dedicated Account Management</li> <li>Online Support and Training</li> <li>Customer Feedback and Co-Development</li> </ul>
Key Resources	Channels	Customer Segments	Cost Structure
<ul style="list-style-type: none"> <li>Technology Infrastructure (IoT, Cloud, AI)</li> <li>Technical Expertise (Data Scientists, Software Developers)</li> <li>Data Sources (IoT networks, satellite imagery)</li> <li>Partnership Network</li> </ul>	<ul style="list-style-type: none"> <li>Direct Sales to Forest Agencies, NGOs, Research Institutions</li> <li>Online Platform for subscriptions and data access</li> <li>Partnerships with environmental NGOs and government agencies</li> <li>Conferences and Exhibitions</li> </ul>	<ul style="list-style-type: none"> <li>Forest Management Agencies</li> <li>Conservation NGOs</li> <li>Research Institutions</li> <li>Timber and Paper Industries</li> <li>Insurance and Risk Assessment Firms</li> </ul>	<ul style="list-style-type: none"> <li>Research and Development Costs</li> <li>Infrastructure Costs (cloud storage, data processing)</li> <li>Personnel Costs (developers, data scientists)</li> <li>Marketing and Sales Expenses</li> <li>Customer Support Costs</li> </ul>
Revenue Streams		Unique Selling Points (USPs)	
<ul style="list-style-type: none"> <li>Subscription-Based Model (monthly/annual)</li> <li>Data Licensing to research institutions and industries</li> <li>Consultancy Services for forest management strategies</li> <li>Premium Features (advanced analytics, integrations)</li> <li>Grants and Funding for sustainable forestry solutions</li> </ul>		<ul style="list-style-type: none"> <li>Real-Time Adaptability with reinforcement learning</li> <li>Comprehensive Ecosystem Modeling using IoT and AI</li> <li>Energy-Efficient Data Updates for sustainability</li> <li>Scalable from small reserves to large ecosystems</li> </ul>	



The SWOT analysis for digital twin for forest ecosystems is presented in 30.

Table 30: SWOT Analysis for Digital Twin for Forest Ecosystems

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> <li>• Real-time forest ecosystem monitoring using IoT and reinforcement learning (RL).</li> <li>• Scalable for diverse ecosystems and sustainability goals.</li> <li>• Energy-efficient operations with adaptive modeling.</li> <li>• Predictive analysis to improve forest management practices.</li> <li>• Spatiotemporal graph modeling for complex ecosystem insights.</li> <li>• Strong collaboration opportunities with conservation NGOs and research institutions.</li> </ul>	<ul style="list-style-type: none"> <li>• High R&amp;D and infrastructure costs for digital twin development.</li> <li>• Dependence on complex IoT and AI technologies.</li> <li>• Initial customer base may be limited due to high costs.</li> <li>• Requires significant personnel and expertise for system management.</li> <li>• Limited market penetration in early stages.</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• Increasing demand for sustainable forest management tools.</li> <li>• Partnerships with government agencies, NGOs, and forestry industries for environmental monitoring.</li> <li>• Growing awareness of deforestation and climate change impacts.</li> <li>• Expanding into new geographic regions and ecosystems.</li> <li>• Revenue from subscription models, data licensing, and consultancy services.</li> </ul>	<ul style="list-style-type: none"> <li>• Competition from other ecosystem monitoring solutions.</li> <li>• Regulatory or political changes affecting IoT or AI deployment.</li> <li>• Technological challenges in scaling the digital twin system.</li> <li>• New entrants offering similar digital twin or AI solutions.</li> <li>• Cybersecurity threats to data privacy and forest ecosystem data.</li> </ul>

**Example Business Case** The Digital Twin startup offers a subscription-based model for forest management agencies, conservation NGOs, research institutions, and the timber industry, allowing users to access data, run advanced simulations, and receive predictive insights (see table 31). With significant investments required for DTs in R&D, infrastructure, and personnel, the startup anticipates operating at a loss in the first two years but aims to achieve profitability by the end of Year 3 through increased customer acquisition and the introduction of premium features and consultancy services.

The Profit & Loss dashboard based on the projected business case data for the Digital Twin Product is shown in Figure 17.



Table 31: Financial Projections for Digital Twin Product (in euros)

Item	Year 1	Year 2	Year 3
<b>Total Customers</b>	15	20	30
<b>Revenue Streams</b>			
Subscription-Based Access (40%)	€120,000	€180,000	€360,000
Data Licensing (20%)	€60,000	€90,000	€180,000
Consultancy Services (25%)	€75,000	€120,000	€240,000
Premium Features (10%)	€30,000	€50,000	€100,000
Grants and Funding (5%)	€15,000	€25,000	€50,000
<b>Total Revenue</b>	<b>€300,000</b>	<b>€415,000</b>	<b>€930,000</b>
<b>Cost Structure</b>			
R&D Costs (40%)	€120,000	€200,000	€300,000
Infrastructure Costs (cloud, IoT) (30%)	€90,000	€150,000	€200,000
Personnel Costs (15%)	€45,000	€75,000	€150,000
Marketing and Sales Expenses (10%)	€30,000	€50,000	€80,000
Customer Support and Training (5%)	€15,000	€25,000	€40,000
<b>Total Costs</b>	<b>€300,000</b>	<b>€500,000</b>	<b>€770,000</b>
<b>Net Profit</b>	<b>€0</b>	<b>€-85,000</b>	<b>€160,000</b>

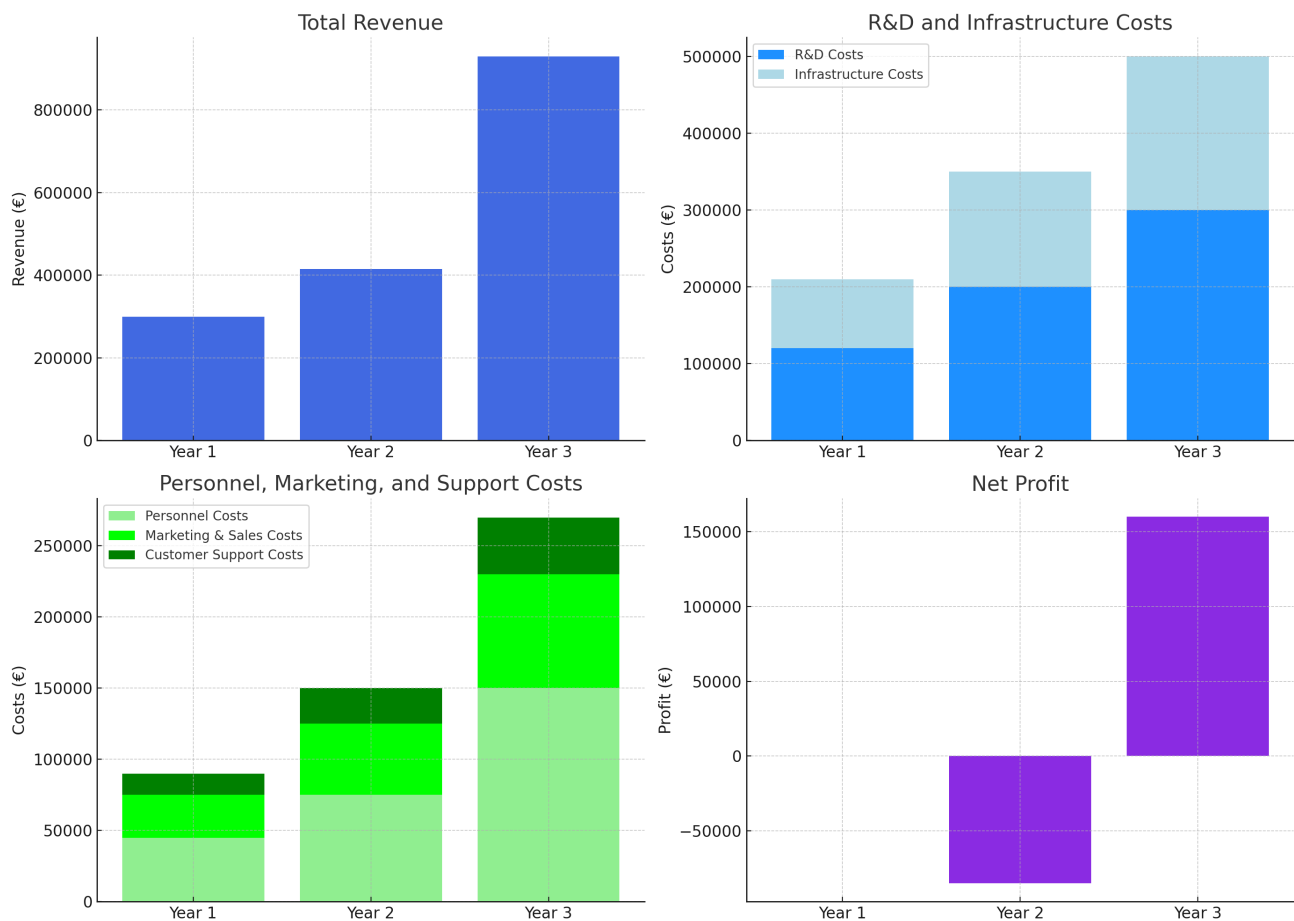


Figure 17: Profit & Loss dashboard based on the projected business case data for the Digital Twin Product



Figure 18 displays the profit distributions for the Digital Twin startup across three years, generated from Monte Carlo simulations. Each plot includes a Value at Risk (VaR) at the 90% confidence level, indicating the potential loss threshold with a 10% probability of being exceeded. In Year 1, the VaR is €-51,194, reflecting moderate financial risk as the startup builds its foundation. The risk intensifies in Year 2, with a VaR of €-101,382, due to high investments in R&D, infrastructure, and personnel. By Year 3, the VaR improves to a positive value of €17,119, indicating that the startup is on a path to profitability as revenue increases from a growing customer base and expanded service offerings, indicating the startup's gradual progression toward financial stability and profitability by the third year.

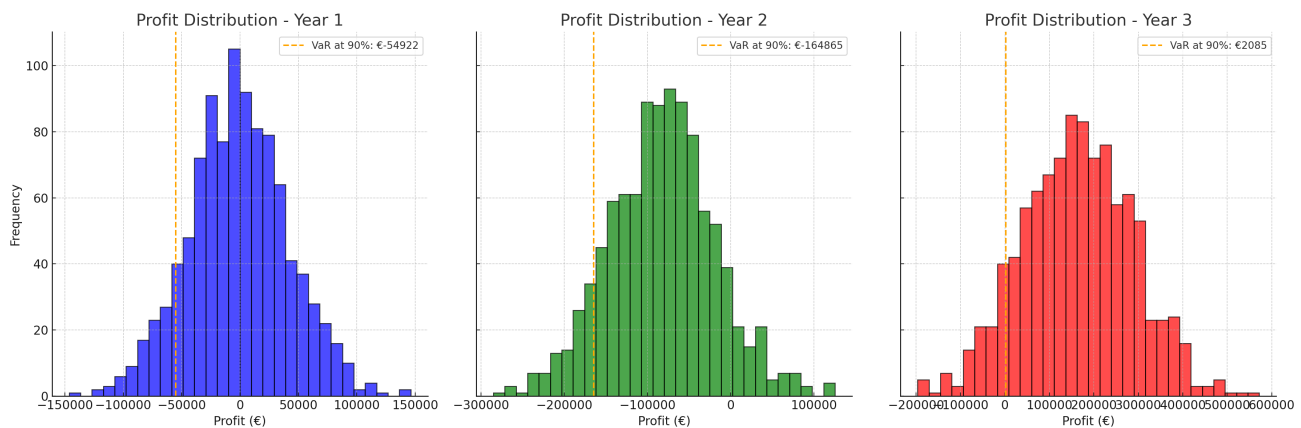


Figure 18: Monte Carlo Simulation Results of Digital Twin Start-up

## 7.6 Decentralized Forest Monitoring Using Blockchain and Large Language Models

The startup works on developing decentralized forest monitoring architecture combining blockchain technology and large language models (LLMs) to address challenges related to data integrity, transparency, and scalability. Using the immutable ledger on the blockchain, the system ensures secure and tamper-proof data storage, which fosters trust between stakeholders, such as environmentalists, policymakers, and the public. This decentralized approach guarantees that forest data, collected from IoT sensors and satellites, is transparent and accessible. Simultaneously, the analytical power of LLMs enables real-time processing and analysis of large data sets, identifying anomalies, generating insights, and producing comprehensive reports on forest health. This architecture allows for swift responses to ecological threats, such as forest fires or illegal logging, enhancing forest conservation efforts. In this scenario, a startup would install IoT sensors in forest regions to collect environmental data, which would be recorded on a blockchain for transparency. LLMs would process this data, generating reports on the ecological state of the forest and potential threats.

The business model (see Table 32) is structured around key partners, including IoT manufacturers, blockchain providers, and environmental NGOs. The platform delivers value through secure, real-time monitoring, transparent data storage, and predictive insights, catering to forest management agencies, conservation NGOs, and industries reliant on forest ecosys-



tems. Revenue streams include subscription services, data licensing and consulting, while its unique selling points, blockchain transparency, LLM-driven analysis, and scalability differentiate it as a comprehensive solution for sustainable forest management.

Table 32: Business Model Canvas of Decentralized Forest Monitoring Product

Key Partners	Key Activities	Value Proposition	Customer Relationships
<ul style="list-style-type: none"> <li>IoT Sensor Manufacturers</li> <li>Blockchain Technology Providers</li> <li>AI and Data Analytics Firms</li> <li>Environmental NGOs</li> <li>Government Forestry Agencies</li> <li>Academic and Research Institutions</li> </ul>	<ul style="list-style-type: none"> <li>Development of Blockchain-Based Monitoring Platform</li> <li>Integration of Large Language Models (LLMs) for Data Analysis</li> <li>Real-Time Data Collection and Processing</li> <li>Customer Support and Training Services</li> <li>Partnership Development for Expanded Capabilities</li> <li>Research and Continuous Improvement</li> </ul>	<ul style="list-style-type: none"> <li>Immutable, Transparent Forest Data Storage using Blockchain</li> <li>Real-Time Analysis and Reporting with LLMs</li> <li>Scalable, Decentralized Monitoring System for Large Forest Areas</li> <li>Enhanced Data Integrity and Stakeholder Trust</li> <li>Predictive Insights for Proactive Forest Management</li> </ul>	<ul style="list-style-type: none"> <li>Dedicated Account Managers for Key Clients</li> <li>Online Support and User Training</li> <li>Collaborative Feedback Mechanisms for Platform Improvement</li> </ul>
Key Resources	Channels	Customer Segments	Cost Structure
<ul style="list-style-type: none"> <li>Blockchain Infrastructure</li> <li>Advanced IoT Sensors and Devices</li> <li>Large Language Models and AI Algorithms</li> <li>Skilled Technical Team (Blockchain Developers, Data Scientists, AI Experts)</li> <li>Strategic Partnerships</li> <li>Data Sources (Satellite Imagery, IoT Networks)</li> </ul>	<ul style="list-style-type: none"> <li>Direct Sales to Forestry Agencies, NGOs, and Research Institutions</li> <li>Online Platform for Data Access and Management</li> <li>Partnerships with Environmental NGOs and Government Agencies</li> <li>Participation in Environmental Conferences and Exhibitions</li> </ul>	<ul style="list-style-type: none"> <li>Forest Management Agencies</li> <li>Environmental NGOs and Conservation Groups</li> <li>Research Institutions and Universities</li> <li>Government Forestry Departments</li> <li>Timber and Paper Industries</li> </ul>	<ul style="list-style-type: none"> <li>R&amp;D Costs (Blockchain, AI Integration)</li> <li>Infrastructure Costs (Blockchain, Cloud Storage)</li> <li>Personnel Costs (Developers, Data Scientists, Support Staff)</li> <li>Marketing and Sales Expenses</li> <li>Customer Support and Training Costs</li> </ul>
<b>Revenue Streams</b>		<b>Unique Selling Points (USPs)</b>	



<ul style="list-style-type: none"><li>• Subscription-Based Access to the Platform</li><li>• Data Licensing to Research and Industry</li><li>• Consulting Services for Forest Management Strategy</li><li>• Premium Features (Real-Time Alerts, Advanced Predictive Analysis)</li><li>• Grants and Funding for Environmental Conservation Initiatives</li></ul>	<ul style="list-style-type: none"><li>• Immutable and Transparent Data Storage with Blockchain</li><li>• Real-Time, AI-Powered Data Analysis using LLMs</li><li>• Scalable and Decentralized Monitoring for Large Forest Areas</li><li>• Enhanced Stakeholder Trust through Data Integrity and Transparency</li><li>• Predictive Insights for Proactive Ecosystem Management</li></ul>
--	--

The SWOT analysis for decentralized forest monitoring using blockchain and large language models is shown in table 33.

**Example Business Case** Decentralized forest monitoring startup aims for gradual growth in customer acquisition and revenue over the first three years (see table 34). In year 1, the company starts with a modest customer base of 10, which increases to 25 by Year 2. By year 3, the customer base expands further to 50, reflecting the company's strategic marketing efforts and improved service offerings. This gradual growth is expected to support the financial health of the business while effectively managing costs.

The Profit & Loss dashboard based on the projected business case data for Decentralized Forest Monitoring is shown in Figure 19.

Figure 20 depicts the profit distributions for the Decentralized Forest Monitoring startup over three years, generated through Monte Carlo simulations. Each plot includes a Value at Risk (VaR) at the 90% confidence level, indicating the potential loss threshold with a 10% chance of being exceeded. In Year 1, the VaR is €-61,023, reflecting moderate financial risk as the startup builds its customer base. The risk intensifies in Year 2, with a VaR of €-130,462, due to costs associated with scaling and customer acquisition. By Year 3, the VaR shifts to a positive €22,698, indicating an improved financial position and potential profitability driven by substantial revenue growth. The results highlight the startup's strategic progression toward financial stability by Year 3.



Table 33: SWOT Analysis for Decentralized Forest Monitoring Using Blockchain and Large Language Models

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> <li>• Secure, transparent data storage through blockchain.</li> <li>• Real-time data analysis powered by large language models (LLMs).</li> <li>• Scalable solution for large forest areas.</li> <li>• Enhanced stakeholder trust due to immutable data.</li> <li>• Predictive insights for forest management and early threat detection (e.g., illegal logging).</li> <li>• Collaboration with environmental NGOs and forestry agencies.</li> <li>• Unique selling proposition with blockchain transparency and AI insights.</li> </ul>	<ul style="list-style-type: none"> <li>• High R&amp;D and infrastructure costs.</li> <li>• Dependence on external partnerships (IoT manufacturers, blockchain providers).</li> <li>• Complex integration of blockchain and AI systems.</li> <li>• Lack of market presence in initial phases.</li> <li>• Risk of low customer base in the early years.</li> <li>• High competition from other environmental monitoring solutions.</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• Growing demand for environmental monitoring and sustainability efforts.</li> <li>• Potential partnerships with government agencies and NGOs for grants and funding.</li> <li>• Expansion into new geographic regions with forest conservation needs.</li> <li>• Emerging technologies (advanced IoT sensors, AI improvements) that can enhance platform capabilities.</li> <li>• Increasing global attention to deforestation and forest health due to climate change.</li> <li>• Licensing forest data to industries and research institutions for long-term revenue.</li> </ul>	<ul style="list-style-type: none"> <li>• New competitors or existing ones adopting similar technologies.</li> <li>• Shrinking target market or changing regulations that might limit operations.</li> <li>• Political or regulatory changes that could impact blockchain use.</li> <li>• Potential technological challenges or limitations of blockchain scalability.</li> <li>• Competition from indirect solutions such as satellite-based monitoring without blockchain.</li> <li>• Possible pushback on blockchain technologies from regulators concerned with environmental impact.</li> </ul>



Table 34: Financial Projections for Decentralized Forest Monitoring Product (in euros)

Item	Year 1	Year 2	Year 3
<b>Total Customers</b>	10	25	50
<b>Revenue Streams</b>			
Subscription-Based Access (50%)	€200,000	€400,000	€900,000
Data Licensing (20%)	€50,000	€120,000	€300,000
Consulting Services (20%)	€80,000	€200,000	€500,000
Premium Features (5%)	€10,000	€30,000	€80,000
Grants and Funding (5%)	€10,000	€30,000	€80,000
<b>Total Revenue</b>	<b>€360,000</b>	<b>€800,000</b>	<b>€1,930,000</b>
<b>Cost Structure</b>			
R&D Costs (30%)	€120,000	€240,000	€600,000
Infrastructure Costs (25%)	€90,000	€200,000	€480,000
Personnel Costs (20%)	€80,000	€160,000	€400,000
Marketing and Sales Expenses (15%)	€60,000	€120,000	€240,000
Customer Support and Training Costs (10%)	€30,000	€60,000	€120,000
<b>Total Costs</b>	<b>€390,000</b>	<b>€870,000</b>	<b>€1,800,000</b>
<b>Net Profit</b>	<b>€-30,000</b>	<b>€-70,000</b>	<b>€130,000</b>

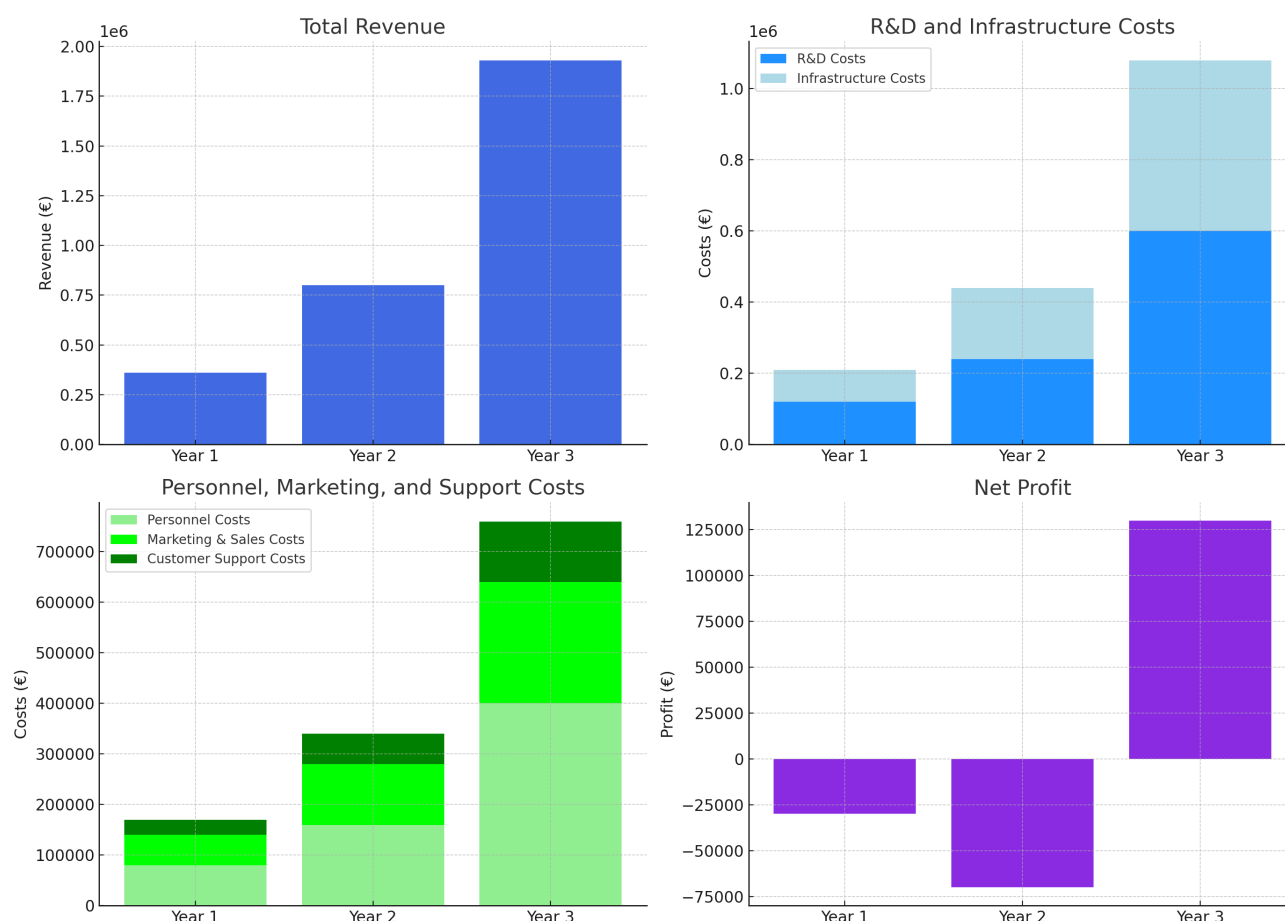


Figure 19: Profit & Loss dashboard based on the projected business case data for the Decentralized Forest Monitoring

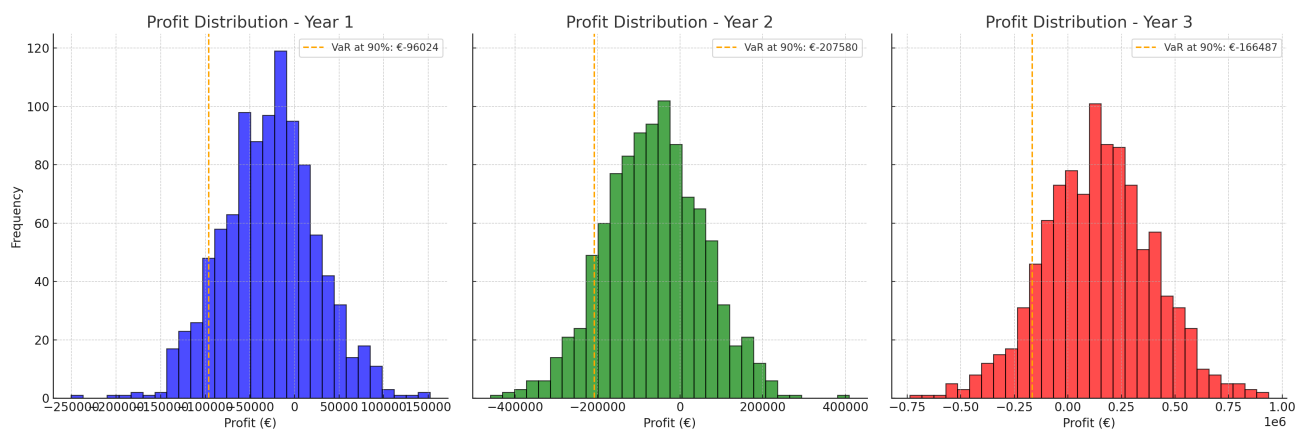


Figure 20: Monte Carlo Simulation Results of Decentralized Forest Monitoring Start-up



## 8 Conclusion and Recommendations

This report outlines the "Forest 4.0 Incubation Design and Implementation Plan," a CoE Forest 4.0 initiative aimed at accelerating products based on advanced technologies such as Artificial Intelligence (AI), the Internet of Things (IoT), and data analytics to promote sustainable forest management in the Baltic Sea Region (BSR), where forests face significant environmental challenges, including climate change, biodiversity loss, pest outbreaks and forest fires. Therefore, the strategic vision of the incubation plan is to improve forest health, improve carbon sequestration, and promote circular economy models in forestry while generating economic growth in forest-dependent communities by integrating technologies such as AI, IoT, remote sensing, and blockchain, the programme aims to facilitate the transition to smart forestry, enabling data-driven decision-making and enhancing forest resilience.

The long-term vision of the "Forest 4.0 Incubation Plan" is to accelerate resilient, technology-driven products aimed at forestry ecosystem in the Baltic Sea Region for sustainable forest management. The key components of this vision include:

- Support the commercialization of successful technologies by helping startups navigate regulatory environments, acquire certifications, and access new markets. The long-term goal is to expand market penetration beyond the Baltic Sea Region, targeting European and global forestry markets with proven, scalable solutions.
  - As the incubation program matures, focus on transferring knowledge and best practices to other European regions facing similar forestry challenges, by creating a digital knowledge platform, organizing international conferences, and participating in global forestry initiatives to share successful models and technologies.
- Promote circular economy models in forestry that minimize waste and maximize the value of forest products, supporting the development of bio-based industries, responsible timber harvesting practices, and innovative products derived from forest resources. The aim is to integrate forest conservation with local economic development, ensuring that forest-dependent communities thrive while protecting natural ecosystems.
  - Build a sustainable funding ecosystem by securing long-term investments from public funding programs, private investors, and carbon credit markets. Establishing a forestry-focused venture capital fund must provide continuous support to start-ups developing innovative forestry solutions, ensuring the long-term impact and sustainability of the programme.
- Foster a network of cross-border collaboration among Baltic countries to create unified forestry policies, shared technology platforms, and standardized best practices. This alignment will facilitate the scaling of forest management solutions beyond individual countries, contributing to regional biodiversity conservation, climate change mitigation, and sustainable economic growth.
  - Align the program's long-term goals with global climate change mitigation efforts by focusing on technologies that enhance forests' carbon sequestration capabilities. Develop monitoring systems that provide accurate assessments of carbon capture, contributing to global climate agreements and carbon credit programs.



The incubation process is structured into six phases: scoping, ideation, prototyping, piloting, business model development, and scaling. We believe that such a proven approach ensures that selected projects undergo rigorous validation, technical development, field testing, and business planning to achieve scalability and long-term impact. Each phase incorporates feedback mechanisms and evaluation criteria, such as technological novelty, environmental impact, market potential, and operational efficiency, to continuously improve and align with the sustainability objectives of forest. The report identifies and maps key stakeholders, including government agencies, NGOs, research institutions, and technology companies in the BSR countries, which play vital roles in the development, implementation, and commercialization of new technologies focused on forest health monitoring, biodiversity conservation, and responsible timber harvesting. Therefore, actionable incubation recommendations for the team running CoE Forest 4.0, following from this report, are:

- Develop customized training sessions and mentoring programs that focus on AI, IoT, remote sensing, and blockchain applications in forestry. The academic pool can empower startups, researchers, and forestry professionals with the necessary skills to develop and deploy innovative forest management solutions.
  - Set up continuous feedback loops with end-users (e.g., forest managers, policy-makers, local communities) to refine technology solutions. Incorporate regular user surveys, pilot project reviews, and performance analysis to inform product improvements and validate their impact on forest sustainability.
- Facilitate field testing of prototypes in diverse forest environments across Lithuania, Sweden, Finland, and Estonia. Gathering real-world data on forest conditions, biodiversity, and ecosystem health will help refine and demonstrate the viability of new technologies in varying contexts.
  - Utilize key performance indicators (KPIs) such as forest health, biodiversity indices, carbon sequestration rates, and market adoption metrics to assess the success of incubated projects. Regular monitoring will enable data-driven decision making, ensuring that technologies meet environmental, economic, and operational goals.
- Establish formal partnerships with government agencies, NGOs, research institutions, and tech companies in the Baltic Sea Region. Networking can facilitate resource sharing, regulatory support, and knowledge exchange, enhancing the effectiveness of sustainable forest management initiatives.
  - Engage local communities and forest-dependent stakeholders in the incubation process to ensure that solutions are socially inclusive and address the needs of those directly affected by forest management practices.
  - Work with forestry certification bodies like FSC (Forest Stewardship Council) and PEFC (Programme for the Endorsement of Forest Certification) to ensure that incubated technologies and business models align with sustainable forestry standards to further enhance market credibility and consumer trust in forest products.
- Actively pursue public funding sources such as EU grants (e.g., Horizon Europe) and private investments, including venture capital, to support startups in the incubation



program. Creating a clear financial strategy will ensure sufficient resources for scaling successful technologies.

## 9 Annex I. Abbreviations used

Abbreviation	Explanation
AI	Artificial Intelligence
IoT	Internet of Things
KPI	Key Performance Indicator
MVP	Minimum Viable Product
FSC	Forest Stewardship Council
PEFC	Programme for the Endorsement of Forest Certification
BSR	Baltic Sea Region
GIS	Geospatial Information System
NGO	Non-Governmental Organization
DEI	Diversity, Equity, and Inclusion
CLV	Customer Lifetime Value
NPS	Net Promoter Score
CSAT	Customer Satisfaction Score
R&D	Research and Development
CoE	Centre of Excellence
WP	Work Package
EU	European Union
ML	Machine Learning
DT	Digital Twin
RL	Recurrent learning
UAV	Unmanned Aerial Vehicle
MCPFE	Ministerial Conference on the Protection of Forests in Europe
KTU	Kaunas University of Technology
VDU	Vytaytas Magnum University
KTH	Kungliga Tekniska högskolan

Table 35: Key abbreviations used in the report and their meanings.



## References

- [1] E. Commission, “The baltic sea region: Cooperation and future prospects,” *EU Regional Policy*, 2020.
- [2] T. Lindholm and J. Wennberg, “Baltic sea forests: Ecosystem services and biodiversity conservation,” *Forest Ecology and Management*, vol. 352, pp. 35–48, 2015.
- [3] Y. Pan, R. A. Birdsey, J. Fang, R. Houghton, P. E. Kauppi, W. A. Kurz, O. L. Phillips, A. Shvidenko, S. L. Lewis, J. G. Canadell, *et al.*, “A large and persistent carbon sink in the world’s forests,” *Science*, vol. 333, no. 6045, pp. 988–993, 2011.
- [4] C. Zilliox and L. Gosselin, “Biodiversity conservation in baltic forests: Preserving habitats and species,” *Journal of Ecology and Conservation*, vol. 118, pp. 99–117, 2021.
- [5] F. Schroeder and P. Koncz, “Forest ecosystem services and climate regulation in the baltic sea region,” *Ecosystem Services*, vol. 14, pp. 12–24, 2015.
- [6] E. Golubiewski and T. Rantanen, “Forestry in the baltic sea region: Economic importance and environmental challenges,” *Journal of Baltic Studies*, vol. 49, no. 3, pp. 270–284, 2018.
- [7] K. Korhonen and A. Rydberg, “Forests, rural communities, and livelihoods: The role of forests in the baltic region,” *Journal of Forest Economics*, vol. 64, pp. 150–162, 2018.
- [8] E. C. H. Keskitalo, *Climate Change and Environmental Impacts in the Baltic Sea Region*. Springer, 2017.
- [9] M. Lindner, M. Maroschek, S. Netherer, A. Kremer, A. Barbati, J. Garcia-Gonzalo, R. Seidl, S. Delzon, P. Corona, M. Kolström, *et al.*, “Climate change impacts, adaptive capacity, and vulnerability of european forest ecosystems,” *Forest Ecology and Management*, vol. 259, no. 4, pp. 698–709, 2010.
- [10] R. Seidl, M.-J. Schelhaas, W. Rammer, and P. J. Verkerk, “Climate change vulnerability of forest ecosystems in the baltic sea region,” *Global Change Biology*, vol. 20, no. 2, pp. 599–612, 2014.
- [11] V. I. Kharuk, J. Ranson, S. T. Im, and M. M. Naurzbaev, “Boreal forests and climate change: Shifts in species distributions and ecosystem impacts,” *Global Ecology and Biogeography*, vol. 22, pp. 761–773, 2013.
- [12] R. Seidl, D. Thom, M. Kautz, D. Martin-Benito, M. Peltoniemi, G. Vacchiano, J. Wild, D. Ascoli, M. Petr, J. Honkaniemi, *et al.*, “Forests under climate change: Risks and opportunities for adaptive management,” *Ecological Applications*, vol. 27, no. 3, pp. 235–252, 2017.
- [13] M. C. on the Protection of Forests in Europe (MCPFE), *European Union Forest Strategy: A renewed commitment to sustainable forest management*. MCPFE Publications, 2015.
- [14] L. H. Gulbrandsen, “Sustainability certification of forests: Fsc and pefc in comparison,” *Journal of Environmental Management*, vol. 74, no. 3, pp. 209–220, 2005.
- [15] H. Faustmann and R. Seidl, “Adaptive forest management and its role in sustainable forests in the baltic sea region,” *Journal of Forest Policy*, vol. 44, pp. 56–72, 2020.



- [16] H. Parviainen, S. Rantala, and K. Korhonen, "Forest 4.0: Technological innovations for sustainable forest management," *Forest Science*, vol. 64, pp. 567–579, 2018.
- [17] S. M. R. A. A. G. K. V. M. J. J. K. K. N. Shivaprakash, Niraj Swami, "Potential for artificial intelligence (ai) and machine learning (ml) applications in biodiversity conservation, managing forests, and related services in india," *Sustainability*, 2022.
- [18] J. F. A. S. E. E. H.-J. K. D. T. T. S. Simon Ecke, J. Dempewolf, "Uav-based forest health monitoring: A systematic review," *Remote. Sens.*, vol. 14, p. 3205, 2022.
- [19] S. G. S. M. C.-S. T. M. F. P. Jain, Sean C. P. Coogan, "A review of machine learning applications in wildfire science and management," *ArXiv*, vol. abs/2003.00646, 2020.
- [20] R. D. A. L. F. R. P. R. S. R. Pandey, Diksha Srivastava, "Enhancing the accuracy of forest monitoring through ai to reduce carbon footprint," in *2022 4th International Conference on Inventive Research in Computing Applications (ICIRCA)*, pp. 1177–1182, 2022.
- [21] L. K. M. H. K. Mulatu, B. Mora, "Biodiversity monitoring in changing tropical forests: A review of approaches and new opportunities," *Remote. Sens.*, vol. 9, p. 1059, 2017.
- [22] W. S. K. J. N. W. Scott Schwenk, Therese M. Donovan, "Carbon storage, timber production, and biodiversity: comparing ecosystem services with multi-criteria decision analysis," *Ecological applications: a publication of the Ecological Society of America*, vol. 22, no. 5, pp. 1612–27, 2012.
- [23] S. Gill and T. Gill, "The internet of things for smart agriculture: Technologies, big data, and challenges," *Computers and Electronics in Agriculture*, vol. 141, pp. 157–165, 2017.
- [24] W. Hart and P. Stone, "Smart forestry: Iot solutions for forest management," *Environmental Monitoring and Assessment*, vol. 191, no. 12, pp. 1–13, 2019.
- [25] T. Linchant, P. Lejeune, C. Vermeulen, and C. Delacourt, "Wildlife monitoring using acoustic sensors: Evaluating ecological and conservation applications," *Biodiversity and Conservation*, vol. 24, no. 5, pp. 1203–1221, 2015.
- [26] M. A. Rassam, A. A. Zaidan, and B. B. Zaidan, "Iot-based precision forestry: Framework and applications," *International Journal of Agricultural and Biological Engineering*, vol. 10, no. 5, pp. 1–12, 2017.
- [27] J. Huang, X. Wang, and L. Yang, "Precision forestry: Iot and big data analytics for sustainable management," *Journal of Forest Research*, vol. 23, no. 3, pp. 225–238, 2018.
- [28] X. Liu, H. Zhang, and M. Tian, "Iot-based early wildfire detection and prevention system: A survey," *International Journal of Wildland Fire*, vol. 30, no. 5, pp. 310–325, 2021.
- [29] S. J. Goetz and R. Dubayah, "Remote sensing of environmental changes: From global monitoring to forest management," *Nature Climate Change*, vol. 5, pp. 123–129, 2015.
- [30] M. C. Hansen, P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, *et al.*, "High-resolution global maps of 21st-century forest cover change," *Science*, vol. 342, no. 6160, pp. 850–853, 2013.



- 
- [31] E. Buchwald and M. Valentas, "Monitoring forest changes in the baltic sea region using remote sensing data: A case study in lithuania," *Journal of Forestry*, vol. 112, pp. 77–89, 2016.
- [32] L. Duncanson, R. Dubayah, B. Enquist, W. Jetz, *et al.*, "The importance of remote sensing for estimating forest biomass: Current trends and future directions," *Nature Reviews Earth & Environment*, vol. 1, pp. 873–889, 2020.
- [33] D. Lu and Q. Chen, "Remote sensing applications in soil degradation and erosion monitoring: A review," *International Journal of Applied Earth Observation and Geoinformation*, vol. 90, pp. 102–134, 2020.
- [34] L. Jansen and A. Di Gregorio, "The role of gis and remote sensing in sustainable forest management," *Forest Ecology and Management*, vol. 260, pp. 80–85, 2010.
- [35] F. Escobedo and G. Kerebel, "Gis-based forest mapping: Applications for sustainable forest management," *Journal of Geospatial Information Science*, vol. 45, no. 2, pp. 130–142, 2016.
- [36] R. Peteers and L. Van Zyl, "Gis applications in forest conservation and management," *Environmental Management*, vol. 63, pp. 304–319, 2019.
- [37] E. Marcinkowska and R. Pawlikowski, "Disaster prevention in forest management using gis and remote sensing technologies," *Journal of Disaster Risk Reduction*, vol. 39, pp. 100–111, 2019.
- [38] W. U. Jaime José Cueva-Sánchez, Aaron Jair Coyco-Ordemar, "A blockchain-based technological solution to ensure data transparency of the wood supply chain," in *2020 IEEE ANDESCON*, pp. 1–6, 2020.
- [39] A. K. S. Preetam Basu, Palash Deb, "Blockchain and the carbon credit ecosystem: sustainable management of the supply chain," *Journal of Business Strategy*, 2023.
- [40] "Treesearch – samverkan kring forskning för nya material från skogen — treesearch.se." <https://treesearch.se/>. [Accessed 22-10-2024].