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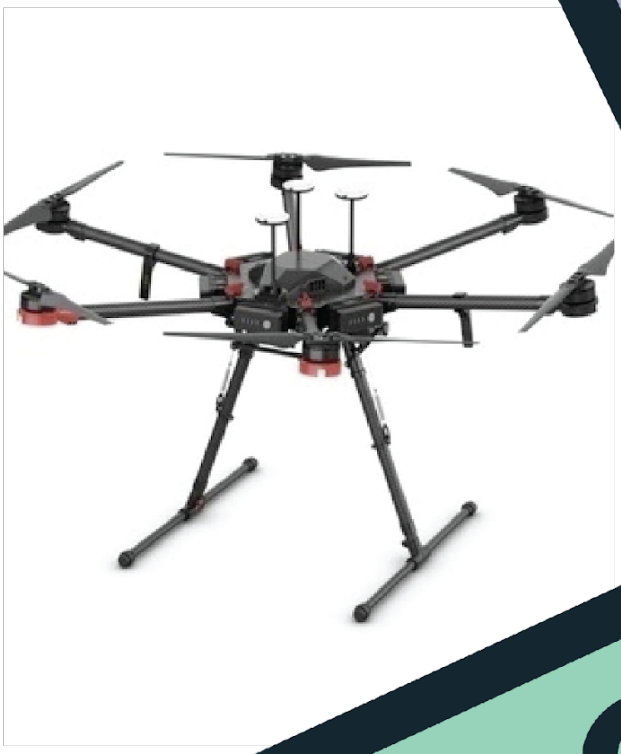

SPOT

SOCIETAL PERSPECTIVES TO INNOVATION OPPORTUNITIES IN TECHNOLOGY

EXPLORING SNIFFIRDRONE USE CASES

ATTRACT

Report:

SUSTAINABILITY & FUTURE IMPACT THROUGH RESEARCH AND IDEATION:

A student perspective

Prepared for:

SNIFFIRDRONE

Projects completed within the course:
Mechanical Engineering in Society
August to December 2023

This compilation of student insights represents a curated selection from 34 individual submissions.

Students were introduced to the SNIFFIRDRONE consortium and technology through the ATTRACT technology card. The reading focused on familiarizing oneself with the Sustainable Development Goals (SDGs) and "Engineering a more Sustainable World" from the UNESCO Engineering for Sustainable Development report.

Students were asked to critically assess the features and opportunities of drone-based aerial monitoring technology in the context of a chosen SDG. They were tasked with imagining an application for this technology within their field of study or personal interest area, emphasizing its potential contributions to sustainable development.

Emerging categories of application include air monitoring in various industrial contexts, monitoring cruise ships air impact, learning more about the air quality post natural disaster, monitoring traffic as well as agricultural applications.

Students also noted the key stakeholders that the consortium could consider collaborating with in future. 19 student stakeholder maps were submitted. These maps were collated to present the stakeholders in order of frequency, as well as a map of the top noted stakeholders.

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Application #1: Air monitoring Natural Disasters

Photo by NOAA on Unspl

Natural disasters, such as earthquakes and hurricanes, can swiftly reshape a landscape with enormous geographical and social effects. These catastrophic events not only disrupt lives but also pose immense challenges for emergency response teams in assessing and managing the aftermath. In the face of such events, innovative solutions are crucial to enhancing the efficiency and effectiveness of disaster response efforts.

Numerous students independently came up with the application for using SniffIrdrone after a catastrophe response or prevention from natural disasters.

Their proposals explore the integration of this technology into disaster response and prevention, offering novel insights into how Sniffirdrone can play a pivotal role in mitigating the impact of calamities and facilitating a more resilient and responsive approach to disaster management.

Henri Wahlman:
"Drone mapping can provide detailed images and data for example from forests and cities. This information helps decision-makers make informed decision to protect and prevent different kind of situations. For an example in earthquake areas drone mapping is extremely useful.
Drones can provide real- time data, from large-areas and quickly. With this application fast actions can be executed to areas in need."

Anonymous student:
"Effective monitoring and response to natural disasters can help to reduce their impact.
Aerial mapping drones with multiple sensors can provide real-time information about areas during a natural disaster. The information could help emergency responders to obtain better situational awareness for planning rescue mission etc"

Riina Koskinen:
"The application would utilize Sniffirdrones for real-time disaster monitoring. It would work based on real-time monitoring, that is possible with advanced sensors that would monitor disaster areas efficiently and continuously. The drone would then collect data from the sensors and the data would be analysed. The data could be e.g., temperature, air quality, humidity, and geographical changes. The data is transmitted to some system and then algorithms would analyse if there were something occurring on the data provided, e.g., quick change on humidity that is not normal. This would then give an early warning, so the disaster could be prevented, and authorities have a rapid response and start for example, evacuating on time."

Anonymous student:
"Natural catastrophes like earthquakes, hurricanes, and floods frequently cause severe humanitarian emergencies, demanding an immediate deployment of search and rescue operations to find and rescue individuals stranded in the impacted areas. SDG11 (Sustainable Cities and Communities) is the primary focus of this application since the significant challenge is ensuring people's safety and well-being in areas hit by disasters."

Application #2: Cruise ships

Photo by Alonso Reyes on Unsplash

Cruise ships in ports raise significant environmental concerns, as emissions from these vessels directly contribute to air quality degradation in highly valued tourist areas. This potent threat of local air pollution poses far-reaching implications for community health and well-being. The implementation of Sniffirdrone may be able to address the critical issue at hand, offering potential solutions to the environmental challenges posed by these maritime giants.

Anonymous student:
"Ships, especially cruise ships, create a lot of local air pollution, such as CO2, SO2 or black carbon, in harbours and docks. This has been a problem, for example in Italy, where the cruise ships idle their engines for hours on end near tourist locations such as Venice.
This relates to the Good Health and Well-Being SDG (no. 3), because this pollution has a large negative impact on the health and well-being of the local population in the area of these docks.
Using this drone-based surface emission monitoring can help gather data on the negative impact these cruise ships have. Even if the cruise ships idle offshore, their pollutants travel long ways in the air, especially towards the shore where the winds are often headed. This technology could also help identify locations where the ships would have the least impact on the local population."

Application #3: Agriculture and soil quality

Photo by no one cares on Unsplash

The agricultural sector is grappling with challenges, primarily soil depletion and drought. Intensive farming practices contribute to soil nutrient loss, compounded by widespread drought conditions that worsen water scarcity. This dual impact poses a significant threat to crop productivity and overall sustainability. Sniffirdrone might be able to address these issues by equipping arial-based monitoring in agriculture.

Anonymous student:
"As sensors develop further, more applications can come to use, such as the solution with Sniffirdrone and their use of chemical sensors. In an agricultural context drone based chemical sensors might be used to detect the chemical composition of the soil."

Osama Zahid:
"This technology can be used in agricultural fields in areas where there is water scarcity. This technology can assist farmers in optimizing water use and consequently improving crop yields. This aligns with SDG Goal 6: Clean Water and Sanitation. This technology could prove to be particularly helpful in water-scarce agricultural countries such as Pakistan. Drones can monitor larger areas and identify regions suffering from drought conditions. According to the UN, water scarcity is a pressing issue as it affects over 40% of the world's population. In fields where water is scarce, knowing how well the crops are likely to perform is crucial for planning and resource allocation.
In addition to crop rotation planning and drought monitoring, the advanced sensing capabilities of this technology might allow detection of variations in soil moisture content and consequently the crop health. Similar to how Sniffirdrone will be able to generate real-time highly dense 3D pollution maps, creating detailed moisture maps will also become a possibility. This will allow farmers to identify areas that require more or less water, allowing for precise irrigation."

Application #4: Industry

Photo by Yusen Sun on Unsplash

The industrial sector faces numerous challenges, ranging from operational inefficiencies to potential risks at a significant scale. These challenges underscore the need for innovative solutions that could lead to substantial cost savings and risk reduction. The scale of industrial operations presents significant opportunities for considerable improvements in engineering projects and processes. This section will explore a multitude of possible industry applications for Sniffirdrone.

DISTRICT HEATING SYSTEM MONITORING

Joona Paivarinne:
"In the past, helicopters have been used to photograph terrain using thermal cameras to identify leaks in the district heating systems. Helicopters make emissions and noise-pollution etc."

ENGINEERING PROJECTS AND GENERAL MONITORING OF INFRASTRUCTURE

Anonymous student:
"Drone based aerial mapping can be used on construction sites as well. They can be used to collect data of a construction process for analysis and monitoring of the building process."

Anonymous student:
"This technology can aid in improving operational efficiency and reducing environmental impact within the realm of production engineering by providing faster and more accurate detection of leaks, it helps industries to streamline their processes, minimize resource wastage, and uphold environmental sustainability."

OIL AND CHEMICAL TANKER LOADING AND DISCHARGE

Anonymous student:
"Drone mapping would be an excellent solution for oil and chemical tankers. Usually during discharging and loading in ports some of the cargo hold vapour is released to the atmosphere through riser pipes. Also, during these operations it is mandatory to have deck crew to check mooring lines and be on gangway watch for attending visitors and inspectors. This poses a risk, since sometimes winds carry these harmful vapours straight into the vicinity of people. Of course, the tanker crew have to carry personal gas meters during these operations, but since the meter is attached to your boiler suit and the moment it goes off you are already under the direct influence of the harmful gas. Some of these vapours are extremely harmful and can cause cancer, so it is not a very warming thought that in this case you are ''the drone'' measuring the gas."

OIL AND LIQUID GAS PIPELINES

Atte Rusanen:
"A challenge in production of energy and industrial facilities can be hard to notice leaks in gas and liquid systems/pipes. Large amount of piping and expensive monitoring can lead some production plants to neglect the proper checking of all the infrastructure related to gases and liquids. Leaking recourses may be toxic when exposed to personnel working in said plants. These relate to SDG 9: build resilient infrastructure, promote sustainable practises. An infrastructure is not resilient if it is continuously leaking materials and wasting materials is not promoting sustainable practices. This problem can however be linked to multiple SDG like 3, 11 and 13.
Since the drone is relatively small and can detect particles in air even in small doses, the drones could be utilized in mapping the inside of industrial buildings. Detecting problematic areas would help guide the maintenance to right areas efficiently. Detecting the leaks quickly as they appear would help save recourses thus boosting sustainability and profits."

POWERPLANTS

Anonymous student:
"The technology is very innovative and interesting offering a new third dimension for observation and measuring. One application would be to measure a power plants exhaust emissions such as carbon monoxide (CO), carbon dioxide (CO2), hydrocarbons (HC), nitrogen oxides (NOx), and sulphur oxides (Sox)."

Application #5: Pollution hotspots in cities

Photo by Egor Myznik on Unsplash

Cities globally are experiencing unprecedented growth, but this expansion comes at a steep environmental price as urban pollution continues to escalate. Emissions from various sources, coupled with urban development, contribute to the escalation of pollution in specific areas. These pollution hotspots demand urgent attention to mitigate their adverse effects. According to the mechanical engineering in society students, Sniffirdrone could address this environmental challenge by providing real-time data on pollution levels.

Anonymous student:
"This technology can be used to identify which regions of the cities have a big contribution in the overall pollution caused in the cities. It can identify those sources which have a big contribution to the worsening of air quality and authorities can then take targeted interventions to improve the air quality. These drones can be used to identify traffic congestions using aerial mapping, which can help authorities in optimizing the traffic flow, thereby reducing emissions."

Anonymous student:
"The Sniffirdrone, along with its modern technology and sensors, could measure the air pollution and odor in an area of land and provide valuable mapping data. Additionally, samples could provide valuable insights of the soil health. This data could be used in both "troubleshooting" means to find out the

cause of air pollution and odor and thus benefit the progress of taking action for such sources of pollution. In some parts of the world, big polluters, such as companies owning factories, might not really care for the consequences of air pollution and conflict-situations might be hard. The Sniffirdrone could easily provide science-based proof of air pollution and make it easier to understand what kind of effect this pollution has for the biodiversity of the land."

Anonymous student:
"Standards and guidelines are only powerful tools if they can be enforced. The Sniffirdone could be used as the new default tool to monitor that the environment pollution values match the safe values. There could be regular automated checkups of certain areas and communities to ensure there are no hazards for humans or animals caused by human pollution."

Anonymous student:
"The Sniffirdrone technology could be applied to monitoring the air quality and pollution levels around industry plants that are located close to cities or neighbourhoods. This would contribute to UN goal 11 – Sustainable cities and communities. This goal talks a lot about the challenges of rapid urbanisation and air pollution in cities. Sniffirdrone could help to analyse how much and what type of compounds are spread, and because it can give the data instantly, it would be quicker to respond to the situation by correcting the polluting processes."

Otto Siltanen:
"Data from a fleet of drones can be shown as public service announcements to warn people if pollution levels are high enough to cause health issues. This would help people avoid certain parts of heavily polluted cities. It can be used also on a larger scale, to see how pollution travels due to wind from heavy emitters such as industrial city districts."

Anonymous student:
"Conducting (relatively) high resolution emissions measuring on a large geographic scale is very labour intensive with traditional methods, and the drone-based solution would be a major game changer."

Anonymous student:
"The data from these drones can be used by municipal authorities to help design green spaces and layouts for areas where the pollution level is high. This would help in improving the air quality."

Anonymous student:
"The Sniffirdrone could be used to map out the safe and unsafe areas around industrial plants where people should or should not be moving in. Using the Sniffirdrone we can obtain accurate data on how the industrial plant output moves in the air and if any current residents in the area are in danger of the pollutants. Roads and walking routes around these areas could be mapped and see if there are areas of critical pollution."

Application #6: Traffic systems and hotspots

Photo by Jared Murray on Unsplash

Just like the pollution hotspots discussed in the previous section, the expansion of urban areas also exacerbates transportation problems such as traffic congestion and focal areas that urgently require attention. Effectively addressing these issues necessitates innovative solutions. The Mechanical Engineering in Society students envision a positive impact through the implementation of aerial monitoring for traffic systems.

Anonymous student:
"Sniffirdrone can be equipped with traffic monitoring technology, this will enable them to overcome the limitations of conventional traffic data collection methods. They can cover larger areas, provide real time data and produce a complete analysis of the traffic conditions at any given moment. EV companies can then use this information and relay them to control system engineers The engineers can then attempt to develop adaptive routing and speed control algorithms, which results in better energy management and reduce congestion-related emissions, this can transform urban transportation into a more sustainable and cleaner future."

Anonymous student:
"With the drone based aerial mapping it's possible to observe emissions that vehicles produce. It is possible to find the areas where the polluting is the biggest problem. Actions can be primarily targeted at these areas."

Anonymous student:
"A similar solution could be used to monitor the emissions from vehicle traffic. Identifying areas where emission levels are higher than average suggests that traffic in those areas is inefficient. For example, suboptimal intersection design causing lots of hard braking, idling, and acceleration. The emissions data would point to areas where infrastructure improvements could be in order. Such areas could be hard to detect with traditional methods, as they might not be apparent from visual surveys."

Considering stakeholders

Identifying a broad range of stakeholders in the innovation process is crucial as they can contribute significantly to successful innovation initiatives. Stakeholders bring varied expertise, experiences, and viewpoints to the innovation table. Involving a broad range of stakeholders, including customers, employees, suppliers, investors, policymakers, and community members, ensures a comprehensive understanding of different needs, challenges, and opportunities. This diversity fosters a rich pool of ideas, encourages creative thinking, and enhances problem-solving by considering multiple perspectives. Beyond realising the solution, relationships with local communities and end users help foster acceptance and adoption of innovative products and services.

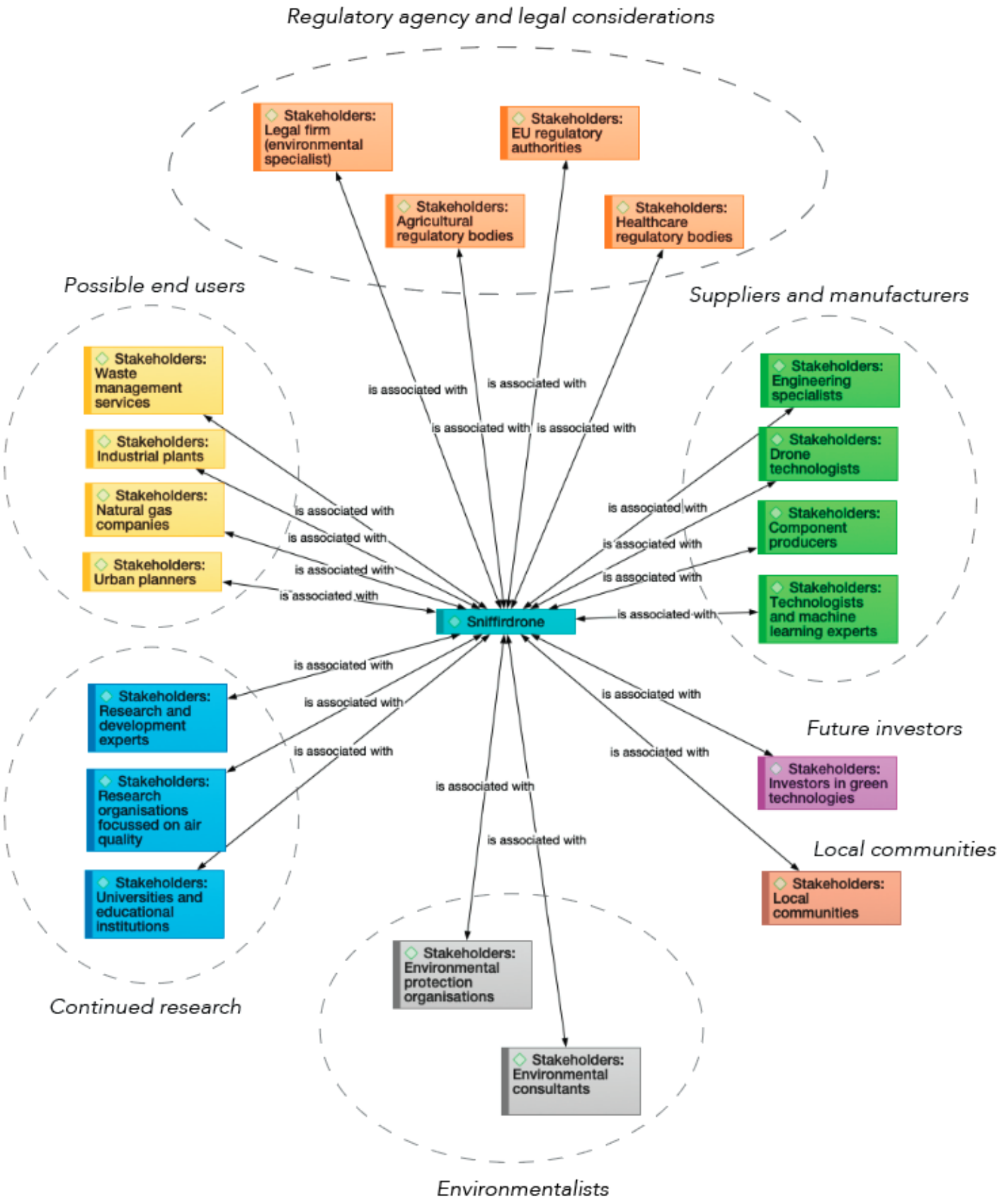
Involving stakeholders throughout the innovation process cultivates a sense of ownership and fosters a supportive environment for change. When stakeholders feel heard and valued, they are more likely to embrace and advocate for the innovation, facilitating smoother implementation and adoption. This buy-in is crucial for the successful integration of innovations into existing systems or markets.

Considering a wide array of stakeholders helps to identify potential risks and barriers early in the innovation process. By understanding various stakeholder concerns and constraints, organisations can proactively address potential challenges, leading to more informed decision-making and risk mitigation strategies. This approach ultimately leads to more robust and sustainable innovations that cater to the diverse needs of stakeholders and society at large.

With this in mind, the students were tasked to map the stakeholders they connected to Sniffirdrone. The full list of their identified stakeholders, and a collated visualisation of the most frequently mentioned stakeholders are included here. The most frequently mapped stakeholder by students included:

- Regulatory agencies and organization that provide legal advice.
- Suppliers and manufactures.
- Possible end used and clients.
- Local communities.
- Organizations that can support ongoing research.
- Environmental support and consulting organizations.
- Future investors.

Most frequently mapped stakeholders



Full stakeholder list

Drone technologists	12
Environmental protection organisations	12
Technologists and machine learning experts	10
Waste management services	10
EU regulatory authorities	9
Research organisations focussed on air quality	9
Industrial plants	8
Local communities	8
Universities and educational institutions	8
Environmental consultants	7
Natural gas companies	7
Urban planners	7
Agricultural regulatory bodies	6
Healthcare regulatory bodies	6
Legal firm (environmental specialist)	6
Research and development experts	6
Component producers	5
Engineering specialists	5
Investors in green technologies	5
Exisiting solutions (Sniffer Robotics)	4
Healthcare providers	4
Media outlets	4
Sensor manufacturers	4
Wastewater treatment plants	4
Biomass enegry producers	3
Environmental disaster management teams	3
Funding authorities	3
GIS specialists	3
Insurance companies	3
Large scale agriculturists and farms	3
Aerospace organisation	2
Data analytics and specialists	2
Energy producers	2
Public awareness groups	2
Real-estate developers	2
Renewable energy providers	2
Traffic management services	2
Wildlife conservation groups	2
Aviation regulators and airports	1
Civil aviation authorities	1
Construction sites	1
Cybersecurity specialists	1
Environmental activist and advocacy groups	1
Governmental regulatory bodies	1
Healthcare consultants	1
Meteorologists	1
Mobile application developers	1
Satellite technologists	1
Smart city planners	1
Worker's unions	1