Protecting the EuROpean terrItory from organised enVironmentAl crime through inteLLigent threat detectiON tools

D2.1 - Co-creation of use case scenarios, specification of user and security requirements

WP2 - Intelligence picture & PERIVALLON requirements and specifications

Project ref.	PERIVALLON HE - 101073952
Deliverable version date	08/09/2023
Deliverable version nr.	1.1
Lead Partner Organisation	KEMEA
Dissemination Level	SEN – Sensitive

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency (REA). Neither the European Union nor the granting authority can be held responsible for them.

Document Information

D2.1 Co-creation of use case scenarios, specification of user and security requirements			
Deliverable number:	D2.1		
Version:	1.1		
Contractual delivery date:	31/08/2023		
Type*:	R – Document, Report	Dissemination Level**:	SEN-Sensitive
Contributing WP:	WP2		
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*Type. R – Document, report; DMP – Data Management Plan; OTHER; DEM – Demonstrator, pilot, prototype; ETHICS

**Dissemination Level. PU – Public, fully open, e.g., web (Deliverables flagged as public will be automatically published in CORDIS project's page); SEN - Sensitive (limited under the conditions of the Grant Agreement); Classified R-UE/EU-R – EU RESTRICTED under the Commission Decision No2015/444.

Document History

Version	Issue Date	Author(s)	Content and changes
0.1	22/05/2023	Vagia Pelekanou Efstathios Skarlatos	Design of ToC
0.2	06/06/2023	Vagia Pelekanou	Comments consolidation regarding the table of contents
0.3	06/07/2023	Vagia Pelekanou	Comments consolidation regarding the table of contents
0.4	20/07/2023	Vagia Pelekanou Efstathios Skarlatos Zeta Aggariti	Integration of inputs provided by the partners of the project
0.5	21/07/2023	Efstathios Skarlatos Vagia Pelekanou	Ready for review
0.51	03/08/2023	Vagia Pelekanou Efstathios Skarlatos Zeta Aggariti	Consolidation of comments received from UNIVIE
0.52	03/08/2023	Vagia Pelekanou Efstathios Skarlatos Zeta Aggariti	Consolidation of comments received from POLIMI
0.53	04/08/2023	Vagia Pelekanou Efstathios Skarlatos Zeta Aggariti	Consolidation of comments received from CERTH
0.54	04/08/2023	Vagia Pelekanou Efstathios Skarlatos Zeta Aggariti	Consolidation of comments received from ETRA
0.6	05/08/2023	Vagia Pelekanou Efstathios Skarlatos Zeta Aggariti	Preparation of second iteration of review
0.7	25/08/2023	Vagia Pelekanou Efstathios Skarlatos Zeta Aggariti	Comments' consolidation from quality review
1.0	28/08/2023	Vagia Pelekanou Efstathios Skarlatos Zeta Aggariti	Comments' consolidation
1.1	08/09/2023	Vagia Pelekanou Efstathios Skarlatos Zeta Aggariti	Final version

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PERIVALLON

PERIVALLON aims to provide an improved and comprehensive intelligence picture of organised environmental crime and develop effective and efficient tools and solutions for detecting and preventing such types of criminal activities and for assessing their environmental impact based on geospatial intelligence, remote sensing, scanning, online monitoring, analysis, correlation, risk assessment, and predictive analytics technologies, by leveraging the latest advancements in Artificial Intelligence (AI) in the fields of computer vision and multimodal analytics. As a result, enhanced investigation processes and methodologies will be derived through the capabilities provided by the developed tools and solutions, and the insights obtained though the proposed Environmental Crime Observatory.

The capacity of end-users (including Police Authorities and Border Guards) will also be improved and will enable them to tackle such criminal activities in an effective manner based on advanced tools and solutions and also on the innovative training curricula developed using physical and/or digital twins of relevant environmental crime scenarios. Moreover, improved international cooperation will be facilitated through improved data sharing enabled by blockchain technologies, while improved regulation shaping and tuning will be supported through relevant policy recommendations.

PERIVALLON will be validated in field tests and demonstrations in four operational use cases. Extensive training, hands-on experience, joint exercises, and training material will boost the uptake of PERIVALLON tools and technologies. With a Consortium 5 Police and Border Guard Authorities, 3 authorities related to environmental protection, 6 Research/Academic institutions, 8 industry partners (including seven SMEs), one EU Agency, and one Foundation, PERIVALLON delivers a strong representation of the challenges, requirements and tools to meet its objectives.

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Executive summary

The scope of the deliverable D2.1 is to present the methodological approach followed for the development of the Pilot Use Case (PUC) scenarios and the definition of the requirements for the PERIVALLON project. For the development of the Pilot Use Cases, the methodological approach starts with the description of the use cases, the steps followed for the identification of the scenarios and the review of the draft versions implemented. Furthermore, part of the deliverable is the definition of the requirements provided by the end-users of the project. For the definition of the end user requirements, the methodological approach is presented as well as their division into functional, non-functionals and security requirements. The methodological approach for the identification of the user requirements involves using the PUCs scenarios, which provide the context and the detailed understanding of how the end-users will interact with the system.

The four Pilot Use Cases that will be carried out in the project, focused on the organised environmental crime. More specific, the following use cases will be presented in the deliverable:

- PILOT USE CASE 1: Illegal waste disposal detection
- PILOT USE CASE 2: Intentional dumping of polluting substances in land and water
- PILOT USE CASE 3: Transnational illegal trafficking of waste electronic and electrical equipment
- PILOT USE CASE 4: Illegal trade in ozone-depleting substances & HFCs

The project's end-users and technical partners engaged in several iterative sessions to ensure that the requirements extracted for the use case scenarios will be carefully considered by the technical team. This alignment is crucial to develop solutions that are in line with the project objectives.

This document serves as the foundation for the other work packages (WP2, WP3, WP4, WP5, WP6) within the PERIVALLON project, encompassing system development through to demonstrations.

Acronyms

Acronym	Full name
AIS	Automatic Identification System
AOI	Area Of Interest
API	Application Programming Interface
ARPA	Agenzia Regionale Per La Protezione Dell'ambiente Della Lombardia
BCPs	Designated Border Control Posts
CFSP	Common Foreign and Security Policy
CSDP	Common Security and Defence Policy
DWG	De Water Group
EO	Earth Observation
ETRA	Etra Investigación Y Desarrollo S.A.
EWC-Stat	European Waste Classification for Statistics
GIS	Geographic Information System
HP	Hellenic Police
HFC	Hydrofluorocarbon
IED	Industrial Emissions Directive
IGP	General Police Inspectorate of Ministry of Internal Affairs of Republic of Moldavia
IoT	Interest Of Things
IT-CC	Carabinieri Corps
LEA	Law Enforcement Agency
MOEE	Hellenic Ministry of Environment and Energy
NFC	National Forensic Centre
PUC	Pilot Use Case
PUCs	Pilot Use Cases
PUC1	Illegal Waste Disposal Detection
PUC2	Intentional Dumping of Polluting Substances In Land And Water
PUC3	Transnational Illegal Trafficking of Waste Electronic and Electrical Equipment
PUC4	Illegal Trade in Ozone-Depleting Substances & Hfcs
RBP	General Inspectorate of Romanian Border Police
SATCEN	European Union Satellite Centre

SPA	Swedish Police Authority
T	Tasks
ToC	Table Of Content
UAVs	Unmanned Aerial Vehicle
UCs	Use Cases
VMM	Flanders Environmental Agency
VOIs	Vehicles Of Interest
WP	Work Package
WSP	Water Safety Port

1. Introduction

1.1. Purpose of the document

The purpose of the document is to present the four Pilots Use Cases (PUCs) of the project, and to specify the user and security requirements, based on these PUCs definition. The ultimate goal is to deliver the specific properties and qualities of the PERIVALLON solution for achieving a successful inter- relationship between the users' needs and the objectives of the projects. Moreover, a strong emphasis on interviews was employed to foster close collaboration with end-users. Organised meetings were conducted, facilitating the exchange of experiences with relevant authorities and LEAs from various countries.

1.2. Scope of the document

The scope of this document is defined to foster collaboration with the stakeholders of the project to conceptualize usage scenarios and formulate precise user requirements, as they were carried out within T2.2 and T2.3 of the project. Based on them, the developed platform shall facilitate a systematic approach for the effective and efficient detection, identification, and prevention of various manifestations of environmental crime. This will be achieved through the comprehensive analysis and correlation of multimodal information, garnered from a diversified array of sources including heterogeneous sensors, autonomous systems, and digitally accessible information repositories.

This deliverable is poised to make a significant and multifaceted contribution to various project's tasks by astutely defining the users' requirements and ensuring their precise alignment with the technologies to be deployed in PERIVALLON. The findings encompassed within this deliverable will act as invaluable input for the upcoming pilot initiatives. More specifically, D2.1 is intimately connected to various Tasks (T) encompassed within Work Packages (WP) WP2, WP3, WP5, WP6, and WP7. The interrelation and connection of these tasks are systematically detailed and displayed within Table 1, exemplifying how they are intricately linked to one another, thereby outlining the cohesive framework guiding this project.

Table 1: Relation to other WPs

Tasks	How they interact
T2.1	For the co-creation of the PUCs scenarios, the existing intelligence picture is considered.
T2.4	The definition of the PUCs will help to identify the legal and ethical requirements.
T2.5	The requirements specified will provide a backdrop for the interaction among the software components.
T3.1	The requirements provided will assist the design and development of AI-based geospatial intelligence solutions.
T3.2	The requirements provided will assist the design and development of high-performance machine and deep learning models through detection through UAVs.

T3.3	The requirements provided will assist the development of an optimised framework.
T3.4	The requirements provided will assist the design and development of services for autonomous missions for a swarm of drones.
T3.5	The requirements provided will assist the design and development of X-ray scanning based on deep learning methods.
T4.1	The requirements provided will assist the development of methods to discover and monitor of online marketplaces.
T4.2	The requirements provided will assist the collection & monitoring of relevant open data from different sources.
T4.3	The requirements provided will assist the design and development of multilingual analysis of all collected information.
T4.4	The requirements provided will assist the design and development of multimedia content to detect and recognise objects of interest.
T4.5	The requirements provided will assist the design and development of models for maritime route prediction.
T5.1	The requirements provided will assist the development of a multimodal data fusion module.
T5.2	The requirements provided will assist the development of AI methods and tools.
T5.3	The requirements provided will assist the development of the environmental crime monitoring centre.
T5.4	The requirements provided will assist the development of data model for secure data management and audit trail for digital evidence.
T5.5	The requirements provided will assist the development and design of blockchain system.
T5.6	The requirements provided will assist the delivers of the prototypes and the final version of the PERIVALLON platform by integrating the components developed in WP3-WP5.
T6.1	The use cases that were defined in this deliverable will provide input for the pilot tests.
T7.3	Engagement of external experts. For the co-creation of some of the PUCs (PUC2B, PUC3) they provide some inputs to the PUC leaders.

1.3. Structure of the document

The document is organised as follows:

- Section 1 - This section gives a brief introduction of the document, presents the purpose and the scope of the report and a brief description of the section that will follow. Finally follows a relation of D2.1 with other project work.
- Section 2– This section describes the methodology followed for the development of the Use Cases of the PERIVALLON project followed to address and prioritize the user requirements.
- Section 3– This section presents and analyses the methodology followed for the development of the pilot use cases. More specifically, it presents the scenarios for PUC1: Illegal waste disposal detection, PUC2: Intentional dumping of polluting substances in land and water, PUC3: Transnational illegal trafficking of waste electronic and electrical equipment, PUC4: Illegal trade in ozone-depleting substances & HFCs.
- Section 4 – This section discusses the methodology used for addressing user requirements. The first chapter presents the end-users of the project and defines some of their characteristics. The next chapter gathers the requirements addressed by the end-users. Finally, the MoSCoW prioritisation technique of end-users' requirements is presented.
- Section 5 – This section presents the end-user requirements (functional, non-functional and security) and their taxonomy based on the MoSCoW methodology. Also, the mapping between the requirements with the PUCs is presented.
- Section 6 – Finally, the last section summarises what has been said in the previous chapters and proposes some future work and recommendations.

2. Pilot Use Case Methodology

2.1. Introduction to Pilot Use Cases

This section describes the methodology followed for the development of the Pilot Use Cases of the PERIVALLON project. The methodological approach starts with the four main UCs and goes towards the respective scenarios. During this period interactions took place with the partners (end-users, technical) of the project and can be found in Annex A Interactions with the partners.

Each step followed is presented briefly below:

- **Step 1: Description of the PUCs**

  This is something that should be done in the beginning of the project. In order to get a better understanding of the PUCs, during the kick-off meeting of the PERIVALLON project, the four PUCs were presented to the consortium. These PUCs form the basis for the extraction of the user requirements (Task 2.3) and the evaluation of the PERIVALLON technologies (WP6). During the meeting, the knowledge and the ideas shared with the consortium formed the starting point for the identification of the PUCs scenarios.

- **Step 2: Identification of the PUCs scenarios**

  To identify the PUCs scenarios, it is essential to take into consideration the end-user and the stakeholders. This step includes: description and conditions of the PUCs scenarios. In the following Section 2.2 is presented in a more analytic way the template used for the presentation of the PUCs.

  The descriptive part includes three paragraphs: the description, the trigger and the workflow paragraph. Firstly, the description paragraph includes an analysis of what is happening in the scenario. Consequently, the trigger paragraph event describes what event initiates the scenario. Lastly, the workflow paragraph presents the steps followed for the execution of the scenario including the actors involved, their task and the components that will be tested for each scenario.

  The output of this step is the creation of a first version of the scenario, which is followed by a Use Case table. The Use Case table is used to represent the dynamic behaviour of a system and to illustrate the flow of the storyline and the different ways the actors may interact with the components.

  The conditions' part includes the pre and post conditions. The pre-condition paragraph describes all the necessary conditions that should be fulfilled before the scenario starts. The post-condition paragraph describes the outcome of an action and will be true when the scenario is completed.

- **Step 3: Review the PUCs scenarios**

  In this step, the consortium of the PERIVALLON project conducts internal reviews of the published versions of the PUCs scenarios. This step is crucial for the creation of a high-level description of the PUCs scenarios.

In conclusion, for the PUCs scenarios it is important to mention that they are dynamic and some of their parts can be defined in other WPs (WP3, WP4, WP5, WP6).

The development of scenarios and requirements for the project was achieved through multiple iterations involving extensive engagement with both end-users and technical partners. Through a series of interviews, invaluable insights were gathered from end-users, enabling a comprehensive understanding of their specific needs and expectations. Furthermore, interviews with technical partners provided in-

depth knowledge of the technologies that would be utilised in the PERIVALLON project. These iterative sessions were conducted synchronously and asynchronously, ensuring maximum participation and collaboration. The process was further bolstered by several workshops held during the kick-off meeting and the plenary meeting, fostering fruitful discussions and refining the project's direction. This collaborative approach has laid a solid foundation for the project's success, ensuring that the solutions developed are closely aligned with the requirements and objectives of all stakeholders involved.

Figure 1. Workshop during PERIVALLON Plenary meeting

Figure 2. Workshop during PERIVALLON Kick-Off meeting

2.2. Pilot Use Case Template

The design of a template is necessary for a common approach outlining the detailed description of the PUCs scenarios. In the context of the PERIVALLON project, the consortium has opted to embrace a standardised template for the comprehensive elaboration of PUCs scenarios, as illustrated in Table 2. Moreover, this approach incorporates several guidelines from the standard template of PUCs. This template encompasses various crucial elements, including the use case leader, contributing partners, detailed description, involved actors, triggering event, pre-condition, relevant datasets, AI and analytical tools employed, and dataset format and pre-condition specifications. Notably, this specific template includes detailed steps that meticulously outline the actions to be taken during the scenario's implementation. This structured and standardised approach ensures clarity, consistency, and effective collaboration throughout the project. The following Table 2, presents the template for the PUCs.

Table 2: Template for PUCs

Use case leader	The partner assigned the ultimate responsibility of completing the use case.
Main contributing partners	Indicate all partners that should be involved in the implementation of the PUC.
Description	Please write down what is happening in this pilot use case (e.g. water has been contaminated, recognised by regular check-up by regional authority, there are information which suggest it has been made by a criminal network).
Actors	Please write down which actors are involved in the Use Case Scenario and what are their tasks (e.g. citizen, LEA first line officer, investigator, external expert, prosecutor...).
Triggering event	Please describe what triggers the PUC.
Pre-condition	Please describe of the necessary conditions that should be true in order the PUC execution to begin.
Relevant Datasets	Please write down which data/datasets/databases do you use for evidence making and/or internal datasets for cross checking.
AI and Analytical tools used	Please write down which AI / analytical tools are being used.
Sequence of steps for Forensics Investigation	
Step	**Step Description**
Step_1: Identification of the potentially critical sites	Please identify the crime.

Step_2: Incident Assessment and Prioritisation	Please define the incident and classify it based on a level of prioritisation.
Step_3: Incident Verification	Please verify if the incident exists.
Step_4: Confirmation and alert generation	Please provide the information and then raise awareness.
Step_5: Site inspection	Please write the set of the regular activities to check and verify the crime.
Step_6: Geospatial data synchronisation and acquisition	Please provide the methods.
Step_7: Environmental Crime Report with Blockchain Integration	Please report the crime.
Post - condition	Description of the status after the use case has completed.

3. Pilot Use Cases of PERIVALLON

3.1. PUC1: Illegal waste disposal detection

3.1.1. Motivation

The challenges surrounding waste disposal are numerous, complex, and evolving. Addressing these challenges is an immediate priority, given the environmental, economic, and societal implications. Here we elaborate on various facets of this pressing issue.

The projection that global waste generation will reach 3.4 billion tons by 2050 is alarming [10.].This astronomical number indicates that we are on a trajectory that could severely strain our planet's resources and capacity to handle waste effectively. Even with current advancements in waste management techniques, the predicted volume of waste surpasses our existing capabilities and necessitates urgent action.

In Europe, waste generation amounted to 5.2 tonnes per inhabitant in 2018, with a disturbing 38.5% of it ending up in landfills [7.] . This practice is highly inefficient and environmentally harmful, contributing to soil degradation, water pollution, and greenhouse gas emissions. Furthermore, the high dependency on landfills indicates a lack of progress in more sustainable waste management options like recycling, reuse, or waste-to-energy conversion.

Interpol and the UN Environment have shed light on the economic aspects of environmental crime. Ranking as the fourth most lucrative illegal business globally, this sector has an estimated annual turnover of $258 billion [23.] . This statistic is alarming because it implies that these activities, despite their illegal nature, are increasingly attractive due to the high profits involved. This economic lure complicates efforts to address waste management from a purely regulatory standpoint, requiring more sophisticated, multi-faceted solutions.

The situation in Italy, highlighted by the "Ecomafia 2020" report, demonstrates the rapid escalation of the problem. Environmental crimes in Italy surged by 23.1% in 2019 compared to 2018, totalling 34,648 incidents. The ecomafia business in Italy alone was worth an estimated €19.1 billion in 2019. These figures suggest a deeply entrenched and growing problem that combines environmental degradation with organised criminal activity.

Lombardy, one of Italy's wealthiest regions, presents a case study in how bad the situation can get even in economically advanced areas [1.]. Between 2017 and 2019, the region experienced 56 instances where illegal waste deposits were intentionally set on fire to destroy evidence of illegal activities. Furthermore, abandoned industrial sites have been converted into illegal waste dumps[1.]. To reclaim just 16 of these sites, the region had to spend a staggering €25.9 million, indicating the massive economic burden that illegal waste activities place on governmental bodies[1.].

It’s important to note that this isn’t a problem isolated to Italy; similar trends in illegal waste disposal have been observed in other EU countries like Greece and Sweden [2.]. The pan-European nature of this issue calls for a coordinated, EU-wide strategy that includes stricter regulations, enhanced enforcement, and public awareness campaigns.

Waste disposal's multifaceted challenges have severe implications for environmental sustainability, economic stability, and social equality. The alarming increase in the scale of waste generation, the inefficiency of waste management systems, and the profitability of environmental crimes combine to create a complex, urgent problem requiring immediate, multi-layered solutions.

3.1.2. Scenario

The process will begin with the acquisition of high-resolution satellite images and aerial photographs of the region, which will be imported into the geospatial intelligence platform.

The platform will then automatically identify potential waste disposal sites, which will result in a first prioritisation list of such sites. Criminal networks are exploiting the high costs associated with legal waste management and are making substantial profits from illegal waste disposal activities (Martini, 2012). The criteria suggestion for the sites' prioritisation will be determined by the platform, using also auxiliary information. Furthermore, the detection of illegal landfills and the characterisation of environmental risk can benefit from a multi-temporal analysis of a collection of images acquired at different times at sites to be monitored.

What is more, the geospatial analyst will access through the platform the list of suspicious waste disposal sites resulted from the application of the machine learning algorithms. The geospatial analysts will validate the rankings and verify the existence of a waste disposal site at those locations using satellite imagery (e.g. World View 3, Google Earth, Aerial Orthomaps, Copernicus imagery), and other auxiliary information where available (e.g., GIS information, land use maps). If the waste disposal site is confirmed, the platform generates an alert and signals this to the competent authorities, who are responsible for investigating the site and enforcing environmental regulations.

The competent authorities then carry out an on-site inspection and collect data using UAVs and mounted cameras. Due to the large extent of the area, UAV-based surveillance swarming (which will feature advanced methods for the cooperative navigation of a swarm of homogeneous drones in combined operations for environmental monitoring and assessment using UAV-onboard sensors) may be utilised. The collected data will be displayed in the monitoring platform.

Moreover, utilizing the acquired imagery and depth data gathered from the UAVs, a 3D model of the scanned region of interest will be produced and presented, providing further insight of the criminal site and further information such as volume estimation, surface measurements and possibly recognition of specific targets.

Then, the data will be analysed and classified according to the predefined subset of EWC-Stat categories, resulting into a list of classified materials with the respective codes (as described in the European Waste Catalogue Code). Based on this, a report will be created from the monitoring platform that presents a short description of the waste disposal site, an overview of the materials found, while highlighting the presence of potentially illegal materials. For the visualisation of the results, the PERIVALLON platform will be used, as well as the visual analytics dashboard and Environmental crime monitoring centre where needed. The report and the data generated will be stored and shared with other relevant authorities by means of secure information sharing and evidence exchange.

The authorities will use the report to act against the violators, for instance by conducting investigations and eventually issuing fines or pursuing legal action. A similar strategy will be pursued for monitoring authorised disposal sites with a focus on detecting unauthorised materials and quantities.

The template for PUC1, is presented in Table 3.

Table 3: Template for PUC1

Use case leader	ARPA
Main contributing partners	IT-CC, MOEE, HP, SPA, POLIMI, KEMEA, DRAXIS, RBP, CERTH, ETRA, CENTRIC
Description	Waste disposal is one of the greatest environmental challenges. The main challenge is to detect and identify the exact location of illegal waste disposal sites.
Actors	Geospatial Analyst/Platform User Responsible Authorities On-site UAV inspector
Triggering event	Periodical Check of illegal landfills.
Pre-condition	Satellite images of the region of interest are available, authorised drone flights
Relevant Datasets	Satellite imagery UAV imagery Waste disposal sites (subset) EWC-Stat categories for investigation (predefined subset)
AI and Analytical tools used	Geospatial intelligence detection tool suite – waste and land pollutants, vessel detection, tracking UAV visual detection for waste and land pollutants module Optimised 3D terrain module Maximised surveillance swarm optimisation module Multimodal fusion module Risk assessment for decision support module Environmental crime monitoring centre module Secure data management module Secure information sharing and evidence exchange based on blockchain technologies module Visual analytics dashboard
Sequence of steps for Forensics Investigation	

Step	Step Description
Step_1: Identification of the potentially critical sites	Acquisition of high-resolution satellite images and aerial photographs of the region, which will be imported into the geospatial intelligence platform. The platform will automatically identify potential waste disposal sites, which will result in a prioritised list of such sites, which will be further investigated.
Step_2: Incident Assessment and Prioritisation	The prioritised list of results will be assessed by the geospatial analyst with the help of a decision-support system.
Step_3: Incident Verification	Illegal waste disposal site verification.
Step_4: Confirmation and alert generation	After the confirmation of the presence and ranking of waste disposals site from the geospatial analyst, an alert will be generated from the platform and sent to the competent authority.
Step_5: Site inspection	The geospatial analyst together with competent authority will inspect the site to collect UAV images.
Step_6: Geospatial data synchronisation and acquisition	The collected imagery will be displayed in the monitoring platform. Moreover, utilizing the acquired imagery from the UAVs, a 3D model of the scanned region of interest will be produced and presented, providing further insight of the criminal site and further information such as volume estimation, surface measurements and possibly recognition of specific targets. The data will be analysed and classified according to the predefined subset of EWC-Stat categories, resulting into a list of classified materials with the respective codes (as described in the guide).
Step_7: Environmental Crime Report with Blockchain Integration	A report will be created from the monitoring platform, that presents a short description of the waste disposal site, an overview of the materials found, while highlighting the presence of potentially illegal materials. The report and the data generated will be stored and shared with other relevant authorities (i.e. LEAs, Ministries, Environmental Agencies, etc.) by means of secure information sharing and evidence exchange.
Post - condition	The authorities will use the report to act against the violators, for instance by issuing fines or pursuing legal action. A similar strategy will be pursued for monitoring authorised disposal sites with a focus on detecting unauthorised materials and quantities.

Table 4: Properties for PUC1

Actors	Italy	Greece	Sweden	Romania (Constanta)
Geospatial Analyst	ARPA	HP	SPA[1]	HP / KEMEA
Responsible Authorities	IT-CC	MOEE	SPA	RBP[2]
On-site UAV Inspector	ARPA	HP / KEMEA	SPA	RBP

Since the proposal preparation phase, Romanian Border Police (RBP) has registered an increased activity on illegal waste disposal sites, more particularly in Constanța. The experience gained through the monitoring, detection and investigation of these criminal activities have led to a re-evaluation of their participation in PERIVALLON Pilot Use Cases (PUCs).

While RBP participation was more predominantly foreseen in "*PUC4: Illegal trade in ozone-depleting substances*" (GA, PartB, pages 18-19-20-21), it was decided within the Consortium to take a more active role under "*PUC1: Illegal waste disposal detection*", at a dedicated Romania use case based on the country's specific needs, particularly in combating environmental crime. Romania faces distinct challenges when it comes to tackling environmental offenses, and addressing these issues requires innovative approaches. By testing a geospatial intelligence tool and utilizing remote sensing technologies, the consortium aims to empower the Romania Police with advanced tools to confront environmental crime effectively. Specifically, as part of this PUC, RBP plan is to:

- exploit real waste disposal cases to collect 2D & 3D drone imagery data to be processed and shared with the rest of the consortium; and
- organize a test scenario in the jurisdiction of the Romanian Coast Guard, in Constanța. Given the modus operandi of persons involved in illegal waste disposal by methods such as burning, burying, dumping, it is considered necessary to monitor risk areas susceptible to these types of crimes.

3.2. PUC2: Intentional dumping of polluting substances in land and water

3.2.1. Land pollutants (Scenario A)

3.2.1.1. Motivation

The pervasive issue of asbestos—a hazardous material linked to lung cancer and other severe diseases—remains alarming in Europe. Despite regulations and warnings by entities like the EU, UN, and WHO [[5.],

[1] SPA is in ongoing discussions with other Swedish authorities (e.g. municipal authorities) that may contribute in the pilots (through SPA).
[2] The Romanian Pilot will be supported by the other members of the Consortium through their geospatial analysts.

[16.], [18.]], improper management and disposal of asbestos persist in various European countries, leading to significant health risks and societal costs. The illegal dumping of asbestos waste contaminates the land, exposing the public to this perilous substance.

The economic impact is equally grim. Mesothelioma deaths in just 15 European countries result in societal costs exceeding €1.5 billion annually [18.]. This financial burden manifests in healthcare costs, loss of productivity, and legal proceedings, among other factors.

While most EU Member States have banned all forms of asbestos, there is an alarming inconsistency in its regulation and use across the European region [18.]. Fifteen countries still employ asbestos in building materials, and some continue to produce and export it, defying international safety guidelines [18.].

Even in countries where asbestos use has been abandoned, its legacy is long-lasting [15.]. Asbestos does not decompose naturally, meaning it remains a latent threat unless properly removed and disposed of [15.].

The estimate of 47,000 annual asbestos-related deaths in Europe alone underlines the gravity and scale of this issue [15.]. It signals an urgent need for immediate and effective intervention to mitigate both health risks and economic burdens [15.].

The pervasive presence of asbestos, despite its known health risks, is an alarming issue that requires immediate, coordinated action [15.]. Its continued use in some European countries, coupled with its enduring presence even where banned, adds layers of complexity to an already dire situation [15.]. The high human and economic costs necessitate a comprehensive, EU-wide strategy for its safe removal and disposal [15.].

3.2.1.2. Scenario

This scenario is a special case of PUC1 (land), with the focus of detection of potential sites with asbestos waste. The illegally dumped asbestos waste is disposed in the normal rubbish collection by organised crime networks. By burying the asbestos, the land will be considered contaminated and exposes the public and the environment to hazardous waste.

It is necessary to accurately select the images to be used, particularly for close-range detection, which might require different detection approach and/or sensing apparatus in addition to those described in PUC1. For example, hyper/multispectral imaging sensors might be leveraged. Particularly, the automatic detection tools on drone flights might also differ, as shapes of wastes might be more relevant to detect rather than specific targets.

Given that this scenario is a specialised instance derived from PUC1, but focusing on the monitoring of illegal dumping of asbestos, we will essentially adhere to the core sequence of PUC1 as a starting point. However, it is essential to acknowledge that significant adaptations will be implemented to address the unique challenges presented by asbestos, which is a hazardous material. The sequence of steps and methodologies of PUC1 will be modified and customised specifically to tackle the complexities associated with detecting and combating the illicit disposal of asbestos. This tailored approach will enable us to effectively deploy the appropriate technologies and strategies, ensuring that our efforts are optimised for detecting and mitigating the environmental risks posed by the illegal dumping of asbestos.

The template for PUC2, is presented in Table 5.

Table 5: Template for PUC2A

Use case leader	IT-CC
Main contributing partners	ARPA, POLIMI, CERTH, ETRA, CENTRIC
Description	Waste disposal is one of the greatest environmental challenges. The main challenge is to detect and identify the exact location of asbestos waste disposal sites.
Actors	Geospatial Analyst/Platform User Responsible Authorities On site UAV inspector
Triggering event	Periodical Check of waste disposal sites of asbestos materials
Pre-condition	Satellite images of the region of interest are available, authorised drone flights
Relevant Datasets	Satellite imagery UAV imagery Waste disposal sites (subset) EWC-Stat categories for investigation (predefined subset)
AI and Analytical tools used	Geospatial intelligence detection tool suite – waste and land pollutants, vessel detection, tracking UAV visual detection for waste and land pollutants module Optimised 3D terrain module Maximised surveillance swarm optimisation module Multimodal fusion module Risk assessment for decision support module AI-based pattern recognition and trend detection module Environmental crime monitoring centre module Secure data management module Secure information sharing and evidence exchange based on blockchain technologies module Visual analytics dashboard
Sequence of steps for Forensics Investigation	
Step	Step Description

Step_1: Identification of the potentially critical sites	Acquisition of high-resolution satellite images and aerial photographs of the region, which will be imported into the geospatial intelligence platform. The platform will automatically identify potential waste disposal sites, which will result in a prioritised list of such sites, which will be further investigated.
Step_2: Incident Assessment and Prioritisation	The prioritised list of results will be assessed by the geospatial analyst with the help of a decision-support system.
Step_3: Incident Verification	Asbestos waste disposal sites verification.
Step_4: Confirmation and alert generation	After the confirmation of the presence and ranking of waste disposals site from the geospatial analyst, an alert will be generated from the platform and sent to the responsible authority.
Step_5: Site inspection	The geospatial analyst together with responsible authority will inspect the site to collect drone images.
Step_6: Geospatial data synchronisation and acquisition	The collected imagery will be displayed in the monitoring platform. Moreover, utilising the acquired imagery from the UAVs, a 3D model of the scanned region of interest will be produced and presented, providing further insight of the criminal site and further information such as volume estimation, surface measurements and possibly recognition of specific targets. The data will be analysed and classified according to the predefined subset of EWC-Stat categories, resulting into a list of classified materials with the respective codes (as described in the guide).
Step_7: Environmental Crime Report with Blockchain Integration	A report will be created from the monitoring platform, that presents a short description of the waste disposal site of asbestos waste, an overview of the materials found, while highlighting the presence of potentially illegal materials. The report and the data generated will be stored and shared with other relevant authorities (i.e. LEAs, Ministries, Environmental Agencies, etc.) by means of secure information sharing and evidence exchange.
Post - condition	The authorities will use the report to act against the violators, for instance by issuing fines or pursuing legal action. A similar strategy will be pursued for monitoring authorised disposal sites with a focus on detecting unauthorised materials and quantities.

Table 6: Properties for PUC2A

Actors	Italy
Geospatial Analyst	ARPA
Responsible Authorities	IT-CC
On-site UAV Inspector	ARPA

3.2.2. Water pollutants

3.2.2.1. Motivation

Water resources, essential for life and economic activities, are under increasing threat in Europe due to pollution, industrial releases, and illegal activities that contaminate water bodies [5.] . Despite regulatory efforts, only around 40% of surface water bodies maintain good ecological and chemical status [5.]. Illegal dumping by organised crime networks further exacerbates the situation, demanding immediate and effective response [5.] .

In this context, the scenario portrays a vigilant approach where citizens, the Water Environmental Agency, and drinking water companies collaborate. Upon a citizen's report of suspicious water contamination, an immediate investigation is launched using cutting-edge tools, including satellite and UAV imagery, artificial intelligence-based analysis, and geospatial intelligence detection. These tools help in identifying pollution hotspots and assessing risks, leading to laboratory confirmation and legal action if needed.

The systematic approach, enabled by technology and coordinated effort, prioritizes incidents based on their severity and potential harm. It not only facilitates prompt intervention but also contributes to the continuous improvement in responsiveness against illegal dumping. This collaborative and technologically driven model serves as a robust mechanism to safeguard water quality, ensuring the well-being of communities and ecosystems.

3.2.2.2. Scenario

The water environmental agency receives from a citizen a report of a potential illegal dumping incident in an inland water body (e.g. river, lake) and/or coastal/estuary area (which after the investigation proved to be done by an organised crime network). The incident is reported, by a concerned citizen who noticed an unusual smell and/or colour in the water, which indicates a possible pollution event. If the incident occurs in the catchment area of one of its water treatment plants, the Water Environmental Agency informs the drinking water company that actions need to be taken to safeguard the intake to the drinking water production site. The water quality management team from the Water Environmental Agency promptly takes action to investigate the incident. Following a risk assessment provided by the platform, the drinking water company also collects extra information about the incident. The investigation is conducted using the most recent available satellite imagery and UAV imagery collect by a UAV operator if the first risk assessment indicates the necessity for this.

To enhance their response to the incident, the drinking water company uses the platform that utilises artificial intelligence-based tools to analyse at first level satellite data and UAV images of the inland water body (e.g. river, lake) and/or coastal/estuary area and its surrounding area. This platform utilises a geospatial intelligence detection tool of surface water pollutants to detect anomalies in the images and identify potential hotspots or zones requiring more intense monitoring. What is more, the platform utilises the secure data management and audit trail for digital evidence to match the historical data with the

ongoing incidents. Further, the platform exploits satellite imagery among other information sources, to perform a risk assessment and prioritise potential spots or zones requiring more intense monitoring. Additionally, the model could be retrained with the new data produced by the incident after it is completely confirmed. Depending on the incidence and its possible implications, the historic data can be used to define its importance (spread, contamination type, etc.) by assessing its risk automatically or upon request from the user. For the visualisation of the results, the PERIVALLON platform will be used, as well as the visual analytics dashboard and Environmental crime monitoring centre where needed.

The water quality management team from the water environmental agency collects water samples for laboratory analysis. The laboratory analysis confirms the presence of pollutants in the water, and a risk analysis is performed through the platform and the risk analysis tool, assigning a priority rank to the incident. A high priority ensures immediate and strict intervention or close monitoring as there are indications of criminal network that intentionally dumping oils into the inland water body (e.g. river, lake) and/or coastal/estuary area, whilst for an incident of low priority, it may be sufficient to monitor the contamination through the monitoring platform or ensure it is reported.

Based on the priority ranking and where needed, the water environmental agency notifies the relevant authorities (LEAs) for the incident. The authorities launch an investigation to identify the responsible party and take appropriate legal actions. They consider if there is a direct harm caused or if it is more likely to cause an effect in the future. The lessons learned from the incident and how it has been tackled are documented and used to improve the water environmental agency responsiveness for future potential incidents of illegal dumping or discharge. By implementing such an approach, the drinking water company can minimise the environmental impact and prevent future incidents of illegal dumping, thereby safeguarding the health and well-being of communities and ecosystems.

The template for PUC2B, is presented in Table 7.

Table 7: Template for PUC2B

Use case leader	DWG
Main contributing partners	ARPA, CERTH, CENTRIC, ETRA
Description	Illegal dumpings or discharges in the water. A report from a citizen (by telephone, mail or other means like e.g. social media) of a potential illegal dumping incident in an inland water body (e.g. river, lake) and/or coastal/estuary area is provided. If the incident occurs in the catchment area of one of its water treatment plants, the drinking water company is potentially impacted. Action is taken to investigate the incident. Based on a risk assessment provided by the platform, extra information is collected about the incident.
Actors	Citizen Geospatial analyst Responsible Authorities On-site UAV Inspector

Triggering event	Report on possible polluting substances in the water. This can be directly to the Water Environmental Agency, drinking water company or indirectly captured via social media. This is not predictable, so we need to make a protocol for intervention. For the drinking water company, it is very important that there is a fast and accurate response to the trigger.
Pre-condition	Satellite images of the region of interest are available, authorised drone flights.
Relevant Datasets	Report from citizen Social media Satellite imagery UAV imagery Historic data of incidents Waterinfo.be for risk assessment (discharges in the river at moment of incident will determine criticality of event) - API available
AI and Analytical tools	Geospatial intelligence detection tool suite – water pollutants UAV visual detection for water pollutants module Secure data management module Multimodal fusion and Risk assessment for decision support Environmental crime monitoring centre module Secure information sharing and evidence exchange based on blockchain technologies module Visual analytics dashboard
Sequence of steps for Forensics Investigation	
Step	**Step Description**
Step_1: Identification of the crime	Incident/notification reception from a citizen (notification to VMM or on social media) for an unusual smell and/or colour in an inland water body (e.g. river, lake) and/or coastal/estuary area in the catchment area of one of its water treatment plants.
Step_2: Incident Assessment and Prioritisation	An analysis will be performed by the geospatial intelligence detection tool suite – water pollutants and a first risk assessment is required. Decision Support System and the risk analysis tool, assigning a priority rank to the incident. A high priority ensures immediate and strict intervention or close monitoring, whilst for an incident of low priority, it may be sufficient to close the incident and make sure it is reported or monitor the contamination through the Environmental crime monitoring centre. Priority should be determined on the basis of

	context (e.g. type of suspected contamination), location (distance from a water protection area or intake point for drinking water production) and spread in space and time.
Step_3: Incident verification	Need to be checked if the notification is something relevant and if it is something that calls for a response. The report is verified according to its source and possible more explanation/information is collected to understand the incident reported to do a first impact assessment.
Step_4: Confirmation and alert generation	After the confirmation of the anomaly detection out of all potential datasets the platform performs a secondary risk assessment based on the possible contamination spread scenarios. Also, the identification of hotspots or zones requiring more intense monitoring will be presented in the Environmental crime monitoring centre.
Step_5: Site inspection	Execution of steps decided in step 4. This can compromise: A team of experts from DWG collects the samples and performs the laboratory analysis. The use of drones also needs to be considered. Online sensor follow-up (if available). First-aid mitigation (reaction on the site inspection).
Step_6: Geospatial data synchronisation and acquisition	The platform that utilises artificial intelligence-based tools continues to gather data to further support the follow-up.
Step_7: Environmental Crime Report with Blockchain Integration	Based on the priority ranking and where needed, the water quality management team notifies through the blockchain module the relevant authorities (i.e. LEAs, Ministries, etc.) for the incident.
Post-condition	Description of the status after the use case has been completed. Logging of status and follow up.

Table 8: Properties for PUC2B

Actors	Belgium
Geospatial Analyst	DWG
Responsible Authorities	VMM
On-site UAV Inspector	DWG

For the creation of the above Pilot Use Case, **external experts** were consulted**.** Specifically, the DWG has been in contact with Flanders Environmental Agency (VMM) all this period and provided a list with historical incidents. VMM expressed their interest to keep updated of the evolutions within this project and to engage in some activities that will take place. The particular area of interest has been tentatively

selected, being the catchment area of WPC De Blankaart, WPC Kluizen and WPG Gavers (northern France, western part of Belgium).

3.3. PUC3: Transnational illegal trafficking of waste electronic and electrical equipment

3.3.1. Motivation

The illegal trafficking of waste electronic and electrical equipment (WEEE) or e-waste is a serious environmental crime, threatening both public health and the environment. A recent operation by a European Law Enforcement Agency spotlighted this issue by intercepting a large shipment of e-waste bound for the Gulf of Guinea. Using sophisticated data analysis and satellite imagery, the agency successfully identified and disrupted a smuggling network. This operation not only led to the dismantling of the criminal network but also highlighted the urgent need for proper waste management and environmental regulations in the affected regions, emphasizing the importance of international efforts to combat such crimes.

3.3.2. Scenario

A European Law Enforcement Agency has received information that a large shipment of containers containing e-waste is about to depart from a European port and it is scheduled to be smuggled into a country in the Gulf of Guinea. The Agency has been tracking the activities of a criminal network operating from Europe that is involved in the illegal trafficking of e-waste and has identified several key players in the network (smugglers, companies and third parties), as well as potential cargo ship.

To prevent the e-waste from entering a certain country in the Gulf of Guinea and to being dump in landfills, as well as, to be sold in the black market, the Agency decides to launch a coordinated operation involving several Law Enforcement Agencies. This operation involves countries from the most probable destinations (Nigeria, Benin and Ghana) in the Gulf of Guinea, based on previous reports from authorities in relation to illegal transport of e-waste containers. The objective of the operation is to intercept the cargo ship containing e-waste shipment and apprehend the members of the criminal network responsible for the illegal trafficking.

To plan the operation, the Agency analyses and exploits a large dataset from AIS data (historical and current data). The exploitation of these datasets aims to identify the current picture of the situational awareness and the standard routes of suspicious cargo ships departing from the expected European Port and with destination to the Gulf of Guinea. Identification of suspicious vessels will support the prediction of the most probable smuggling route. Current and available information is statistically analysed using unsupervised learning models, such as anomaly detection network, running under the platform in order to produce a risk assessment output indicating the level of risk for the suspicious vessels.

During monitoring and analysis activities in relation to the vessels following the probable smuggling route previously identified by the platform, one cargo ship approaching the Gulf of Guinea stops transmitting the AIS signal, triggering an automated alert in the platform. For the visualisation of the results, the PERIVALLON platform will be used, as well as the visual analytics dashboard and Environmental crime monitoring centre where needed. The operator uses available tools in platform to foresee the most plausible position for the suspicious vessel matching a Sentinel 1 and/or Sentinel 2 satellite pass, as well as, potentially Very High-Resolution Imagery from Copernicus Contributing Missions. At the moment that a selected satellite image becomes available the platform is used to perform automated vessel detections on top of that satellite image (based in a pre-defined threshold for length and width). Detected vessels meeting the criteria established in the platform are highlighted in the platform and operator/imagery

analyst proceeds with manual verification. Operator/imagery analyst reaches the conclusion that one of the detected vessels has exactly the same length and width than the suspicious cargo vessel, which switched off the AIS transponder and there is a high probability of this cargo ship carrying illicit cargo, potentially including e-waste disguised as "used goods" or "second-hand electronics". Based on the aforementioned information, the monitoring team immediately notifies the local authorities and begins to coordinate with them the interception of the vessel in order to investigate her cargo.

Using the platform and based on the last verified position for the suspicious vessel (satellite image), the team manages to identify the potential port in Ghana where the cargo ship made its first stop and could have delivered some containers with e-waste, which would be, subsequently, transported to an illegal dumpsite or sold in the black market. Afterwards, the cargo ship went to the final destination in Nigeria. Thereafter, they work closely with local authorities to focus their efforts on targeted inspections of vessels arriving at ports in the destination country.

Over time, the team's efforts pay off, as they are able to intercept several shipments of illicit e-waste at different period and disrupt the smuggling networks operating in the region. By identifying key players and disrupting their operations, the team is able to make a significant impact on the illegal trade and improving maritime security in the region. The success of the operation leads to the dismantling of the criminal network involved in the illegal trafficking of e-waste in the region. Mainly operating from European ports and with destination to the Gulf of Guinea, where these electric and electronic waste components are used to provide valuable raw materials, to be sold in black markets, as well as, to finance terrorist groups. The operation also raises awareness of the dangers of e-waste dumping and highlights the need for proper waste management infrastructure and enforcement of environmental regulations in the Gulf of Guinea region.

The template for PUC3, is presented in Table 9.

Table 9: Template for PUC3 (merged A&B)

Use case leader	SATCEN
Contributing partners	POLIMI, MT, ETRA, CERTH
Description	Transnational illegal trafficking of waste electronic and electrical equipment.
Actors	European Law Enforcement Agency Geospatial Analyst LEAs
Triggering event	Received information in relation to large shipment of containers containing e-waste to be smuggled from a European Port towards the Gulf of Guinea
Pre-condition	-
Relevant Datasets	AIS data Satellite Imagery
AI and Analytical tools	Geospatial intelligence detection tool suite –vessel detection

	Maritime traffic monitoring for vessel routes detection module Risk assessment for decision support module Environmental crime monitoring centre module Secure information sharing and evidence exchange based on blockchain technologies Visual analytics dashboard
Sequence of steps for Forensics Investigation:	
Step	**Step Description**
Step_1: Identification of the crime	A European Law Enforcement Agency has receives information that a large shipment of containers containing e-waste is about to depart from a European Port and it is scheduled to be smuggled into the Gulf of Guinea
Step_2: Incident Assessment and Prioritisation	During monitoring and analysis activities in relation to the vessels following the probable smuggling route previously identified by the PERVIALLON platform, one cargo ship approaching the Gulf of Guinea stops transmitting the AIS signal, triggering an automated alert in the PERIVALLON platform
Step_3: Incident Verification	The operator uses available tools in the platform to foresee the most plausible position for the suspicious vessel matching a Sentinel 1 and/or Sentinel 2 satellite pass, as well as, potentially Very High-Resolution Imagery from Copernicus Contributing Missions.
Step_4: Confirmation and alert generation	The Risk assessment module combines the available information to generate hints/alerts, to determine the risk of criminal activities and correlate them with the VOIs in the AOI and to trigger the request for satellite data provided by Sentinel missions once the AIS is shut down and the vessel is designated as a dark vessel.
Step_5: Site Inspection	Based on the aforementioned information, the monitoring team immediately notifies the local authorities and begins to coordinate with them the interception of the vessel in order to investigate her cargo.
Step_6: Geospatial data synchronisation and acquisition	Thereafter, they work closely with local authorities to focus their efforts on targeted inspections of vessels arriving at ports in the destination country.
Step_7: Environmental Crime Report with Blockchain Integration	Using the platform and based on the last verified position for the suspicious vessel (satellite image), the team manages to identify the potential port in Ghana where the cargo ship made its first stop and could have delivered some containers with e-waste, which would be, subsequently, transported to an illegal dumpsite or sold in the black market.
Post - condition	-

Table 10: Properties for PUC3 (merged A&B) demonstration 1: Maritime Routes data exploitation and predicted routes (Using AIS datasets) and demonstration 2 Dark Vessel threshold detection (ship length and width) using Satellite Imagery

Actors	Gulf of Guinea (Port of Nigeria and Benin)
European Law Enforcement Agency	TBD
Geospatial Analyst	SATCEN
LEAs	Guardia Civil; Romanian Border Police

After a thorough analysis, a set of meetings with partners involved in those scenarios and dedicated group work, we concluded that the combination of both scenarios in a single one will be more beneficial due to the following:

- To grant the continuity of the narrative and complementarity of technical capabilities applied in both scenarios.
- To remove potential risks in relation to technical developments implemented at different paths.
- To provide a continuous workflow linked with an optimised narrative, supporting end-users at the time that contribute to enhance the PERIVALLON platform (i.e.: decision-making process, alert-based system, …).

It is worth to highlight that merging both scenarios in just one is not jeopardising in anyway the foreseen exploitable assets to be demonstrated with this PUC3 but promoting a more efficient interaction between the partners involved in the development and implementation of both scenarios.

In addition, or the creation of the above storyline, external experts were supported in the design part. Specifically, SATCEN has been in contact with the Guardia Civil and were provided some valuable input regarding modus operandi, ports of departure and ports of destination.

3.4. PUC4: Illegal trade in ozone-depleting substances & HFCs

3.4.1. Motivation

The illegal trade of ozone-depleting substances (ODS) and hydrofluorocarbons (HFCs) is a serious environmental concern. Despite regulations, recent seizures across Europe highlight a growing problem.

In a specific case, an intelligence team detected a suspicious online advertisement for refrigerant cylinders. Through advanced analytics and collaboration with maritime authorities, a vessel was identified, and a concealed shipment of HFCs was discovered at the port. The successful interception underscores the importance of vigilant monitoring and coordination among authorities in combating the illegal trade of substances that contribute to climate change.

3.4.2. Scenario

The intelligence team is on high alert for the detection and prevention of online illegal trade of ozone-depleting substances (ODS) and hydrofluorocarbons (HFCs). They have been constantly monitoring relevant online marketplaces to detect potential illegal sales of refrigerants in cylinders.

One day, an advertisement is placed on eBay for the sale of a certain quantity of refrigerant in a cylinder. The intelligence analyst detects this potential illegal sale within collected data of the PERIVALLON platform by checking the title of the advert -which is translated to English-, the specific details of the sale, and the published images. Then, the information is fed into the multimedia and multilingual extraction and analytics services for Web marketplaces to automatically analyse textual content in order to identify and extract named entities and concepts that are potentially relevant to the illicit sale of ODS and HFCs.

The multimodal analytics translates and processes the textual content to identify named entities (i.e., persons, locations, organisations, etc.) and concepts (e.g., chemicals) that are potentially relevant to the illicit trading of ODS and HFCs. At the same time, visual content is analysed for the automatic detection of objects of interest, such as refillable/non-refillable (non-disposable/disposable) cylinders while also potential textual labels/logos on the cylinders will be extracted. After that, an alert is triggered from the multimodal analytics services and is displayed at the Environmental crime monitoring centre. Considering the alert, the intelligence team performs pattern recognition, which allows for the automatic identification of other similar advertisements that may be managed by the same publisher (individual or group of individuals) as part of an online criminal network.

The intelligence team then conducts trend analysis as well as predictive analytics to better understand how the illegal trade of ODS and HFCs is evolving over time. This analysis provides clues to possible similar e-trades in the future, which allows the intelligence team to take preemptive actions to combat such activities.

Using the platform, the intelligence team analyses maritime data considering the entities i.e., location -extracted from the online data analysis- to estimate the destination port of the shipment. Considering the collected information and the registration details of the vessels, the intelligence team works together with the Coast Guard for the detection of the suspicious vessel at the perimeter of around 5-10 marine mile from the shore. Considering also the history of illegal acts of one of the vessels owners leads to a reasonable doubt that this particular vessel could be involved in the respective contraband act.

The suspicious cargo ship carrying various goods arrives at the port, and an importer notifies the respective authorities (i.e. LEAs, Ministries, etc.) about the possibility of illegal trade of HFC-134a. The competent authority uses X-Ray scanners to identify any potential threats within the cargo. The collected data is automatically correlated and analysed within the platform, leading to the detection of any suspicious objects, including among others the concealed HFC cylinders.

The threat is detected and an alarm is raised in the platform accessed by border authorities. Experienced investigators evaluate the data to support the decision-making process on further on-site investigation, such as a manual inspection of the cargo.

During the manual inspection, the competent authorities (Border Guards together with other authorities (i.e. Environmental Agencies, etc.) locate the concealed HFC cylinders and discover that there is no relevant documentation for importing such goods. The authorities seize the illegal goods and take legal action against the importer for violating the regulations on the importation of refrigerants.

The detection and predictive analytics will continuously run in the background, considering historical data and any new information available, to predict potential future occurrence of similar events. The authorities will use this information to improve the monitoring and prevention measures towards combating the illegal trade of ozone-depleting substances and HFCs smuggling in the future.

The template for PUC4, is presented in Table 11.

Table 11: Template for PUC4 (merged A&B)

Use case leader	RBP
Contributing partners	RAD, CERTH, CENTRIC, DYLOG, MT, ETRA
Description	Illegal trade in ozone-depleting substances & HFCs
Actors	Intelligence analyst Border guards
Triggering event	An advertisement is placed on eBay.
Pre-condition	The PERIVALLON platform is able to gather large data from various sources. The RBP system is well populated with data and provides valuable data. The meteorological condition allows the UAV flight off the sea.
Relevant Datasets	Data from online marketplaces AIS data Satellite data Textual data
AI and Analytical tools	Discovery and monitoring of online marketplaces module Machine Translation module Object Detection module Printed Labels Detection module Maritime traffic monitoring for vessel routes detection module Multimodal fusion module Risk assessment for decision support module Environmental crime monitoring centre module Optimised X-Ray scanner Visual analytics dashboard
Sequence of steps for Forensics Investigation[3] **(Phase A – refers to sub-scenario (A), Phase B - refers to sub-scenario (B) that are not running in parallel but after step 6)**	
Step	**Step Description**
Step_1: Identification of the crime	**Phase A** - The intelligence team has been constantly monitoring relevant online marketplaces to detect potential illegal sales of refrigerants in cylinders. One day, an

[3]Referring to the original scenario A "Online illegal trade A" and B "Illegal smuggling" described in the GA.

	advertisement is placed on eBay for the sale of a certain quantity of refrigerant in a cylinder. The intelligence analyst detects this potential illegal sale.
Step_2: Incident Assessment and Prioritisation	**Phase A** - An alert is triggered from the multimedia extraction and analytics service and is displayed at the Environmental crime monitoring centre. Then, the information is fed into the multimedia and multilingual extraction and analytics services for Web marketplaces.
Step_3: Incident Verification	**Phase A** - The outputs of these analyses enable the intelligence team to perform pattern recognition, which allows for the automatic identification of other similar advertisements that may be managed by the same publisher (individual or group of individuals) as part of an online criminal network. This will be a strong indicator for the verification of the incident. Moreover, the intelligence team conducts trend analysis as well as predictive analytics to better understand how the illegal trade of ODS and HFCs is evolving over time.
Step_4: Confirmation and alert generation	An alert is triggered from the multimedia extraction and analytics service and is displayed at the Environmental crime monitoring centre. **Phase A -** This analysis provides clues as to possible similar e-trades in the future, which allows the intelligence team to take pre-emptive action to combat such activities. Meanwhile, the intelligence team uses the platform and analyses maritime data considering the entities i.e., location -extracted from the online data analysis- to estimate the destination port of the shipment. **Phase B** - The threat is detected and an alarm is raised in the platform accessed by port authorities. Experienced investigators evaluate the data to support the decision-making process on further on-site investigation, such as a manual inspection of the cargo.
Step_5: Site inspection	Experienced investigators evaluate the data to support the decision-making process on further on-site investigation, such as a manual inspection of the cargo.
Step_6: Geospatial data synchronisation and acquisition	**Phase B** - The port authority uses X-Ray scanners to identify any potential threats within the cargo. The collected data is automatically correlated and analysed within the platform, leading to the detection of any suspicious objects, including among others the concealed HFC cylinders. Return to Phase B of steps 4 and 5.

Step_7: Environmental Crime Report with Blockchain Integration	**Phase B** - The authorities seize the illegal goods and take legal action against the importer for violating the regulations on the importation of refrigerants.
Post – condition	**Phase B** - The detection and predictive analytics will continuously run in the background, considering historical data and any new information available, to predict potential future occurrence of similar events. The authorities will use this information to improve the monitoring and prevention measures towards combating the illegal trade of ozone-depleting substances and HFCs smuggling in the future.

Table 12: Properties of PUC4 (merged A&B)

Actors	Romania (Constanta)
Intelligence Analyst	IGP
Border guards	RBP

PUC4 was devoted in two scenarios: Scenario A focused on the online illegal trade of ozone-depleting substances and HFCs and scenario B focused on their illegal smuggling. The scenarios have been merged as both relate to the same investigation and belong to the same investigation process, as the proposed steps form a continuation from scenario A to B. Specifically, the narrative provided by the end-uses for scenario A starts with an online investigation and concludes with an on-site inspection of the detected cylinders, while the narrative of scenario B starts with the physical on-site inspection of a detected cargo from an already found illegal vessel (i.e., a potential result from scenario A) and concludes with the authorities seizing the illegal goods. Hence, the end-users considered in the consortium that a merged version will lead to a richer and more comprehensive scenario incorporating the two phases (i) the online investigation and on-site inspection, and (ii) the physical intervention.

4. Methodology on addressing the User Requirements

4.1. Overview

In this section the final set of Functional, Non-functional and Security requirements for the PERIVALLON project will be presented. User requirements illustrate the user's needs and will form the starting point for the system architecture. Each PUC scenario is developed according to the user requirements. For the prioritisation of the requirements the MoSCoW method was used [19.], which is a well-known technique for managing the requirements.

The methodology followed for the extraction of the user requirements contains two main steps:

1. Specification of User Requirements. This will be achieved by defining the end-users, their mission, main responsibilities, main needs from the platform and their involvement in the project.
2. Formalisation of Technical Specifications. To understand this a detailed technical document is provided by the technical partners of the project, specifying the tools and the solutions that they intend to develop in order to meet the end user's needs.

Throughout the whole process followed for addressing the user requirements, there was interaction between the end-users and the technical partners of the project and the following sections describes the relevant activities that performed.

4.1.1. Defining End-users

4.1.1.1. Agenzia Regionale Per La Protezione Dell'ambiente Della Lombardia (ARPA)

- **Mission**

  ARPA Lombardia, the Regional Agency for the Protection of the Environment of Lombardy, Italy, is a public body operational since 1999. Missions of the Agency is to monitor the state of environment of Lombardy, to provide technical and scientific decision support about the environmental policies, promote sustainable development technologies and practices.

- **Main Responsibilities**

  ARPA, among other competencies, has in charge environmental controls to industrial installation under IED Directive and authorised waste treatment plants (landfills and hazardous waste treatment plants); ARPA manages regional databases such as the regional waste plants cadastre and the regional waste observatory. A unit in ARPA is focused in developing operational services of environmental monitoring and control, based on Earth Observation (EO) data from satellite, airborne and drone data. In the framework of these competencies, it was recently developed a geospatial intelligence methodology based on the analysis of images acquired by very high-resolution satellites and drones and auxiliary environmental data for the detection of illegal waste management sites in Lombardy, has strong been developed in strong cooperation with other public Authorities involved.

- **Main needs**

  ARPA, as a regional authority with environmental competences, is interested in improving efficiency in its monitoring and control activities. ARPA main interests in the project focus on the exploitation of algorithms and methodologies for wide area monitoring based on EO data and AI,

searching for illegal waste disposal sites or authorised sites with illegal waste management. This could lead to a more efficient approach in institutional activities, in a time saving way with respect to traditional photointerpretation. The system should exploit different EO and other data sources, standardising the detection of critical sites, prioritising them for future direct controls, and sending warnings for the most relevant cases.

Moreover, ARPA is interested in methodologies, protocols and operational procedures in the usage of drones supporting controls and investigations in critical sites for waste management (waste type identification, volume estimations, accuracy evaluation, etc..). Also, and important point is to develop, test and share methodologies in surveying and post-processing, defining common standards.

More in general, ARPA is interested in improving internal skills and know-how about geospatial intelligence and AI operational applications, also with technology transfer from technological partners of the project.

4.1.1.2. De Watergroep (DWG)

- **Mission:**

  DWG is an autonomous Flemish drinking water company offering products and services throughout the water chain. Ther historical mission - namely to supply quality drinking water at an acceptable price now and in the future - remains valid to this day. In addition, through a sustainable cycle approach, we ensure economically and ecologically responsible management of all links in this water chain: rainwater, ground and surface water, drinking water and wastewater.

- **Main Responsibilities:**

  The core activities of DWG are the production and distribution of drinking water and the management of drinking water infrastructure. DWG must supply sufficient and high quality drinking water to its customers. This is achieved through a WSP approach where all parts of the water supply, from source to tap, are monitored and controlled.

- **Main needs:**

  - good detection methods and follow up procedures for intentional or unintentional environmental incidents such as water pollution incidents.
  - clear process diagram that can be followed as soon as an incident occurs, describing who is handling an incident and in what way.
  - database to store the various incidents that have taken place.
  - a rapid detection and notification of both an accidental or intentional environmental incident that could lead to contamination in surface water or groundwater. Currently, we are notified of an incident based on reports from people or by alerts from the watercourse manager. This way of working allows some incidents to remain under the radar and for others to not be detected soon enough.
  - it should be possible to track the identified contamination in time and space so that the impact of the incident on the water quality at the intake point can be determined and informed decisions can be taken (further monitoring, additional sampling needed, stopping the intake).

- a risk analysis (e.g., what risk, where) and a priority rank needs to be assigned to identified environmental incidents. A high priority ensures immediate and strict intervention or close monitoring. If a low priority is assigned, it may be sufficient to monitor the contamination or ensure it is reported to avoid repetition in the future.

4.1.1.3. Hellenic Police (HP)

- **Mission:**

  The HP is the national law enforcement agency of Greece. Its mission is to maintain public order, prevent and investigate crime, and ensure the safety and security of the Greek population.

- **Main Responsibilities:**
  - Prevent criminal activities.
  - Enforces laws and regulations to protect public order, safeguard lives and property.
  - Regulating and controlling traffic on Greek roads
  - Manages Greece's borders and immigration control, by preventing illegal migration and combating human trafficking.
  - Combats terrorism monitors extremist activities and protects critical infrastructure.

- **Main needs:**

  Crucial for HP is to fulfil its mission of maintaining public order, preventing crime, and ensuring the safety and security of the Greek population, are the follow:

  - Equipment and Technology: The Hellenic Police requires a range of equipment and technology to enhance operational capabilities. This includes vehicles for patrols and rapid response, communication systems, surveillance equipment (such as cameras and drones), forensic tools, etc.
  - Infrastructure: The Hellenic Police requires appropriate infrastructure to support its operations. This includes police stations, detention facilities, operational centre, specialised units or departments dedicated to specific tasks (e.g., environmental crime, cybercrime, narcotics).
  - Legal Framework: The Hellenic Police requires a robust legal framework that provides clear guidelines and powers for law enforcement activities.

4.1.1.4. General Police Inspectorate of Ministry of Internal Affairs of the Republic of Moldavia (IGP)

- **Mission:**

  Ensuring, in accordance with the law, the implementation of state policies in the field of maintaining, ensuring and restoring public order and safety, protecting the rights and legitimate interests of the individual and the community, preventing, investigating and discovering crimes and offences, administering justice, assisting the population and local public administration authorities.

- **Main Responsibilities:**
  - Maintaining, ensuring and restoring public order and security, protecting the rights and legitimate interests of the individual and the community.

- Preventing of crimes and offences.
- Investigating crimes and offences and prosecuting them.
- Ensuring the administration of justice.
- Assisting to the population and local public administration authorities.
- Organising the police work.

- **Main needs:**
  - Intelligent equipment and technologies for detecting and monitoring sectors with potential for environmental pollution. Installation of "SMART" type surveillance cameras for photo and video surveillance of means of transport and persons committing violations of the law.
  - International and inter-agency cooperation to exchange information with other countries and international agencies to streamline their investigative and enforcement activities, as well as work closely with various government agencies and departments responsible for the environment. Establish the National Focal Point on Environment.
  - Staff training programs for the use of smart equipment and technologies. Training of employees on the prevention, prosecution and investigation of environmental crime by organised crime, as well as methods and techniques for detecting such cases. Exchange of experience between law enforcement employees, involving them in the process of documenting/investigating cases of environmental crime committed by organised criminal groups (taking over best practices). Study visits to law enforcement agencies where these branches are well developed.
  - Assessment of existing national legislation by the expert group for compliance with European standards by including the recommendations and needs identified.

4.1.1.5. Carabinieri Corps (IT-CC)

- **Mission:**

  The Carabinieri is one division of the military police force in Italy. This department of Italian police, the Carabinieri, is responsible for carrying out domestic and foreign policing duties.

- **Main Responsibilities:**

  By Legislative Decree 177 of 2016 on "Provisions on the rationalisation of police functions and absorption of the State Forestry Corps," the Forestry, Environmental and Agribusiness Unit Command was established, from which departments dedicated to the performance of special and highly specialised tasks in the field of environmental, land and water protection, as well as in the field of safety and control in the agribusiness sector, in support or with the support of the territorial organisation (the specific functions were assigned to the Carabinieri Corps by Art. 7).

  The Forestry, Environmental and Agribusiness Unit Command reports hierarchically to the Commander General of the Carabinieri Corps and functionally to the Minister of Agricultural Food and Forestry Policies for matters pertaining to agribusiness and forestry safety and protection. The Command is also supported by the Minister of the Environment and Protection of Land, Sea and Tourism limited to the performance of specific functions expressly attributable to the powers of the same Ministry.

Dependent on the Forestry, Environmental and Agribusiness Unit Command are:

- the Carabinieri Command for the Protection of Forests and Parks.
- the Carabinieri Command for the Protection of Biodiversity.
- the Carabinieri Command for Environmental Protection and Ecological Transition.
- the Carabinieri Command for Agribusiness Protection.
- The Carabinieri Command

- **Main needs:**

  Improve technical skills to tackle the environmental crime.

4.1.1.6. Hellenic Ministry of Environment and Energy (MOEE)

- **Mission:**

  The mission of the Ministry of Environment and Energy is to reduce Environmental Crime.

- **Main Responsibilities:**
  - Basic study of the geology and the geodynamic situation in Greece.
  - Cooperation with the Special Secretariat for Water of the Ministry of Environment and Energy and any other responsible body for the collection, archiving and inspection of water areas in the country.
  - Geophysical studies for imaging the geological structure for technical projects, for the protection of the environment, for the survey and detection of mineral resources and the management of natural resources.
  - Cooperation with the Directorate of Environmental Licensing, the Directorate for Planning and Management of Water Services and the Special Service for Coordinating Environmental Action of the Ministry of Environment and Energy.
  - Counselling the competent service of the Ministry of Environment and Energy regarding Strategic Studies of the Environmental Repercussions as defined by the directive 2001/42//EK when there is geological or mining interest, by examining the qualitative adequacy.
  - Any type of action that refers to the environment.

- **Main needs:**

  Protection of environment by combating environmental crime, correct management, and awareness of citizens.

4.1.1.7. General Inspectorate of Romanian Border Police (RBG)

- **Mission:**

  The Romanian Border Police is the Romanian institution empowered with all Romanian borders management regarding the control of the documents of persons entering and/or leaving the territory of Romania. At the same time, RBP has the territorial competence regarding the detection of various crimes.

- **Main Responsibilities:**
  - Romania has 2.953,2 km of land borders and a coastline of 193,5 km (total length:3146.7 km). The land-borders are divided as follows: Bulgaria 631.3 km, Hungary 444.8 km, Moldova 681.3 km, Serbia 649.4 km, Ukraine (North and East) 649.4 km. There are currently 80 BCPs (19 ports, 28 road, 16 airports and 17 railway). Out of the total of 80 BCPs, 77are operational. Out of the 77 BCPs, 53 BCPs (17 ports, 13 road, 16 airport and 7 railway) are located towards NON-EU-countries (or international) and 24 BCPs (14 road, 8 railway) towards EU-countries.
  - Measures at the external borders consist of border checks and border surveillance based on criminal intelligence and risk analysis and are carried out in cooperation with the competent authorities at central, regional and local level. Resources for border control are deployed along the border on the basis of the identified threats and pursuant of the plans for border control. In case of changes in the operational situation due to the appearance of new threats the relevant relocation is realised.
  - Detection and investigation of cross border crime is carried out in coordination with all competent law enforcement authorities. Border control in Romania is carried out by special units of the Border Police, subordinated to the Ministry of Internal Affairs (MAI). These units carry out border checks at border crossing points (BCPs) at air, sea and land border and border surveillance between the BCPs.
  - Depending on the type of the border, a different entity of the General Inspectorate is responsible for the border control. Border control is carried out only by professional border guards who have passed specific training.
  - A detailed system of information management and risk analysis provides all managerial levels with necessary information for decision taking. The implemented system of border surveillance is able to provide situational pictures on the land and sea borders. Close cooperation with national authorities and international partners responsible for combating of illegal immigration provides information about routes of illegal immigration and modus operandi.
  - The reaction capacity is determined by availability of necessary human and technical resources, their reaction time and capability to react adequately in different situations, availability and capabilities of the command and control units to lead different operations.
  - The surveillance concept ensures the achievement of an integrated surveillance system, its subsystems being capable to interact, to be interoperable and complementary while fulfilling the strategic objectives regarding Romania and European Union border surveillance.
  - In order to achieve the strategic objectives regarding Romanian and European Union border surveillance, the installed technical devices are essential for optimising all actions. The objectives of the proposed surveillance system are reached through technical improvement and support of surveillance activities, achieved by proper equipage with modern surveillance devices. Romanian Border police is an experienced institution in project management. We have experts in all specific domains such as: legal, financial, illegal migration, illicit border activities, border surveillance, IT&C, procurement, project management.

- **Main needs:**

  One of the main purposes of RBP is stopping to all kind of smuggling. In this line the developing of the advanced and effective tools for detecting and retaining all attempts to illegal cross border (both in and from Romania) of waste is a basic concern of the RBP management, along with supporting the detection activities of illegal waste deposits on the territory of Romania, in the area of responsibility of the RBP.

4.1.1.8. European Union Satellite Centre (SATCEN)

- **Mission:**

  SATCEN supports the decision making and actions of the European Union in the field of Common Foreign and Security Policy (CFSP), in particular Common Security and Defence Policy (CSDP), including EU crisis management missions and operations, by providing products and services resulting from the exploitation of relevant space assets and collateral data, including satellite imagery and aerial imagery, and related services. SATCEN is an agency under the Common Foreign and Security Policy / Common Security and Defence Policy of the EU working under the supervision of the Political and Security Committee and the operational direction of the High Representative of the Union for Foreign Affairs and Security Policy.

- **Main Responsibilities:**

  Linking Space and Security with technical and operational expertise as key primary user of satellite data as well as product and service provider in the framework of the Common Foreign and Security Policy and Copernicus.

- **Main needs:**

  - Increase AI-based geospatial intelligence and remote sensing solutions to improve the detection of environmental crimes, namely transnational maritime routes and dark-vessels detection in a more efficient and effective way.
  - Enhance internal capabilities with the improved AI-based extraction, analysis, and correlation technologies to identify illegal environmental crime activities by detecting irregularities in (online) data generated across the processing, shipment and trafficking ecosystem.
  - Contribute to the decision-making process by having access to an easy-to-use environmental crime-monitoring platform that collects court-proof crime evidence and provides decision support by fusing heterogeneous data for identifying patterns, assessing the likelihood of criminal activities, and forecasting trends. In terms of involvement, SATCEN has the responsibility to contribute to PUC3 storyline, support the requirements definition (functional and non-functional) and the KPI definition (validating the proposed solutions in the grant agreement in terms of feasibility and propose new ones whenever applicable).

4.1.1.9. Swedish Police Authority (SPA)

- **Mission:**

  The mission of the Swedish Police Authority is to reduce crime and increase public safety.

- **Main Responsibilities:**

The National Forensic Centre (NFC) is an independent expert organisation within the Swedish Police Authority with an overall responsibility for forensics. Our main task is to conduct forensic investigations and analyses on behalf of the judicial authorities. NFC also conducts research and development within the forensic field, in close cooperation with the National Operations Department and the police regions of Sweden.

- **Main needs:**

  NFC has the need to enhance abilities, especially 3D documentation for forensic purposes. This includes requirements to achieve the best possible inputs for generating accurate 3D models. It also includes volume estimations with uncertainties, approaches on how to distinguish the ground plane beneath waste piles and methods for performing density estimations.

4.1.2. End-users' involvement in the project

The end-users' involvement in the project is presented per Task at the following Table 13.

Table 13: End user's involvement in the project

	ARPA	DWG	HP	IGP	IT-CC	MOEE	RBG	SATCEN	SPA
T2.1: Environmental Crime Observatory: modus operandi, statistics, and societal dimensions	X	X	X	X	X		X	X	
T2.2: Co-creation, analysis, and definition of pilot use cases	X	X	X	X	X	X	X	X	X
T2.3: User and security requirements specification	X	X	X	X	X	X	X	X	X
T3.1: Geospatial intelligence through earth observation	X			X	X	X		X	X
T3.2: Aerial visual detection through UAVs	X		X						
T3.3 Optimised 3D terrain mapping				X		X			
T3.4: Swarm intelligence and	X		X						

optimisation for mission planning and surveillance									
T3.5: X-ray scanning							X		
T4.1: Discovery and monitoring of online marketplaces									X
T4.2: Online monitoring of relevant open data						X	X		
T4.3: Multilingual text analysis and concept extraction				X					
T4.4: Automatic identification of objects of interest in multimedia content				X					
T4.5: Maritime traffic monitoring for vessel routes detection							X	X	
T5.1: Multimodal fusion and risk assessment for decision support						X			
5.2: AI-based pattern recognition, trend detection, and predictive analytics									X
T5.3: Environmental crime monitoring centre	X		X	X			X	X	X
T5.6: Platform development and integration							X		
T6.1: Pilot planning and preparation	X	X	X	X	X	X		X	X
T6.2: Representative	X	X	X	X		X		X	X

datasets for the pilot use cases									
T6.3: Pilots execution and evaluation	X	X	X	X		X		X	X
T6.4: End user training and innovative curricula	X		X	X		X		X	X
T7.1: Dissemination and communication activities	X		X					X	
T7.3: Standardisation, collaboration with other projects, and stakeholder network		X		X	X	X		X	X
T7.4: Policy impact and recommendations at EU level	X		X			X		X	

4.1.3. Gathering End-users' Requirements

For the collection of the end-users' requirements the process followed is presented below:

- Identification of the end-users of the PERIVALLON project and their role, which is critical for the development of the system.
- Interviews with the end-users to understand their mission, main responsibilities, main needs from the platform and their involvement in the project.
- Bilateral meetings with the technical providers of the PERIVALLON project to understand the tools and solutions that will be developed. The main goal is to get a deeper understanding of the tools that they intent to develop.
- Organisation of online and in-person workshops to address the user requirements expressed by the end-users. These workshops were essential in ensuring that the end-users' needs were thoroughly understood and incorporated into the project's development. During the workshops, the requirements were diligently categorised into functional, non-functional, and security aspects, providing a clear roadmap for their seamless integration into the project's overall objectives and outcomes.
- Prioritisation using the MoSCoW methodology.
- Refining the end-users' requirements through collaborative discussions with the technical providers. These discussions encompassed a thorough examination of the requirements expressed by the end-users, their implementation strategies, and their prioritisation. By engaging in this

iterative process, the project ensured a comprehensive understanding of the users' needs, enabling the development of solutions that align closely with their expectations and project objectives. This iterative process lead to three iterated versions of the user requirements that were distributed to the end-users as well as to the technical partners to review them and provide their comments.

- Distribution of the final version of the requirements to the consortium and especially with the technical partners.

Below the schematic illustration followed for the collection of the end-users' requirements is presented in Figure 3.

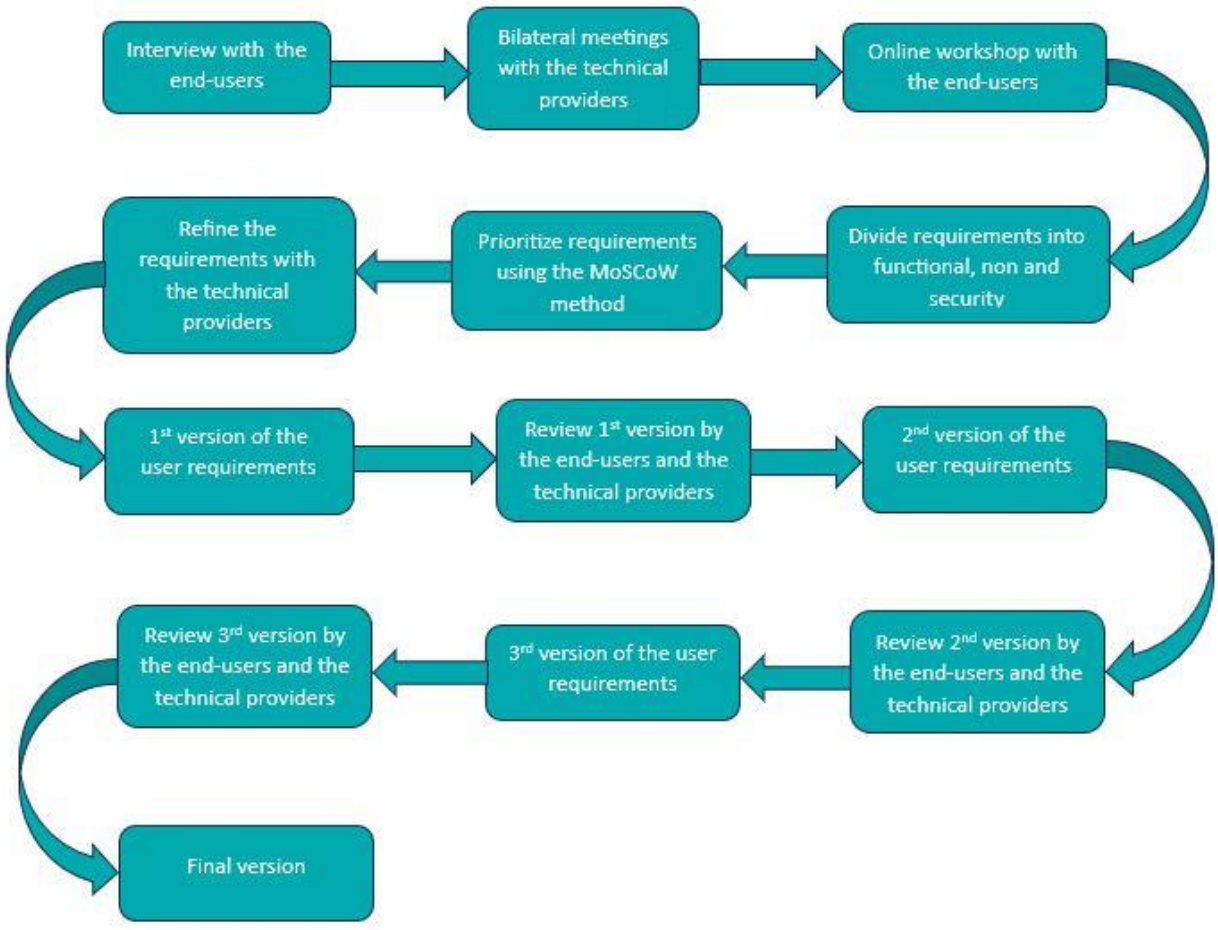

Figure 3. Schematic illustration of the Requirements Process

4.1.4. Collecting feedback from workshops

An online workshop, titled "Co-creation Use Case Scenarios - End User Requirements," was conducted by KEMEA on 3rd March 2023. The primary objective of this one-day event was to gather additional feedback on the user requirements from the project's end-users, including representatives from various sectors such as industry and research. The workshop aimed to ensure that the forthcoming modules developed precisely align with their specific needs. A diverse group of approximately 25 participants from Greece,

Moldova, Belgium, Romania, Italy, and Sweden took part in the workshop, actively contributing their valuable insights and perspectives.

The workshop was organised around two main axes. The first axis involved presenting the UCs scenarios to the participants in a storyline format. The second axis focused on engaging the end-users in discussions to gather feedback on the user requirements. To facilitate interaction with the participants, the Sli.do[4] tool was utilised, incorporating live polls to collect valuable insights and feedback concerning the user requirements. In Figure 4, the content of the workshop is presented.

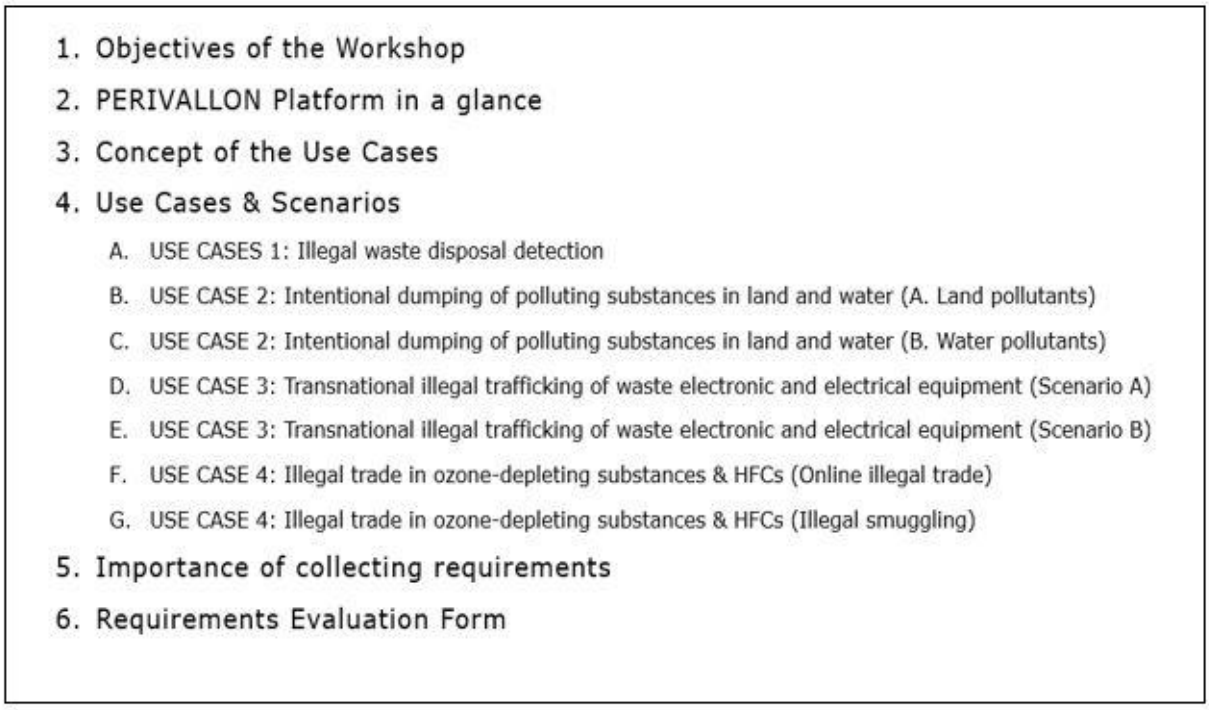

Figure 4. Content of the workshop

During the workshop, a series of 42 questions related to the four UCs scenarios were presented to the end-users using the Sli.do interaction app. The participants' responses and corresponding graphs were displayed in real-time and can be found in Annex C.

Following the workshop, a comprehensive questionnaire was developed using Microsoft Forms to further gather insights from the end-users of the consortium. The questionnaire consisted of 103 questions aimed at analysing the end-users' profiles and prioritising the requirements of the PERIVALLON project based on the MoSCoW categories, as detailed in Annex D. Seven end-users representing their respective organisations completed the questionnaire, contributing valuable input to the project. All the requirements have been reviewed and prioritised by the technical partners of the Consortium.

[4] https://www.slido.com/

4.2. MoSCoW: Prioritisation of End User requirements

The MoSCoW methodology is a well-known technique for the prioritisation of the requirements [19.]. By using this method it's important to involve the stakeholders in the decision-making process and review the prioritisation of the requirements. The MoSCoW categories used to provide the prioritisations of the requirements are presented in Table 14.

The prioritisation of End User requirements in the project was executed through a hybrid approach that integrated two key components: survey responses from the end-users and direct bilateral communication with them. This mixed-method strategy was designed to obtain a comprehensive understanding of the requirements' significance, ensuring that the end product aligns closely with end user needs and expectations.

The first aspect of this approach involved collecting survey responses from end-users. These responses provided quantitative data on what features or aspects are most desired or needed by the end user. This gave the project team initial insights into which requirements should be given higher priority based on general user sentiment.

The second component of the strategy involved direct, two-way communication with end-users. This allowed for a more nuanced understanding of the requirements. Through these interactions, the project team could explore why certain requirements were more critical than others, enabling them to grasp the context or specific scenarios in which these requirements become vital.

By engaging in bilateral conversations, the project team could also assess the subjective importance of each requirement directly from the end-users. This often helped in resolving any ambiguities or contradictions that might have appeared in the survey data, providing a more well-rounded view.

The synergy between these two methods — survey data and bilateral communication — allowed for a robust prioritisation process. It ensured that the requirements were not only statistically validated but also qualitatively understood, leading to a more balanced and end user-centric outcome.

The mixed-method approach for prioritizing End User requirements offered a more holistic view of what the end-users actually need and consider important. By marrying quantitative data with qualitative insights, the project team could ensure that the prioritised requirements are both broadly accepted and deeply understood, setting the stage for a more successful and user-aligned end product.

Table 14: MoSCoW methodology

MoSCoW	Description	Scoring
Must (M)	A requirement which is essential and must be implemented for the project's success.	4
Should (S)	A high priority requirement and should be included in the project if possible.	3
Could (C)	A nice to have requirement.	2
Won't (W)	Not a priority requirement that is necessary to be implemented.	0-1

5. End User Requirements

5.1. User Requirements' taxonomy

In this chapter the end user requirements will be analysed. The end user requirements were extracted by bilateral discussions, responses from the workshop, questionnaire and through continuous communication with the end-users and the technical providers of the project.

The user requirements of the PERIVALLON project, are grouped in the following categories:

- Functional requirements which describe the behaviour of the system and the actions that must perform to meet the users' needs. It defines what the system should do in order to meet the user need.
- Non – functional requirements which describe how well a system should operate. Focus on the characteristics of the system, and
- Security requirements, which define the measures that are necessary to protect a system from various security threats and build a secure and robust system.

In total, the project successfully gathered 76 Functional, 25 Non-Functional, and 13 Security requirements. This comprehensive collection of specifications provides a robust foundation for the development and implementation of the PERIVALLON project, ensuring that all aspects, from functionality to security, are well-addressed and aligned with the project's objectives. The diverse set of requirements obtained from various sources and stakeholders guarantees a holistic approach in creating a solution that effectively meets the needs of end-users and upholds the project's overall success.

5.2. Functional Requirements

Table 15: End User Requirements on PERIVALLON (Functional)

No	PUC	Description	MoSCoW
FR1	1,2,3	Ability to process high-resolution and/or very high-resolution satellite images and aerial photography data.	4
FR2	1,2	Automated image processing and analysis to detect potential waste disposal sites.	4
FR3	1,2	Integration with sensors, such as cameras, to verify the presence of waste.	4
FR4	1,2	Ability to identify patterns and anomalies in the data that may indicate the presence of waste.	3
FR5	1,2	Automated notifications and alerts when new potential waste disposal sites are identified.	3
FR6	1,2	Ability to estimate the volume, track the location and produce reports containing statistics about the accuracy of the estimation, the waste density, and the uncertain data that requires further verification.	4
FR7	1,2	Integration with GIS and mapping tools to visualise the location of waste disposal sites.	4
FR8	4	Ability to process different languages. Multi-language support for global use. At least 3 languages for example English, Greek and Spanish.	3
FR9	1,2	Integration with local databases to cross-check known waste sites.	1
FR10	3,4	Customisable data analysis dashboards to view trends and data insights.	2
FR11	1,2,3,4	Data encryption and secure data transfer.	4
FR12	1,2,3,4	Ability to manage users and roles with appropriate permissions.	4
FR13	4	Integration with social media and citizen reporting channels for real-time alerts.	1
FR14	1,2,3	Machine learning algorithms to identify different types of waste, such as hazardous waste, organic waste, or electronic waste.	4
FR15	1,2	Geo-fencing features to alert when a waste site has been tampered with or increased.	4

FR16	1,2	AI-powered monitoring and updates of waste sites.	3
FR17	1,2,4	Integration with drones to create 3D models and better understand waste site features.	4
FR18	2,3,4	Historical data analysis to identify long-term waste trends.	4
FR19	1,2	Use of multi-temporal approach for satellite image interpretation.	2
FR20	1,2	Automated reporting for regulatory compliance.	2
FR21	2,3	Automated analysis for identification of hotspots of illegal waste dumping and trends.	4
FR22	1,2	Ability to detect waste in remote or inaccessible areas.	4
FR23	1,2	Ability to generate heatmaps to indicate the density of waste sites.	4
FR24	1,2,3,4	Utilisation of APIs to obtain weather forecasts for a specific area of interest.	2
FR25	4	Machine Learning methods to extract Named Entities from textual content.	4
FR26	1,2	Ability to analyse waste data by geographic regions, proximity to bodies of water, and other environmental factors.	4
FR27	3	Automated notification to the platform operator/analyst in case of hazardous waste.	3
FR28	1,2,3,4	Integration with third-party data providers for additional data sources.	3
FR29	4	Ability to export data for analysis and visualisation.	4
FR30	3,4	Generation of alerts when a vessel is observed with a suspicious direction towards ports or configurable coastal areas of interest.	4
FR31	2,3	Integration with IoT sensors and networks using protocols and/or standards.	2
FR32	1,2,3,4	Automated workflows and decision-making systems.	3
FR33	4	Machine Learning methods to extract concepts of interest from textual content.	4
FR34	2	Use of multispectral sensors to identify different types of waste.	4
FR35	1,2	Ability to identify illegal waste dumping from land, sea.	3
FR36	1,2	Identification of changes in topography, vegetation, and soil colour that may indicate illegal waste dumping.	3

FR37	1,2	Ability to incorporate the analysis of water/soil ground samples of the incident.	3
FR38	2	Integration with models that simulate the spread of contaminants.	3
FR39	3,4	Capability to track the origin and destination of waste transportation vessels.	4
FR40	3,4	Identification of illegal waste export or import across national borders.	3
FR41	1,2,3	Integration with blockchain to create a trusted and tamper-proof record of waste disposal activities.	3
FR42	1,2	Create automated reporting illegal waste sites.	4
FR43	4	Machine Translation to translate textual content in languages Greek, Romania, Italian to English.	3
FR44	4	Anomaly detection and alert raise based in a vessel suspicious behaviour compared with AIS historical data.	4
FR45	3,4	Regarding the automatic detection of suspicious vessels, also estimate possible route and both departure and arrival points, in order to optimise response.	3
FR46	3,4	Regarding the automatic detection of suspicious vessels, route analysis should be based not only on vessel type, but also take into account freight type, vessels' flag.	2
FR47	3,4	Automatic detection of suspicious vessels and classify risks according to the type of crime.	2
FR48	1,2,3,4	A service designed for risk investigation, aiming to pinpoint potential risk factors.	3
FR49	2	Early detection of both an accidental or intentional incident which could lead to a contamination in surface water or groundwater. Early detection might involve indirect (e.g. social media checks) or direct (satellite imagery) tools.	4
FR50	1,2,3,4	Automated risk assessment of the detected incidents, providing risk prioritisation. A high priority ensures immediate and strict intervention or close monitoring. A low priority, it may be sufficient to monitor the contamination or ensure it is reported.	4
FR51	1,2,4	Ability to optimise path planning of multiple UAVs in terms of energy and time.	4
FR52	1,2,4	Ability to adapt path plan output based on available equipment (i.e. for different number of UAVs, and/or different kinds of UAVs, e.g. different battery life, speeds, payloads etc).	4

FR53	1,2	Capability to receive user input regarding the trade-off between speed and data quality for the 3d-reconstruction.	3
FR54	1,2	3D-mapping-aware algorithm when maximising scanning efficiency.	3
FR55	1,2,4	Correlation and analysis of different multimodal analytics outputs (e.g. key named entities identification, objects of interest detection) to identify potential patterns across online advertisements.	3
FR56	4	Trend analysis and predictive analytics to understand how the illegal trade of ODS and HFCs is evolving over time.	3
FR57	2,3,4	Consideration of historical data in addition to newly acquired information to predict the possible occurrence of smuggling illegal trade in the future.	3
FR58	4	Detection of cylinders in multimedia content and extraction of their characteristics.	3
FR59	2	Ability to perform the risk assessment and propose remediation processes.	3
FR60	2	Risk assessment service with the ability to learn continuously from the users' decisions and new incidents data.	3
FR61	1,2,3,4	Ability to share information among all actors involved in a secure, reliable and trustworthy manner.	4
FR62	3	PERIVALLON platform shall include trigger management definition/threshold based on pre-defined rules of behaviour analysis.	3
FR63	3	Automatic alert generation and manual alert generation should depend on results of rules of behaviour analysis as well as must be configurable.	4
FR64	4	Machine Learning methods to extract Named Entities from textual content.	4
FR65	3	Automated crawling and classification functionality to consistently monitor new posts across Surface, Deep, and Dark Web marketplaces. This functionality should not only seek out specific indicators and facilitators of environmental crime but also classify them according to relevance.	3
FR66	3	Intelligent URL scoring mechanism that can determine the relevance and potential importance of links related to environmental crimes, as well as link-following mechanism to follow those that are likely to provide targeted information related to the identified criminal activities.	3

FR67	3	Secure metadata extraction, with appropriate access controls and data storage compliant with relevant legal and regulatory standards.	3
FR68	3	Identification and analysis functionality of the various materials inside the scanned objects such as containers, cargo, or trucks, utilizing dual-energy image analysis. The system should be able to compare the materials against a database of allowed and disallowed substances, providing indications of any suspicious or prohibited goods.	3
FR69	3	Integration of data from multiple sources, either they have been manually inputted by the operator or automatically retrieved through QR code scanning. This data integration should seamlessly inform the algorithm's analysis and decision-making process, ensuring that real-world data is utilised for accurate detection.	3
FR70	3	The system must include an alerting mechanism that can produce clear and immediate alerts or indications if any not-allowed material is detected within the determined Region of Interest.	3
FR71	3	The algorithm requires access to a substantial database of heterogeneous object scan images. The system must have functionality for managing and supplying this database to the software core, facilitating continuous optimisation of the algorithm's parameters.	3
FR72	3	Integration with existing dual-energy image analysis system through the development of appropriate interfaces, protocols, and compatibility checks, without disrupting current operations.	3
FR73	1,2,3,4	The PERIVALLON platform shall continuously monitor the visual analytics dashboard.	2
FR74	1,2,3,4	The Visual Analytics Dashboard need to provide interactive elements which enhance the user’s engagement.	4
FR75	1,2,3,4	The Visual Analytics Dashboard shall ensure that the dashboard updates in near real time.	3
FR76	4	Identification of suspicious or not allowed objects in container, cargo or track content (focus on HFC gas cylinders) based on x-ray imagery.	3

5.3. Non-Functional Requirements

Table 16: End User Requirements on PERIVALLON (Non- Functional)

No	Description	MoSCoW
NFR1	Accessibility: The platform should be accessible to all users, including those with disabilities, through various devices and channels.	3
NFR2	Accuracy: The platform must provide accurate data analysis and identification of waste disposal sites.	4
NFR3	Adaptability: The platform should be adaptable to changing environmental policies and regulations.	3
NFR4	Auditability: The platform should have a comprehensive audit trail to enable traceability of all activities and data.	3
NFR5	Availability: The platform must be available 24/7 to enable prompt response to incidents.	4
NFR6	Availability: The platform should be available to authorised users 24/7, with minimal downtime for maintenance or upgrades.	3
NFR7	Compatibility: The platform should be compatible with various operating systems, devices.	3
NFR8	Compliance with Standards: The platform should comply with relevant industry standards and best practices (OGC Geospatial Standards).	3
NFR9	Data quality: The platform must have mechanisms in place to ensure the accuracy, completeness, and integrity of the data collected and processed.	4
NFR10	Disaster Recovery: The platform must have a disaster recovery plan to ensure functionality continuity in case of disasters.	4
NFR11	User Support: The platform should have a robust user support system to address user queries and concerns.	3
NFR12	Error handling: The platform must have robust error handling mechanisms to detect and recover from any errors or exceptions that occur during processing.	4
NFR13	Extensibility: The platform must be extensible to allow future enhancements and upgrades to accommodate.	4
NFR14	Usability for Different User Groups: The platform must be user-friendly and easy to use for all types of users, such as government agencies, non-governmental organisations, with clear and intuitive user interfaces.	4

NFR15	Interoperability with External Systems: The platform should be able to integrate with external systems and databases, such as law enforcement and regulatory agencies.	3
NFR16	Maintainability: The platform must be easy to maintain and update to ensure continued functionality and performance.	4
NFR17	Performance Metrics: The platform must be able to measure and report on performance metrics, such as response time and data processing time.	4
NFR18	Performance monitoring: The platform should be able to monitor its own performance and provide alerts to system administrators if any issues are detected.	2
NFR19	Versioning: The platform should maintain a version control system to enable proper management and tracking of changes made to the data.	3
NFR20	Resilience: The platform must be able to recover from system failures or crashes.	4
NFR21	Performance: The platform should be able to process and analyse data quickly and efficiently to enable prompt response to incidents.	3
NFR22	Portability: The platform should be able to run on different hardware, operating systems, and cloud environments (e.g. PathWave Advanced Design System, DigitalOcean, Google Cloud Platform).	2
NFR23	Precision: The platform must provide precise location and size information of waste disposal sites.	4
NFR24	Scalability: The platform should be able to handle large amounts of data.	3
NFR25	Reliability: The platform must be reliable and able to detect and recover from any system failures or errors.	4

5.4. Security Requirements

Table 17: End User Requirements on PERIVALLON (Security)

No	Description	MoSCoW
SR1	Data Encryption: All sensitive data, including geospatial and AI-related information must be encrypted both during transit and at rest to prevent unauthorised access.	4
SR2	Access Control: Implement strong access control measures to ensure that only authorised personnel can access and modify the project's AI and geospatial data.	4

SR3	Secure Communication: Utilise secure communication protocols to protect data transmission between different components and systems involved in the project.	4
SR4	User Authentication: Implement robust user authentication mechanisms, such as multi-factor authentication, to prevent unauthorised access to the project's AI and geospatial systems.	4
SR5	Audit Logging: Maintain comprehensive audit logs to track and monitor activities related to the project's AI and geospatial data, allowing for accountability and forensic analysis.	4
SR6	Secure Storage: Ensure that all data, including AI models, geospatial datasets, and training data, are stored securely, following best practices for data storage and protection.	4
SR7	Privacy Protection: Adhere to relevant data protection laws and regulations, such as the General Data Protection Regulation (GDPR), to safeguard the privacy of individuals involved in the project.	4
SR8	Secure Integration: Ensure that any third-party APIs, libraries, or external systems used in the project are properly vetted for security and integrated securely into the overall solution.	3
SR9	Secure Development Lifecycle: Follow secure coding practices and incorporate security testing throughout the project's development lifecycle, including penetration testing and code review.	3
SR10	Network Security: Implement robust network security measures, including firewalls, intrusion detection and prevention systems, to safeguard project resources.	4
SR11	Security testing: The platform should undergo security testing to identify and address any vulnerabilities or weaknesses in the system's security measures.	2
SR12	Security: The platform should have robust security measures in place to protect the data collected and processed, including access controls, encryption, and other security protocols.	4
SR13	Security: The platform should have robust security measures to ensure the confidentiality and integrity of sensitive data.	4

6. Conclusions

6.1. Summary

In conclusion, this deliverable plays a pivotal role in the PERIVALLON project, providing a comprehensive outline of the storyline for the four PUCs and presenting the final end-users' requirements, systematically prioritised through the MoSCOW methodology. The report exemplifies the diligent and collaborative approach undertaken throughout the development of PUC scenarios, emphasising the active engagement between end-users and technical partners.

By gathering user requirements through various means, such as live polls, questionnaires, and continuous collaboration, the project ensures that the developed solutions truly cater to the needs of the stakeholders and address the complex challenges of tackling environmental crime. This iterative process of feedback and refinement guarantees that the project remains adaptive to the evolving demands and expectations of its users.

The categorisation of 76 Functional, 25 Non-Functional, and 13 Security requirements demonstrates the extensive scope of the gathered user inputs and the project's meticulous attention to detail in meeting each aspect of the end-users' needs.

Looking ahead, the future work outlined below serves as a roadmap for continual improvement and advancement. The ongoing refinement and validation of requirements, the integration of cutting-edge technologies, real-world testing, and knowledge dissemination will undoubtedly enhance the project's effectiveness and contribute to long-term sustainability.

The collective efforts put forth in this deliverable reflect the commitment of the PERIVALLON project to safeguard the European territory from organised environmental crime through intelligent threat detection. With an unwavering focus on user collaboration, innovation, and shared knowledge, the project is poised to leave a lasting and positive impact on the preservation of our environment for present and future generations. By bringing together end-users, technical partners, and stakeholders, the project unites diverse expertise, forging a collaborative force that will lead to more effective environmental crime prevention and a greener, safer Europe.

6.2. Future work and recommendations

As the PERIVALLON project progresses, there are several crucial avenues for future work regarding the deliverable of gathering end-user requirements and co-creating the scenarios to tackle environmental crime. The immediate continuation of the work carried out and described in this report is T6.1 of WP6, regarding the pilot planning.

The initial phase of requirement gathering and scenario co-creation has laid a solid foundation, but there are key areas that demand continued attention and focus to enhance the project's effectiveness and impact, as presented below:

Refinement and Validation of Requirements: The gathered end-user requirements serve as a starting point, but it is essential to continually refine and validate them throughout the project's lifecycle. Regular consultations with end-users, stakeholders, and technical partners should be conducted to ensure that the evolving needs and challenges are adequately addressed, and the solutions remain aligned with the project's objectives. (*Links to T2.5, T3.1, T3.2, T3.3, T3.4, T.3.5, T4.1, T4.2, T4.3, T.4.4, T4.5, T5.1, T5.2, T5.3, T5.4, T5.5, T5.6)*

User Engagement and Collaboration: Active engagement with end-users and stakeholders should remain a priority. Co-creation sessions should be organised to ensure that the scenarios are shaped collaboratively, incorporating diverse perspectives and expertise. *(Links to T6.1, T6.2, T6.3, T6.4, T7.3)*

Integration of Cutting-Edge Technologies: As technology rapidly advances, it is crucial to keep the project at the forefront by integrating the latest advancements in AI, geospatial intelligence, and data analytics. Regular technology assessments should be conducted to identify new tools and methodologies that can augment the project's capabilities in detecting and combating environmental crime effectively. (*Links to T3.1, T3.2, T3.3, T3.4, T.3.5, T4.1, T4.2, T4.3, T.4.4, T4.5, T5.1, T5.2, T5.3, T5.4, T5.5, T5.6*)

Data Privacy and Security: With the sensitive nature of environmental crime data, data privacy and security measures must be meticulously addressed. Continued efforts should focus on implementing robust data protection protocols and adhering to EU data protection regulations, ensuring that the project operates with the highest standards of data privacy and security. (*Links to T2.4, T5.4, T5.5*)

Piloting and Real-World Testing: Moving beyond the initial scenario co-creation, piloting the developed solutions in real-world settings is critical to validate their feasibility and effectiveness. Collaborations with relevant law enforcement agencies and environmental authorities will enable field testing and evaluation of the project's outcomes in practical scenarios. (*Links to T6.1, T6.2, T6.3, T6.4*)

Dissemination and Knowledge Sharing: The knowledge and insights gained from this project should be disseminated widely to the scientific community, policymakers, and other relevant stakeholders. Engaging in conferences, seminars, and publishing research papers will foster knowledge sharing and enable others to benefit from the project's outcomes. (*Links to T7.1, T7.2*)

Long-Term Sustainability: Consideration should be given to the long-term sustainability of the project's solutions beyond the project's duration. Developing strategies for the integration of the PERIVALLON tools and methodologies into existing environmental crime detection systems will ensure their continued use and impact in the future. (*Links to T7.4, T7.5*)

International Collaboration: Given the global nature of environmental crime, seeking opportunities for international collaboration and knowledge exchange with similar initiatives and projects will enhance the project's effectiveness and foster a more coordinated approach to addressing environmental crime on a broader scale. (*Links to* T7.3)

In conclusion, the future work for the deliverable of gathering end-user requirements and co-creating scenarios for the PERIVALLON project is an ongoing and dynamic process. Continuous engagement with end-users, integrating cutting-edge technologies, addressing data privacy, real-world testing, knowledge sharing, and long-term sustainability are critical aspects that will contribute to the project's success in combating environmental crime and preserving the European environment for generations to come.

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Annexes

Annex A Interactions with the partners

Action	Date	Partners
Workshop during Kick-Off meeting	01/12/2022	All Consortium partners
Interview with technical partner	13/01/2023	ETRA, SMOB
Interview with technical partner	16/01/2023	CENTRIC, SMOB
Interview with technical partner	16/0/2023	POLIMI, SMOB
Interview with technical partner	17/01/2023	CERTH, SMOB
Interview with technical partner	17/01/2023	DYLOG, SMOB
Interview with technical partner	20/01/2023	DRAXIS, SMOB
Discussion for PUC1	25/01/2023	ARPA, DWG, SPA, HP, IT-CC, MOEE, ETRA
Interview with technical partner	2/02/2023	MT
Discussion for PUC2	1/02/2023	ARPA, DWG, IT-CC, HP, MOEE, ETRA
Discussion for PUC3	1/02/2023	SATCEN, POLIMI, MT, ETRA
Discussion for PUC4	2/02/2023	RAD, RBP
Discussion of the draft scenario of PUC1 and PUC2	17/02/2023	End-users and technical partners participating in the respective PUCs.
Discussion of the draft scenario of PUC3 and PUC4	17/02/2023	End-users and technical partners participating in the respective PUCs.
WP2 - Workshop for the scenarios of PUC1 & PUC2	3/03/2023	End-users and technical partners participating in the respective PUCs.
WP2- Workshop for the scenarios of PUC3 & PUC4	3/03/2023	End-users and technical partners participating in the respective PUCs.
Meeting on drone image processing issues	20/03/2023	POLIMI
Workshop during Plenary meeting	25-26/05/2023	All Consortium partners

Annex B Questions from Sli.do

USE CASE 1: Illegal waste disposal detection

Q1: How likely are you to report a suspicious waste disposal site through the dedicated form provided by the platform?

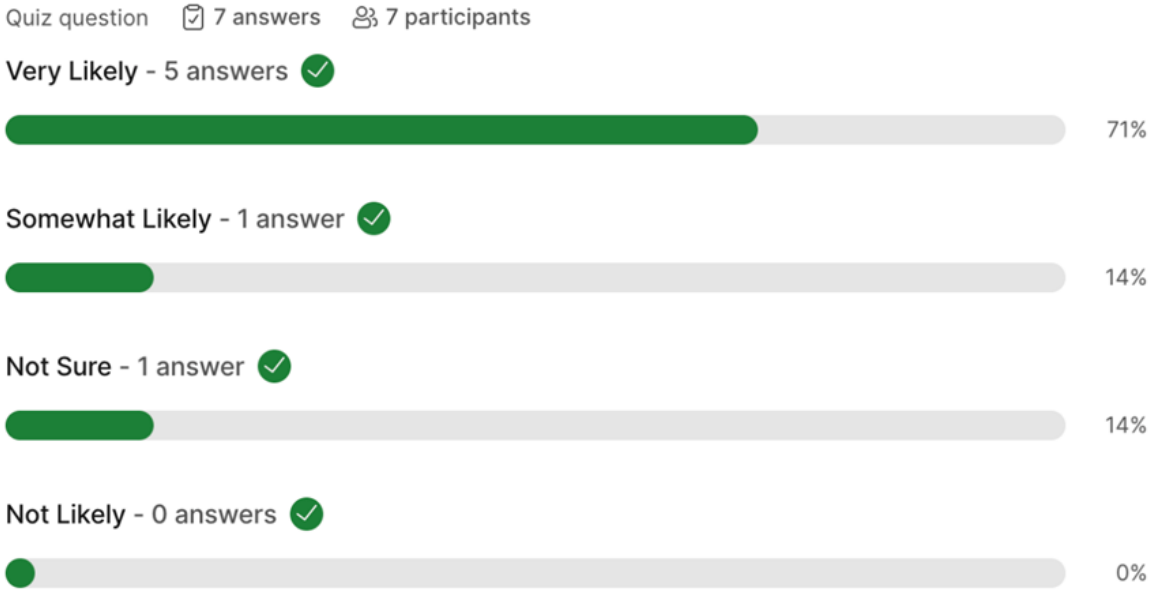


Figure 5. Rate how likely is to report a suspicious waste disposal site through the dedicated form provided by the platform

Q2: How important do you think it is to have a system in place for detecting and reporting illegal waste disposal?

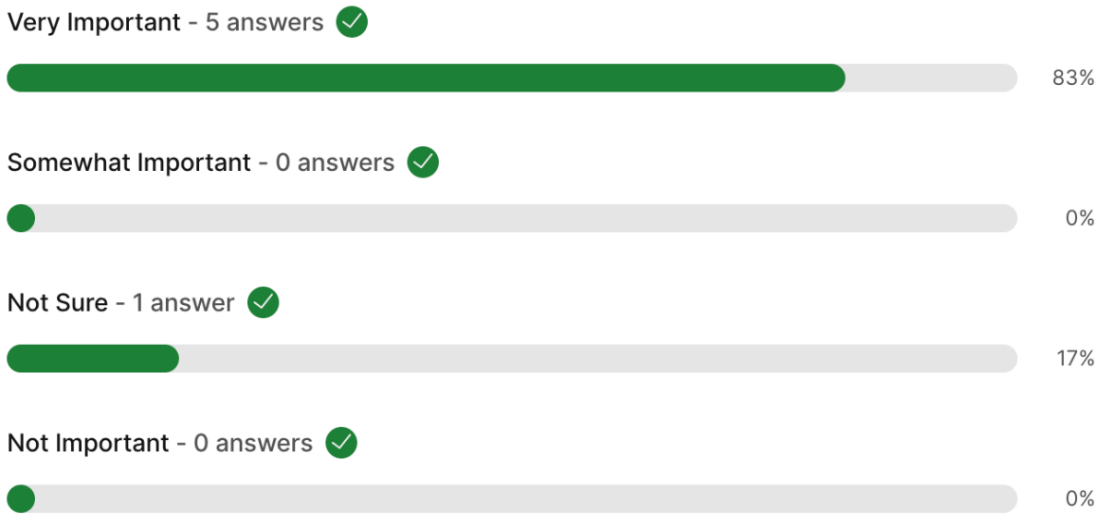


Figure 6: Importance of having a system in place for detecting and reporting illegal waste disposal.

Q3: Do you think the use of drones, cameras, and other tools for on-site inspections is a good approach?

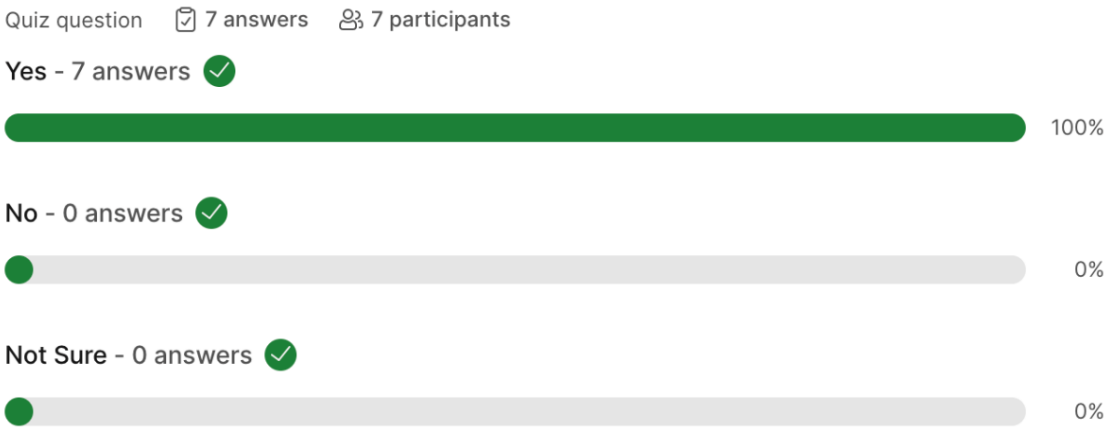


Figure 7: The usage of drones, cameras, and other tools for on-site inspections considered as a good approach.

Q4: How important is it for the platform to prioritise waste disposal sites for urgent investigation?

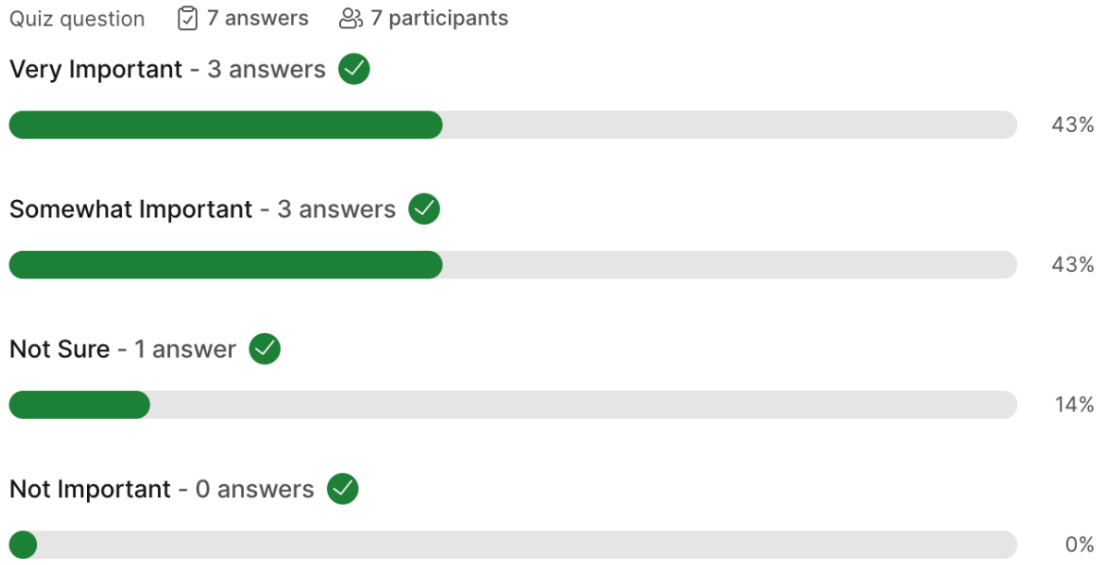


Figure 8: Importance of the platform to prioritise waste disposal sites for urgent investigation.

Q5: How likely are you to access the information made available to the general public, including a map visualisation of the waste disposal site and a summary of the violation?

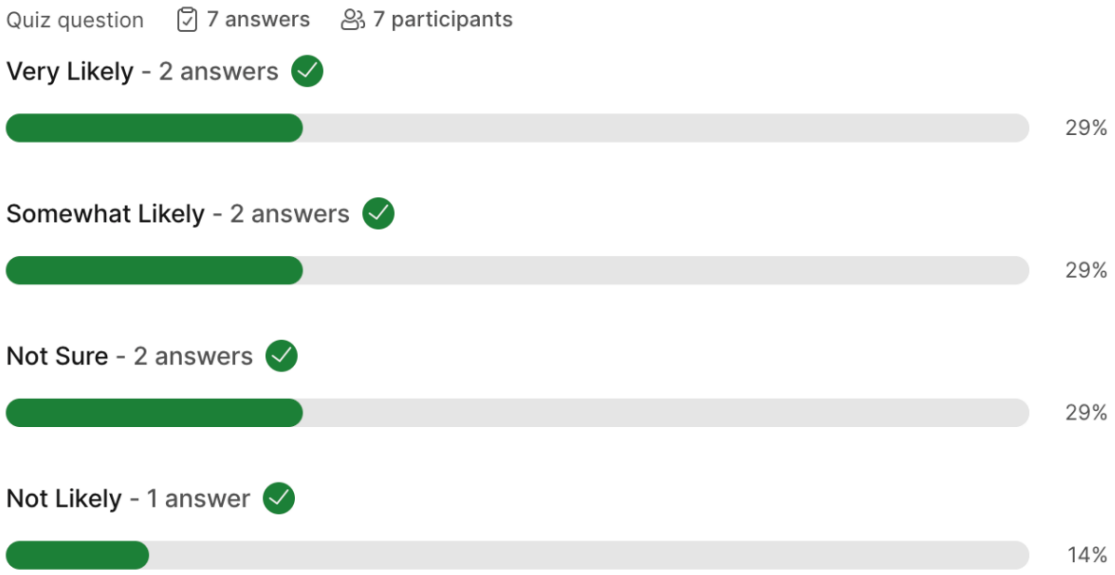


Figure 9. Rate how likely is to access the information made available to the general public, including a map visualisation of the waste disposal site and a summary of the violation.

Q6: Do you think the platform's system for detecting and reporting illegal waste disposal will be effective in reducing the amount of illegal waste disposal in the region?

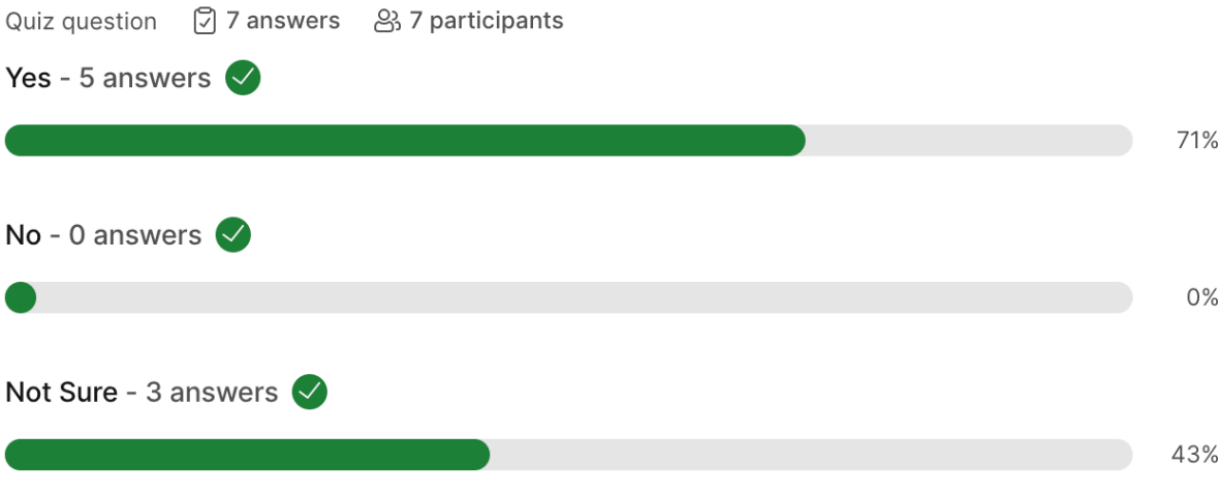


Figure 10. Efficiency of the platform's system for detecting and reporting illegal waste disposal in reducing the amount of illegal waste disposal in the region.

Q7: How important is it for local authorities to enforce environmental regulations in regard to illegal waste disposal?

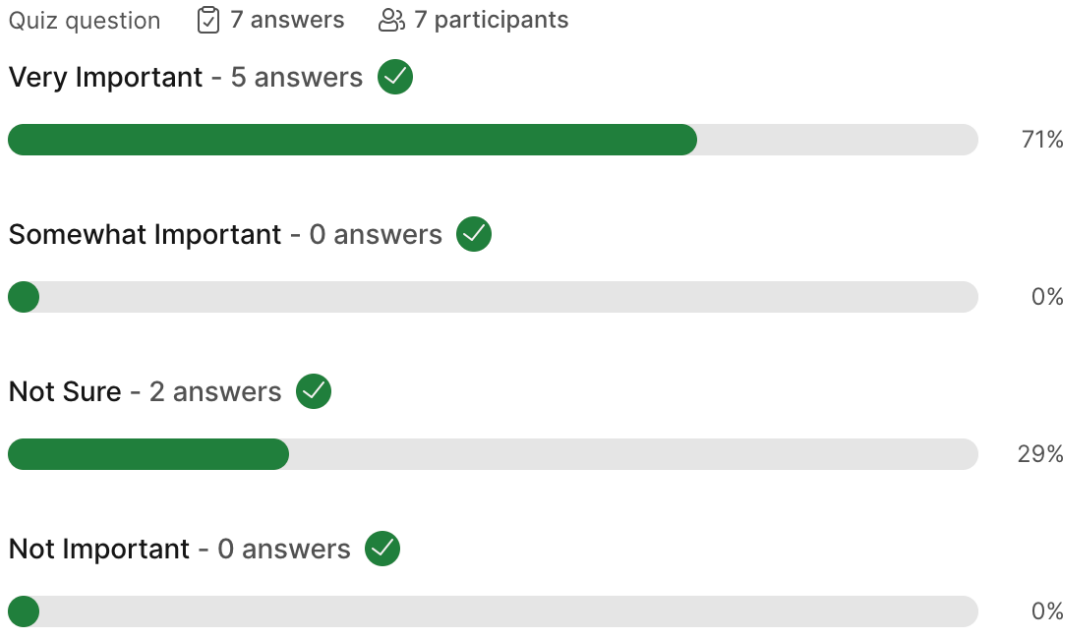


Figure 11. Importance of the local authorities to enforce environmental regulations in regard to illegal waste disposal.

USE CASE 2: Intentional dumping of polluting substances in land and water (A. Land pollutants)

Q1: How do we identify potential waste disposal sites?

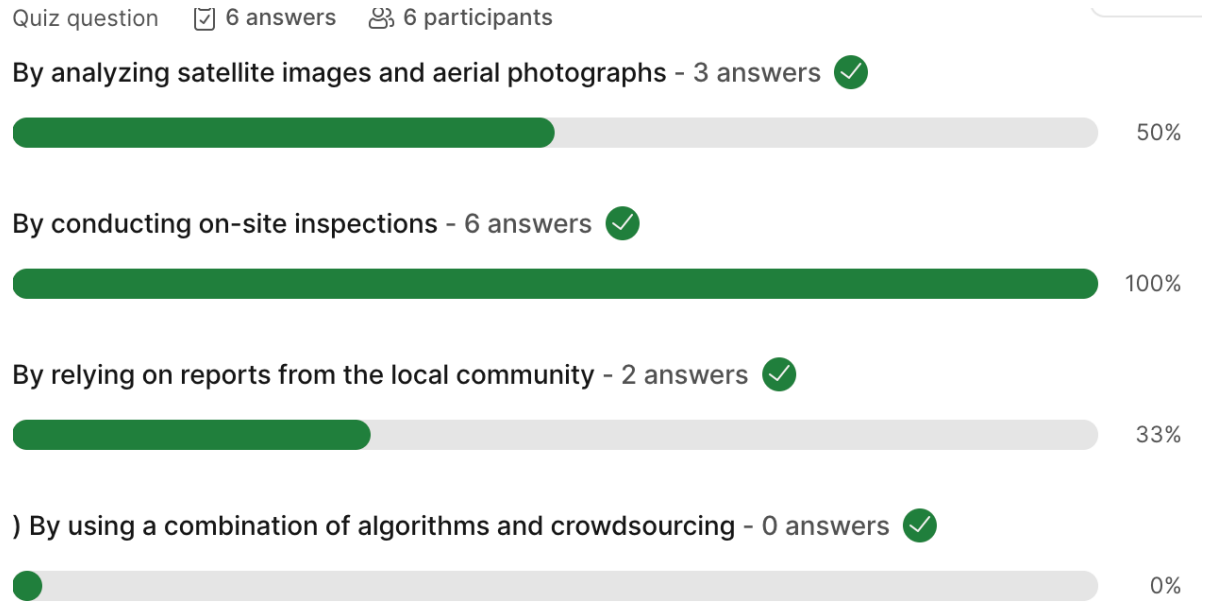


Figure 12. Ways to identify potential waste disposal sites.

Q2: What happens after a waste disposal site is identified?

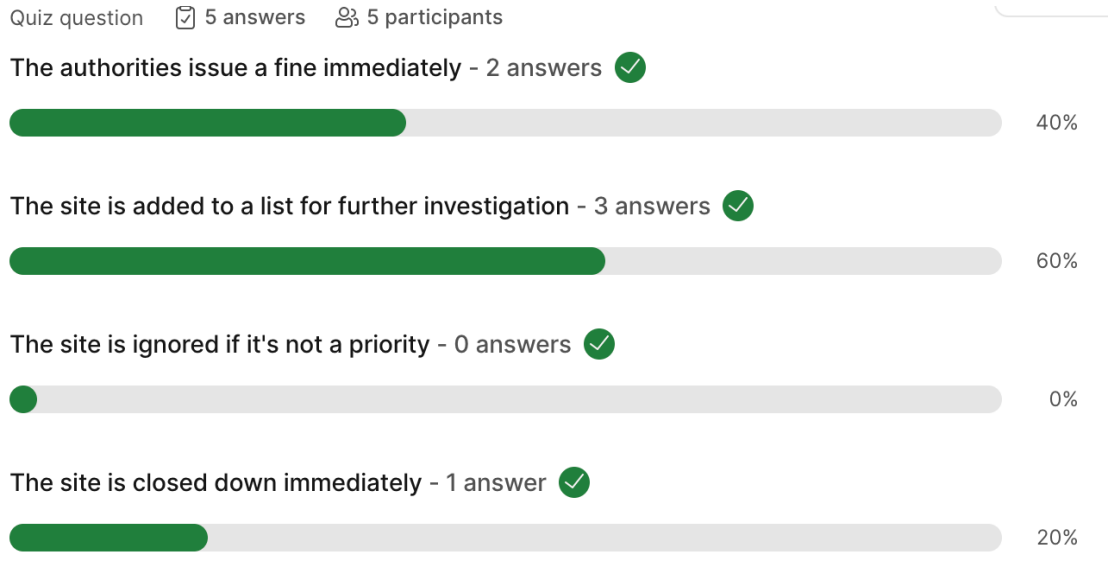


Figure 13. What happens after a waste disposal site is identified.

Q3: How is data collected from the waste disposal site?

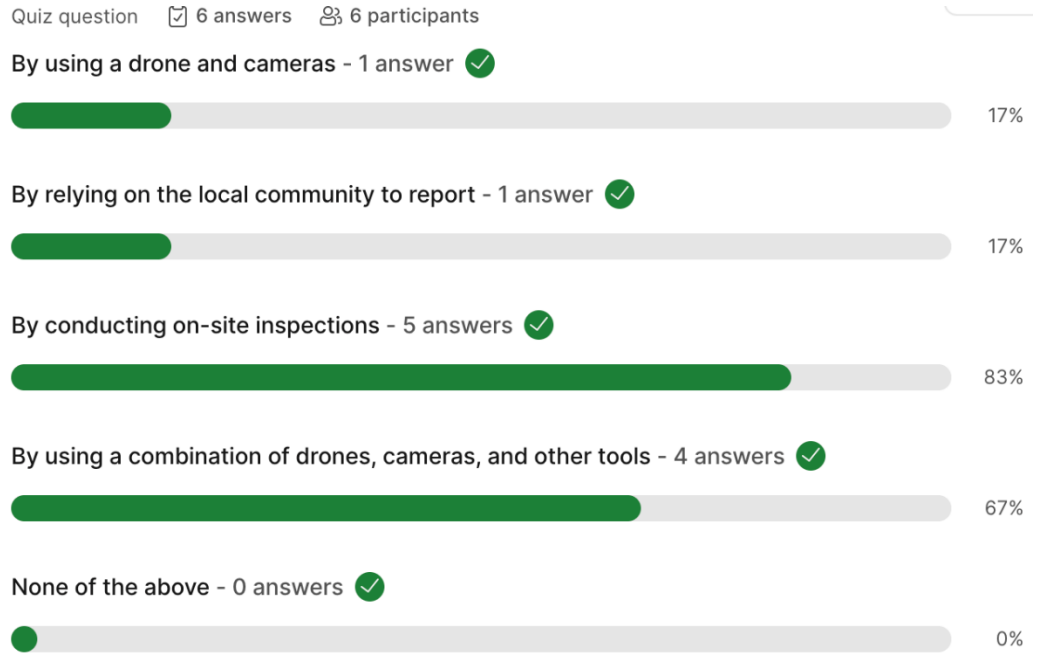


Figure 14. Ways of how data collected from a waste disposal site.

Q4: What tool do you use to collect data from the waste disposal site?

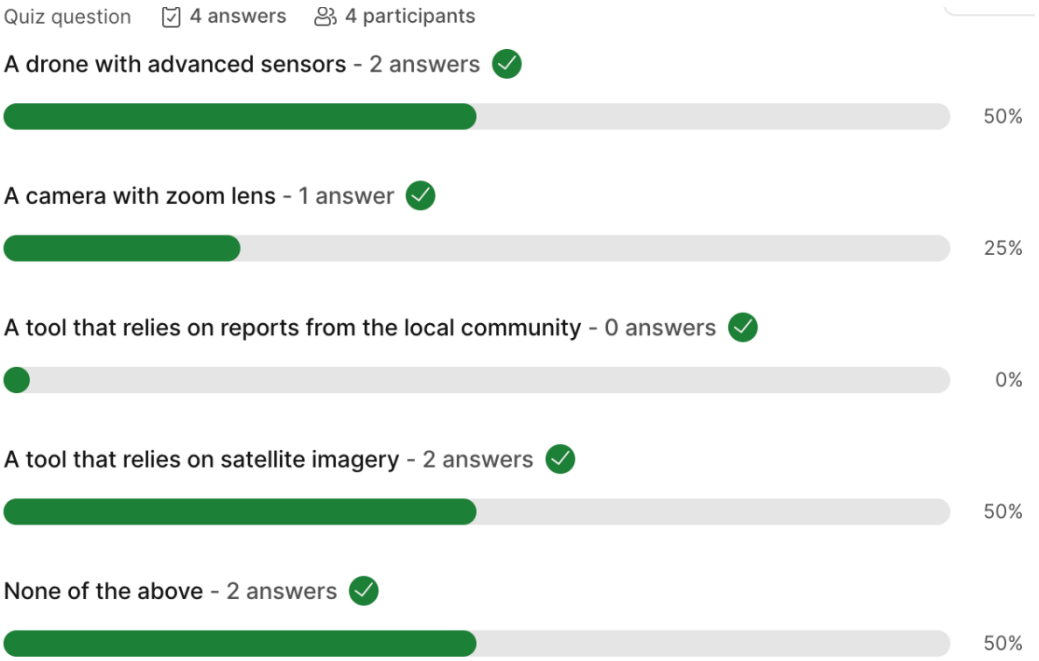


Figure 15. Tools used to collect data from the waste disposal site.

Q5: How is the collected data analysed and classified?

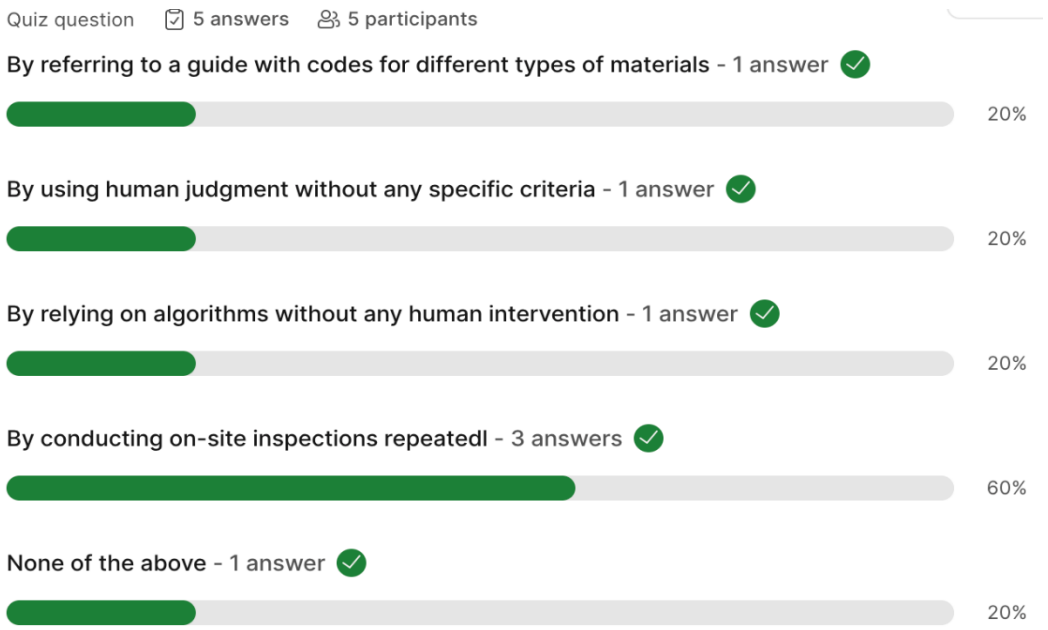


Figure 16. Ways the data analysed and classified.

Q6: What information is made available to the general public?

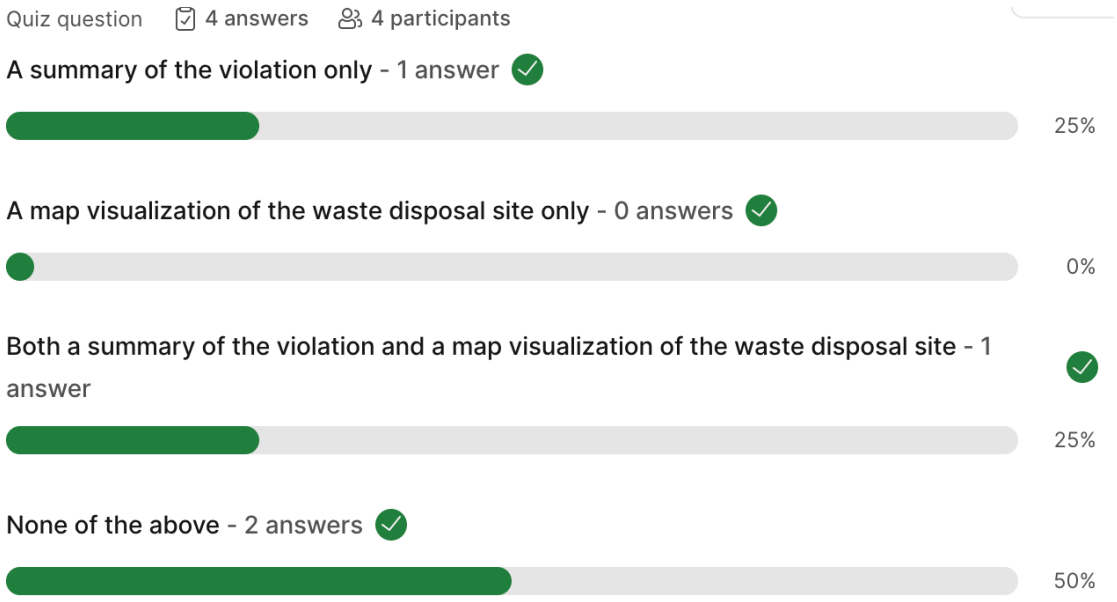


Figure 17. Information made available to the general public.

Q7: What happens after the authorities receive the report on the waste disposal site?

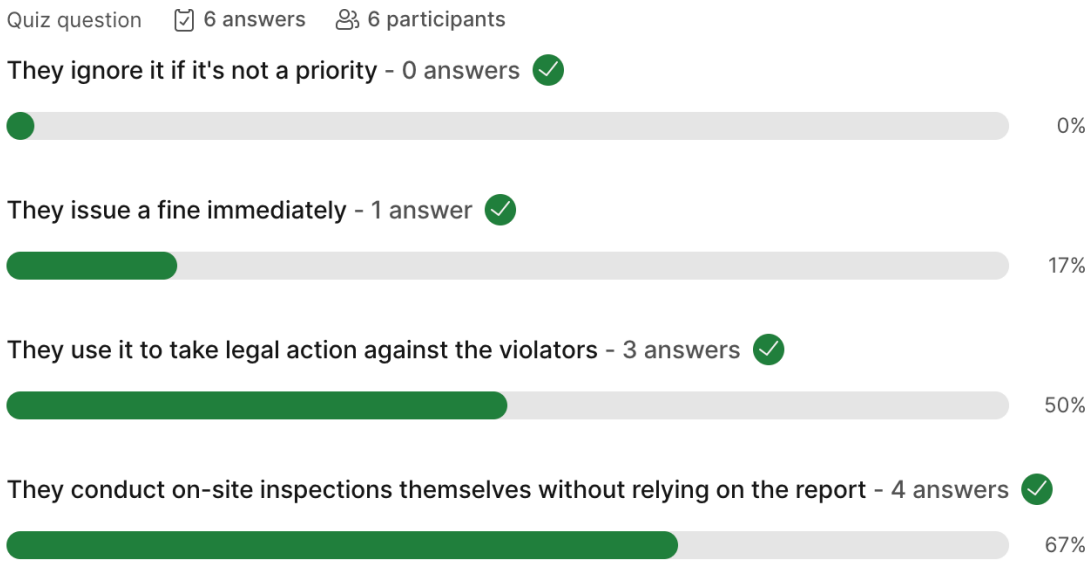


Figure 18. What happens after the authorities receive the report on the waste disposal site.

USE CASE 2: Intentional dumping of polluting substances in land and water (B. Water pollutants)

Q1: What types of substances are most commonly dumped intentionally in bodies of water?

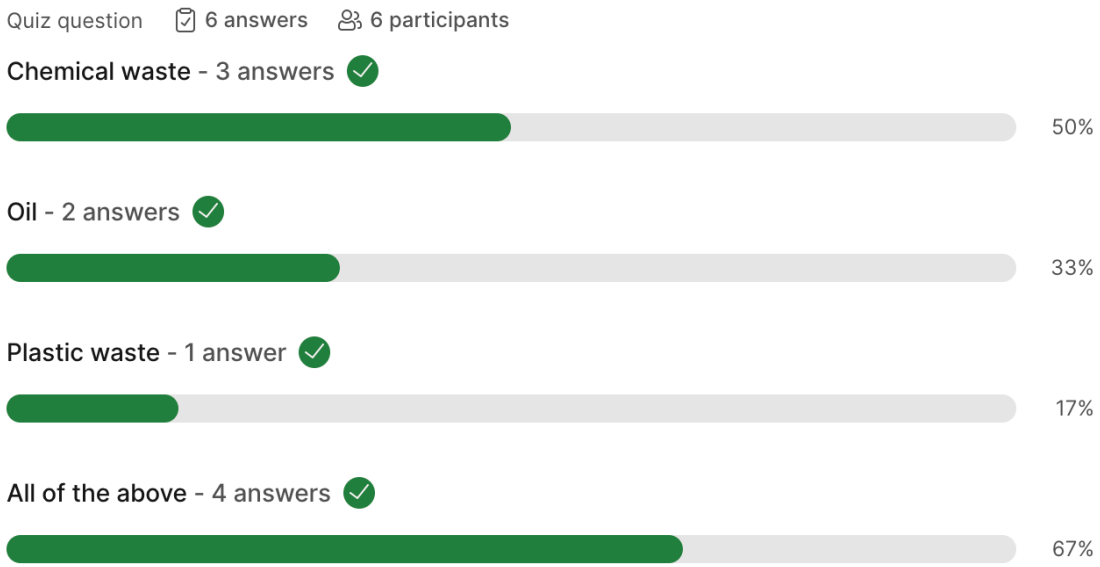


Figure 19. Types of substances are most commonly dumped intentionally in bodies of water.

Q2: In your experience, how frequently do intentional dumping incidents occur in bodies of water?

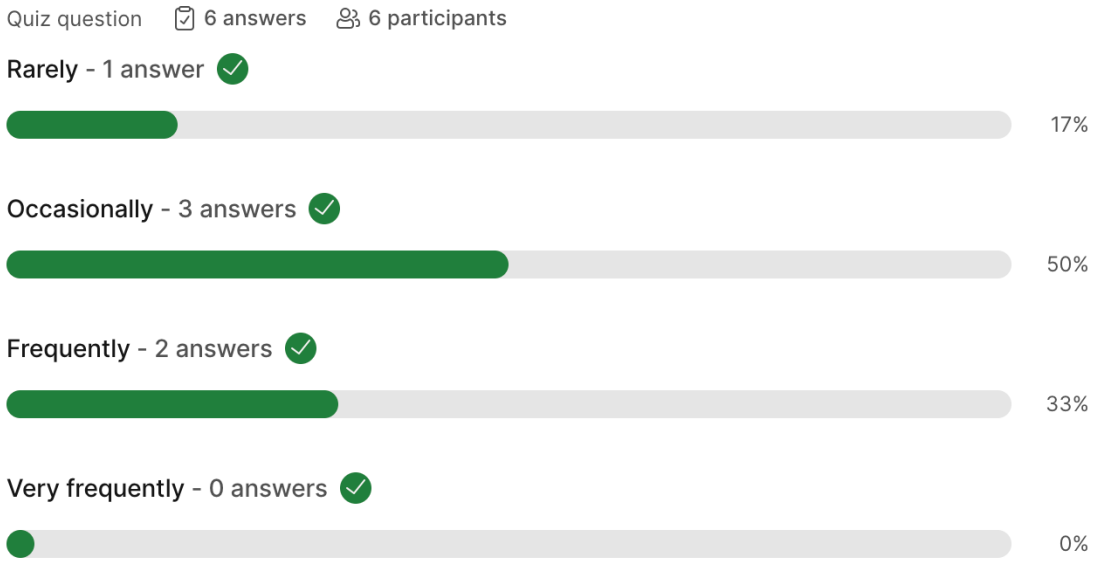


Figure 20. Frequency of intentional dumping incidents occur in bodies of water.

Q3: What measures do you think would be most effective in preventing intentional dumping of pollutants in water bodies?

Figure 21. Measures that would be most effective in preventing intentional dumping of pollutants in water bodies.

Q4: What are some of the main reasons why individuals or companies may intentionally dump pollutants in water bodies?

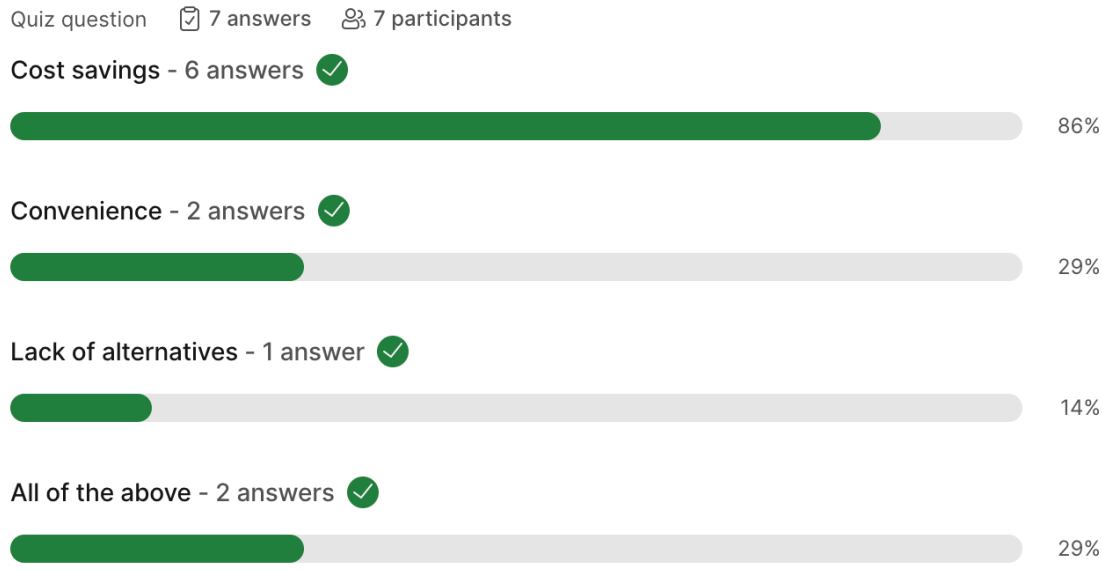


Figure 22. Main reasons why individuals or companies may intentionally dump pollutants in water bodies.

Q5: Have you personally witnessed intentional dumping of pollutants in a body of water?

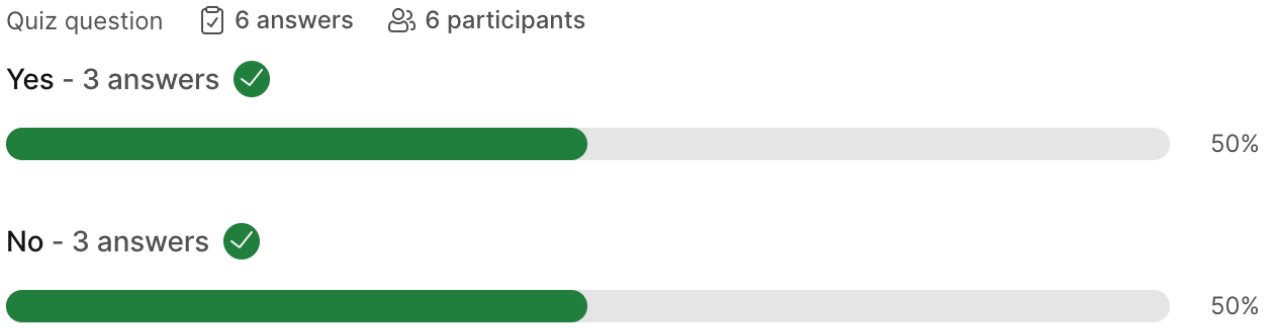


Figure 23. Personally witnessed intentional dumping of pollutants in a body of water.

Q6: In your opinion, what role should technology play in preventing intentional dumping of pollutants in water bodies?

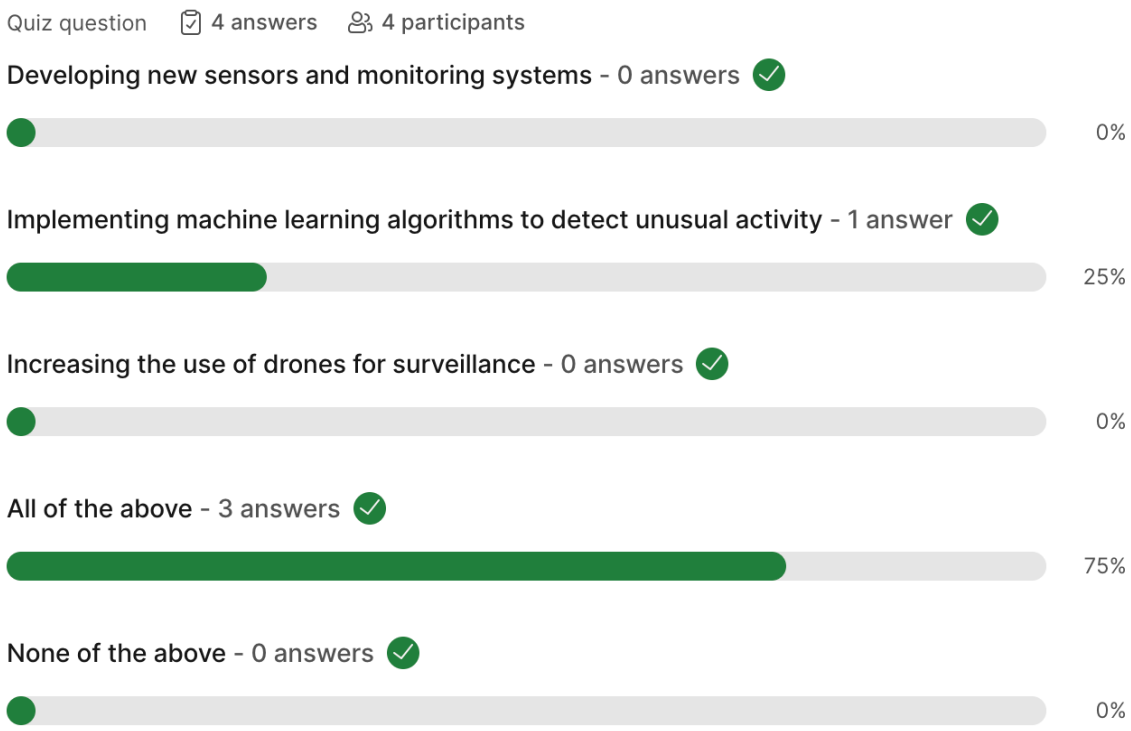


Figure 24. The role of technology preventing intentional duping of pollutants in water bodies.

Q7: Which government agencies do you believe are most responsible for preventing intentional dumping of pollutants in water bodies?

Figure 25. Government agencies that believe are the most responsible for preventing intentional dumping of pollutants in water bodies.

Q8: What are some of the potential long-term consequences of intentional dumping of pollutants in water bodies?

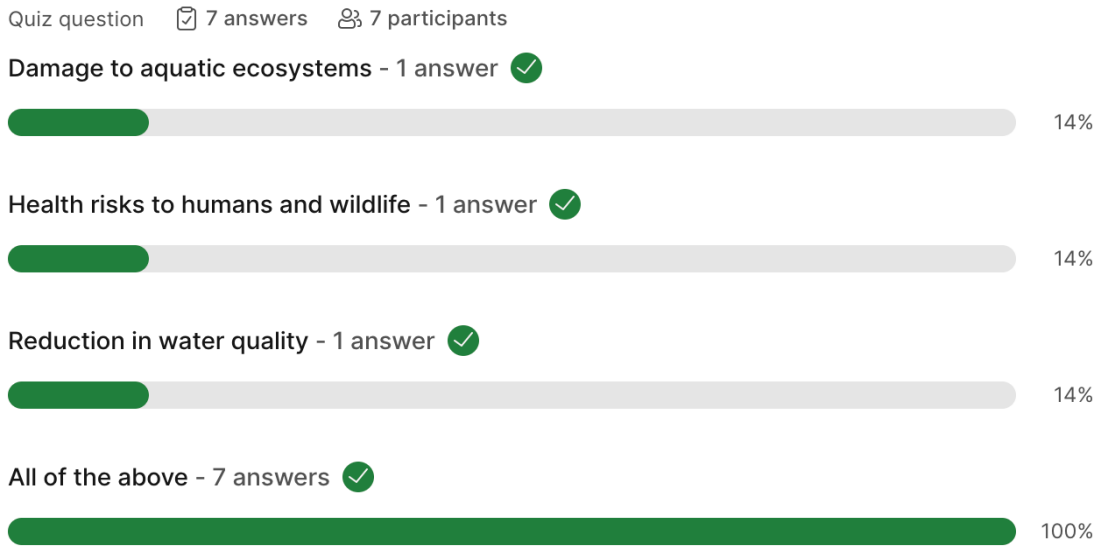


Figure 26. Potential long-term consequences of intentional dumping of pollutants in water bodies.

USE CASE 3: Transnational illegal trafficking of waste electronic and electrical equipment (Scenario A)

Q1: What are the most common types of electronic waste that are illegally trafficked across borders?

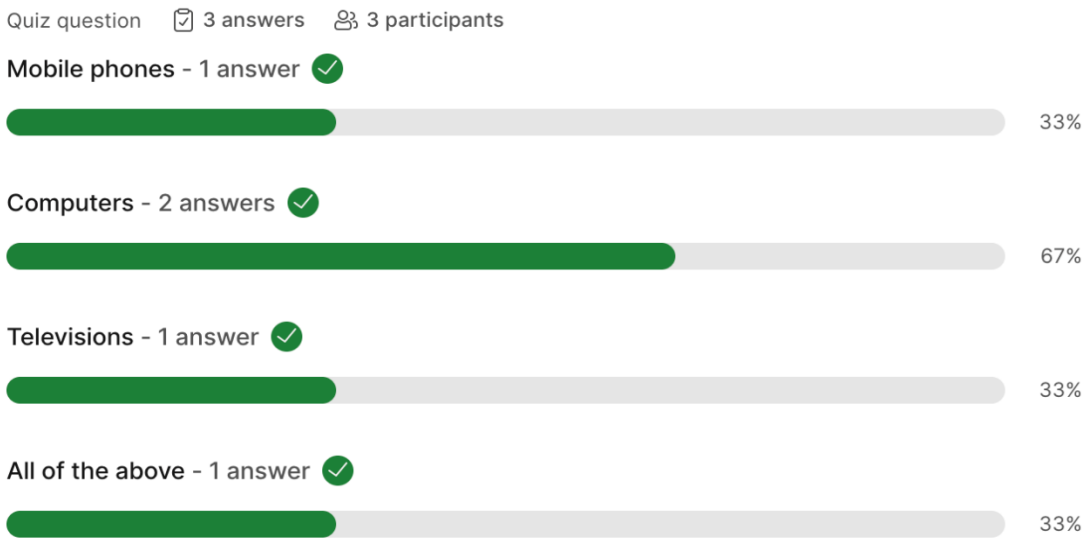


Figure 27. Most common types of electronic waste that are illegally trafficked across borders.

Q2: Which regions or countries are the most common destinations for illegally trafficked e-waste?

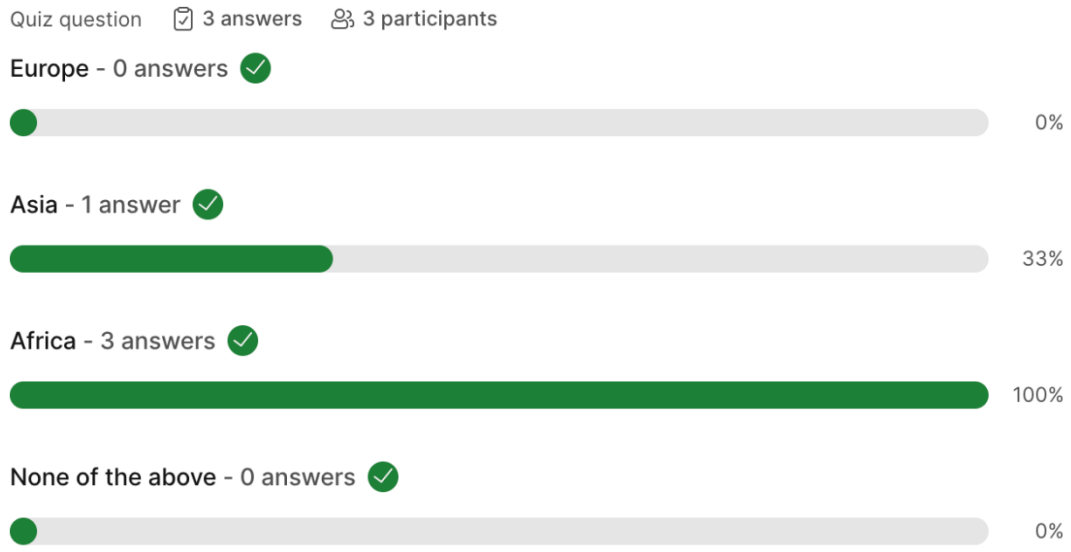


Figure 28. Regions or countries are the most common destinations for illegally trafficked e-waste.

Q3: What are the primary methods used by criminal networks to smuggle e-waste across borders?

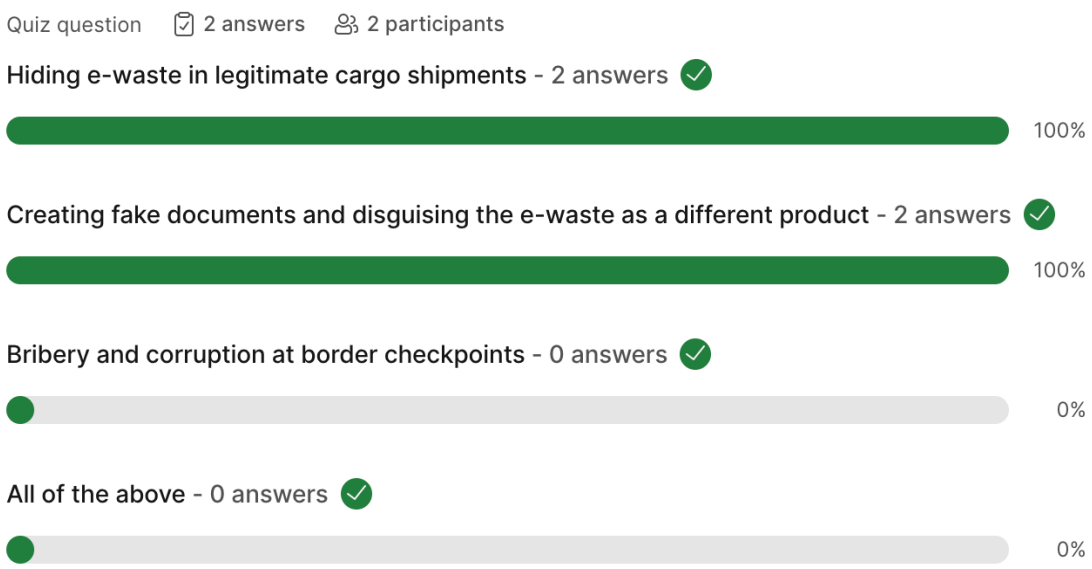


Figure 29. The primary methods used by criminal networks to smuggle e-waste across borders.

Q4: What are the environmental risks associated with illegally dumped e-waste?

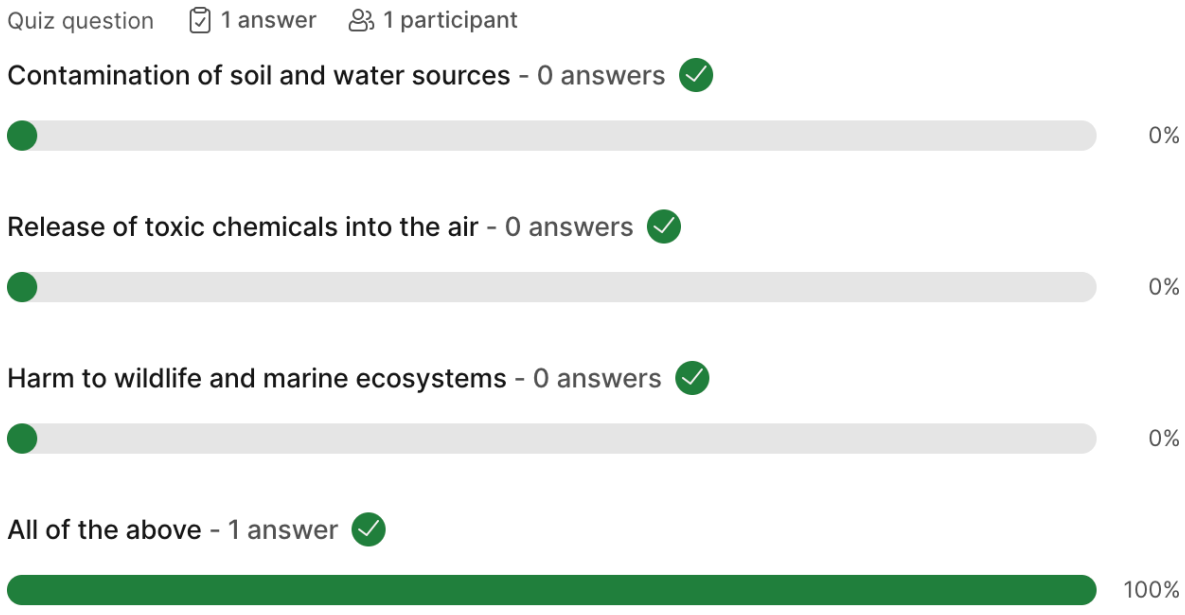


Figure 30. Environmental risks associated with illegally dumped e-waste.

USE CASE 3: Transnational illegal trafficking of waste electronic and electrical equipment (Scenario B)

Q1: How can technology be used to detect and track illegally trafficked e-waste?

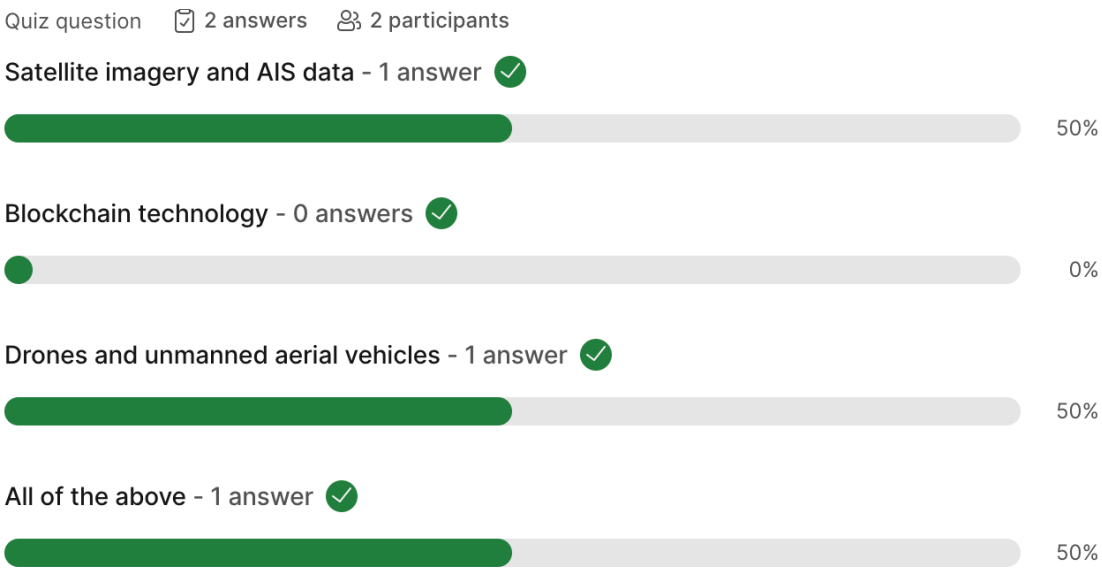


Figure 31. How can technology be used to detect and track illegally trafficked e-waste.

Q2: What are the challenges faced by law enforcement agencies in identifying and intercepting illegal e-waste shipments?

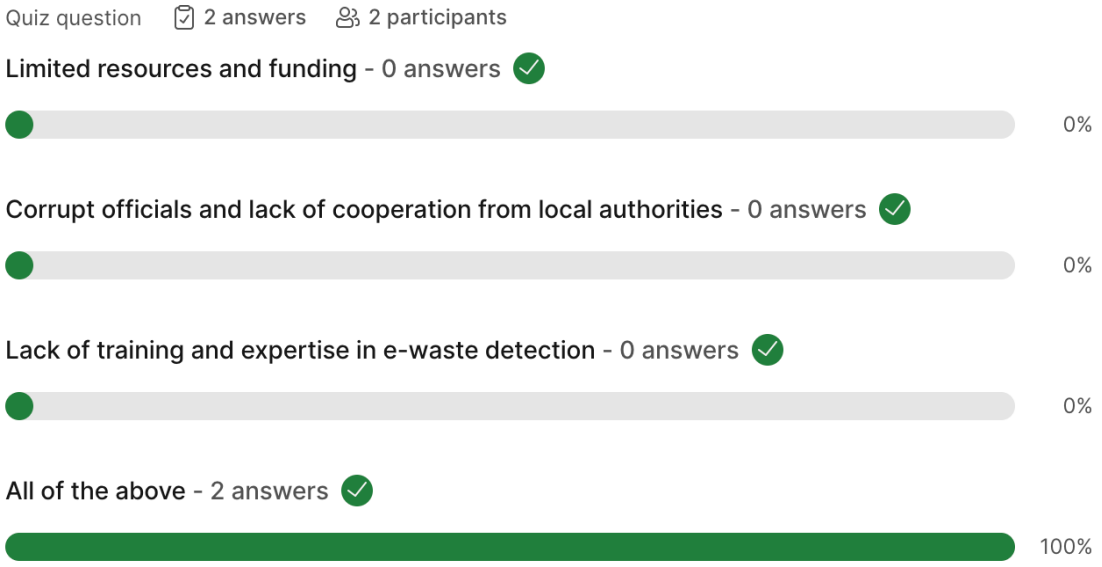


Figure 32. The challenges faced by law enforcement agencies in identifying and intercepting illegal e-waste shipment.

Q3: How can international cooperation and collaboration between law enforcement agencies help to combat the illegal trafficking of e-waste?

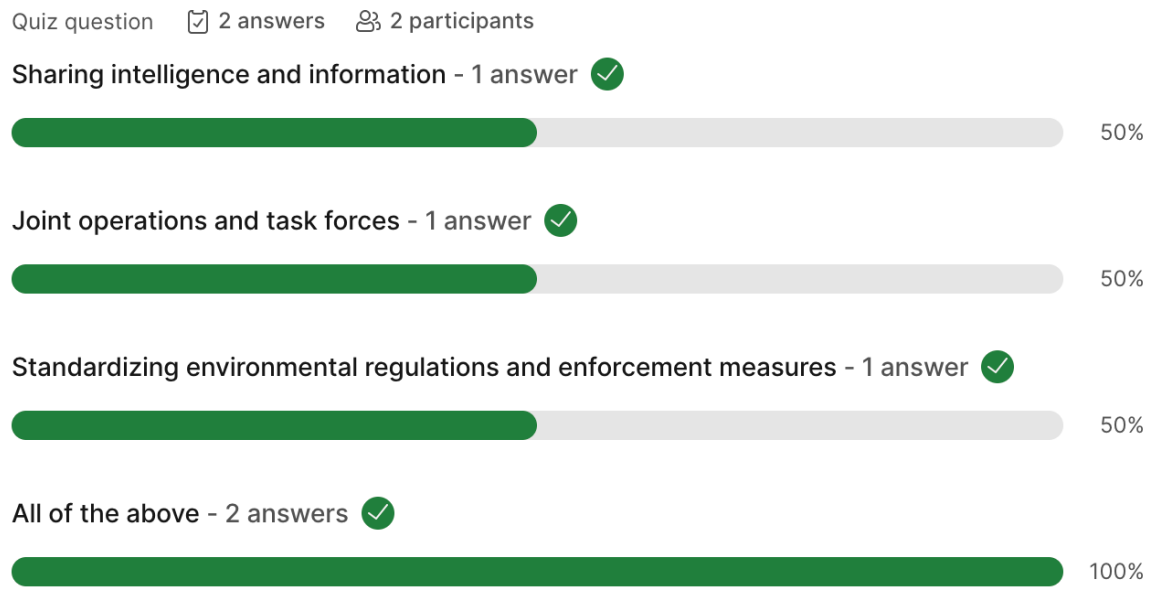


Figure 33. How can international cooperation and collaboration between law enforcement agencies help to combat the illegal trafficking of e-waste.

Q4: What are the potential economic impacts of the illegal trafficking of e-waste?

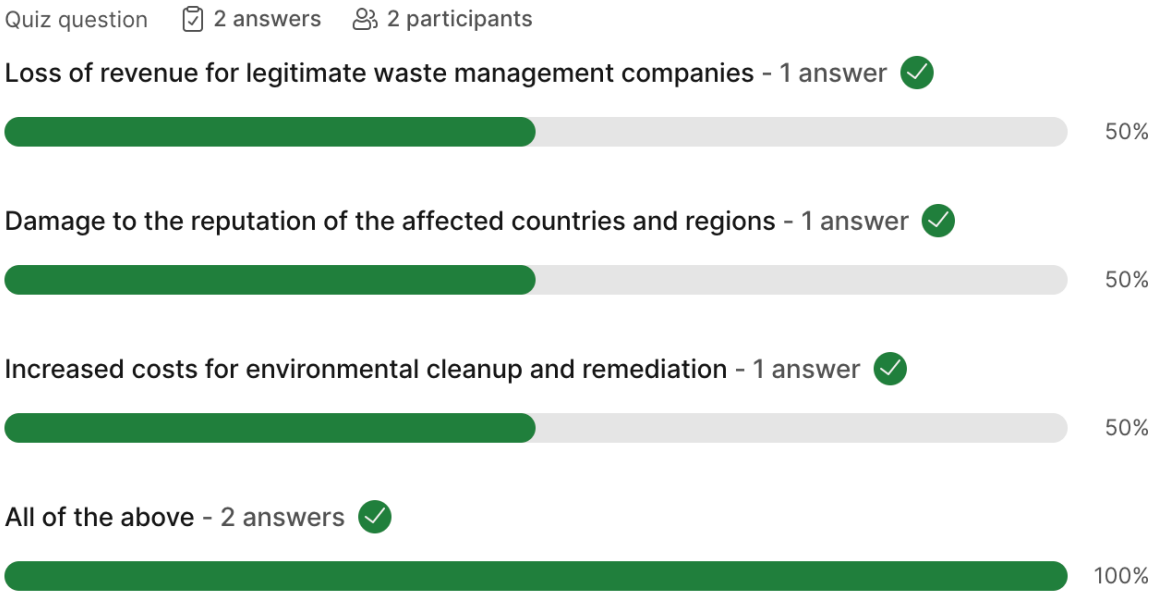


Figure 34. The potential economic impacts of the illegal trafficking of e-waste.

Q5: What steps can be taken to prevent the illegal trafficking of e-waste?

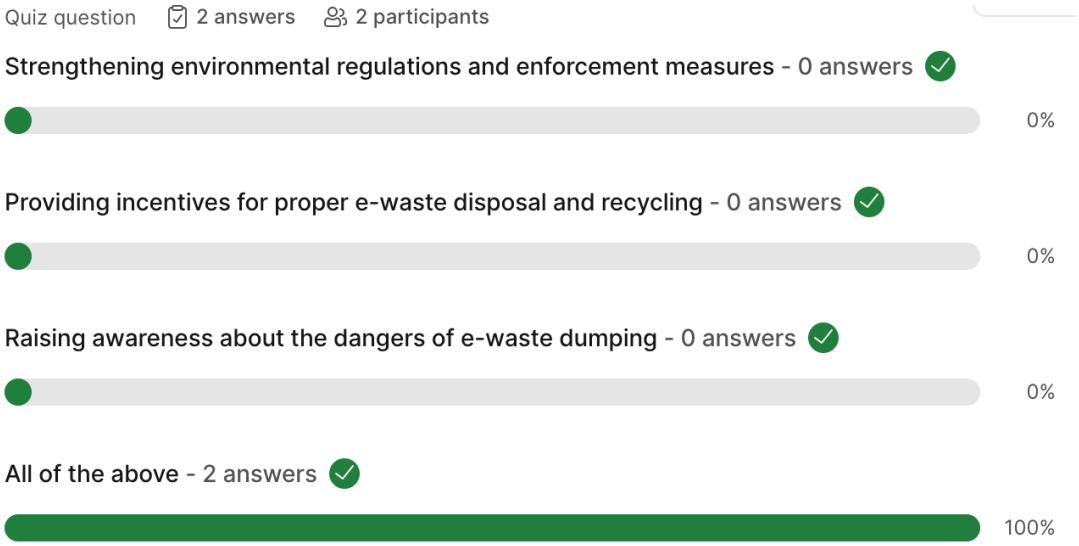


Figure 35. Steps can be taken to prevent the illegal trafficking of e-waste.

USE CASE 4: Illegal trade in ozone- depleting substances & HFCs (Illegal smuggling)

Q1: What measures would you prioritise for preventing illegal smuggling of ozone-depleting substances and HFCs?

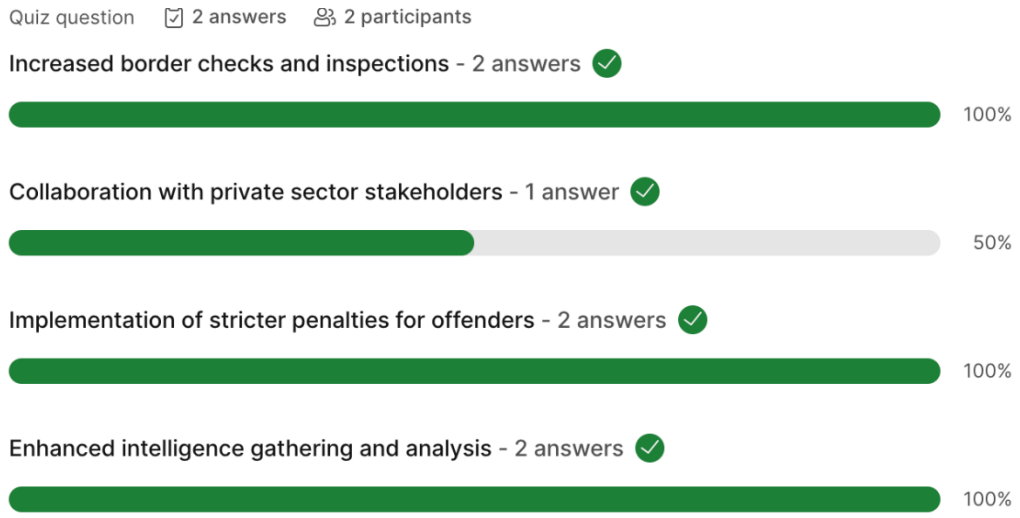


Figure 36. What measures would you prioritise for preventing illegal smuggling of ozone-depleting substances and HFCs.

Q2: How effective do you think current international treaties and agreements are in combating the illegal smuggling of ozone-depleting substances and HFCs?

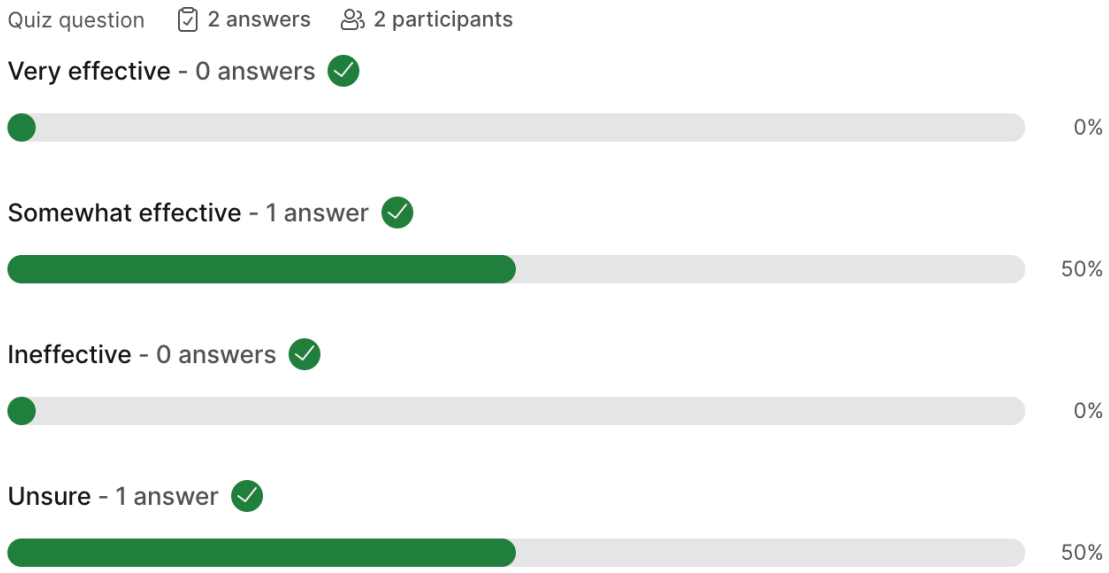


Figure 37. How effective do you think current international treaties and agreements are in combating the illegal smuggling of ozone-depleting substances and HFCs.

Q3: What role can technology play in combating the illegal smuggling of ozone-depleting substances and HFCs?

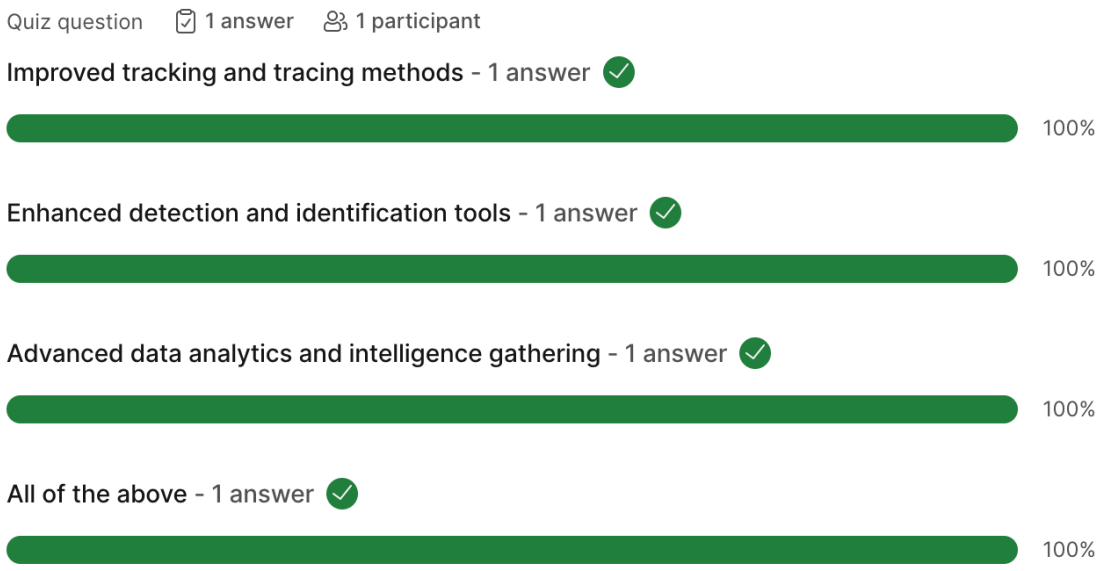


Figure 38. The role can technology play in combating the illegal smuggling of ozone-depleting substances and HFCs.

Q4: How important is cross-border cooperation and information sharing among law enforcement agencies in combating illegal smuggling of ozone-depleting substances and HFCs?

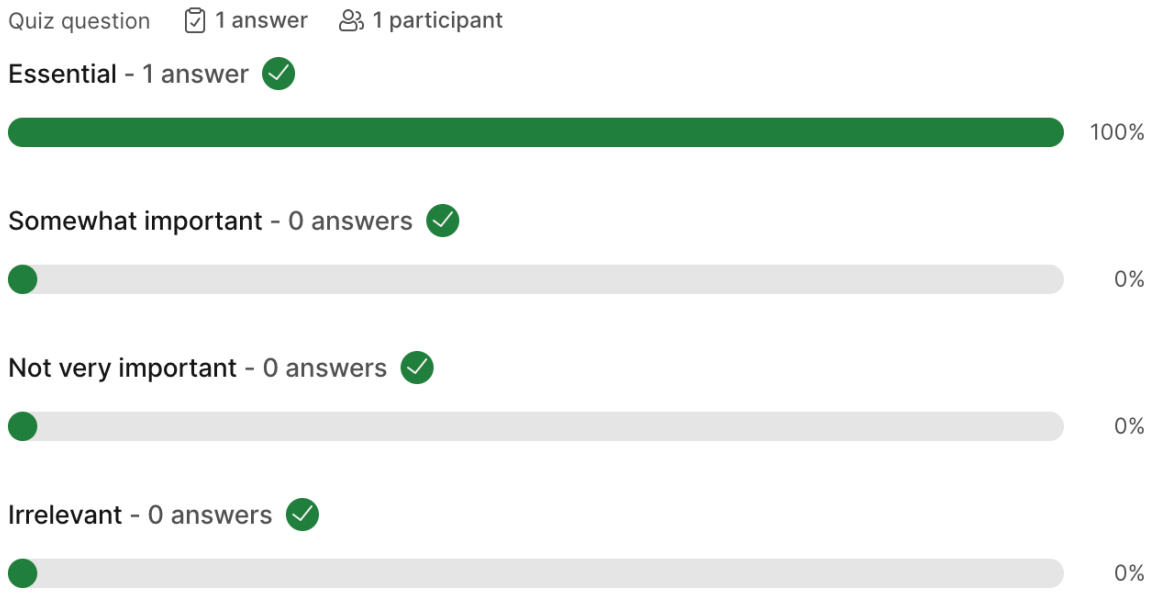


Figure 39. Importance of cross-border cooperation and information sharing among law enforcement agencies in combating illegal smuggling of ozone-depleting substances and HFCs.

Q5: What challenges do you foresee in combatting the illegal smuggling of ozone-depleting substances and HFCs in the future?

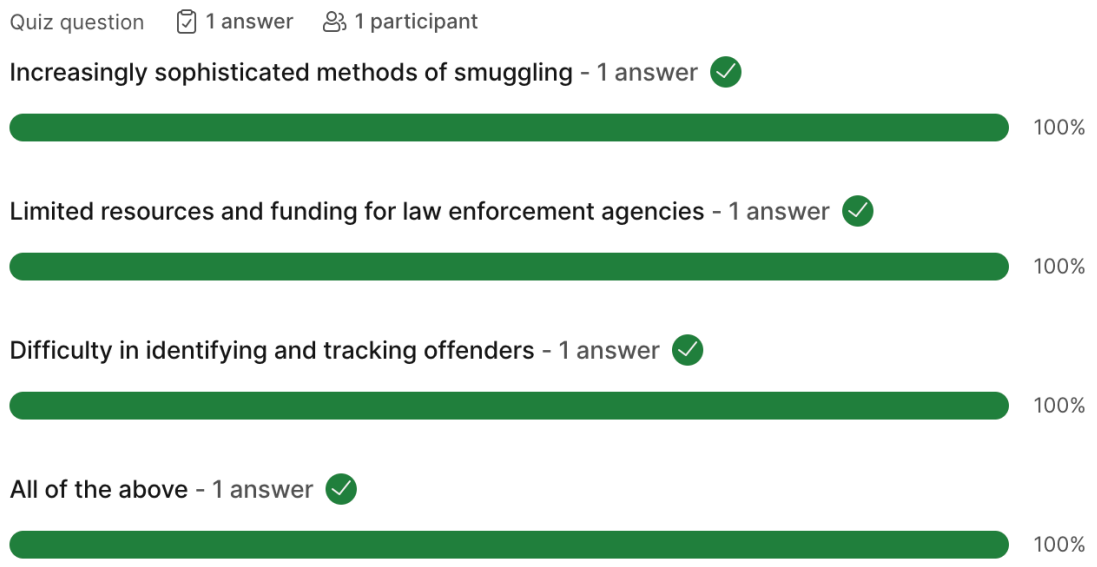


Figure 40. Challenges you foresee in combatting the illegal smuggling of ozone-depleting substances and HFCs in the future.

Q6: What recommendations do you have for improving international efforts to combat the illegal smuggling of ozone-depleting substances and HFCs?

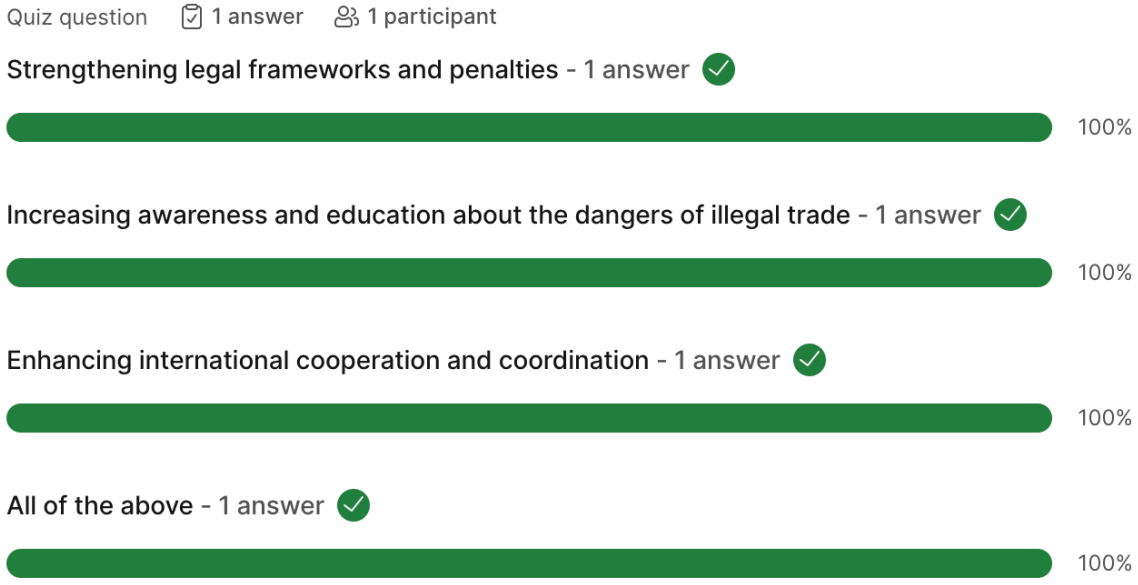


Figure 41. What recommendations do you have for improving international efforts to combat the illegal smuggling of ozone-depleting substances and HFCs.

USE CASE 4: Illegal trade in ozone- depleting substances & HFCs (Online illegal trade)

Q1: What measures do you currently have in place to monitor and combat illegal online trade of ODS and HFCs?

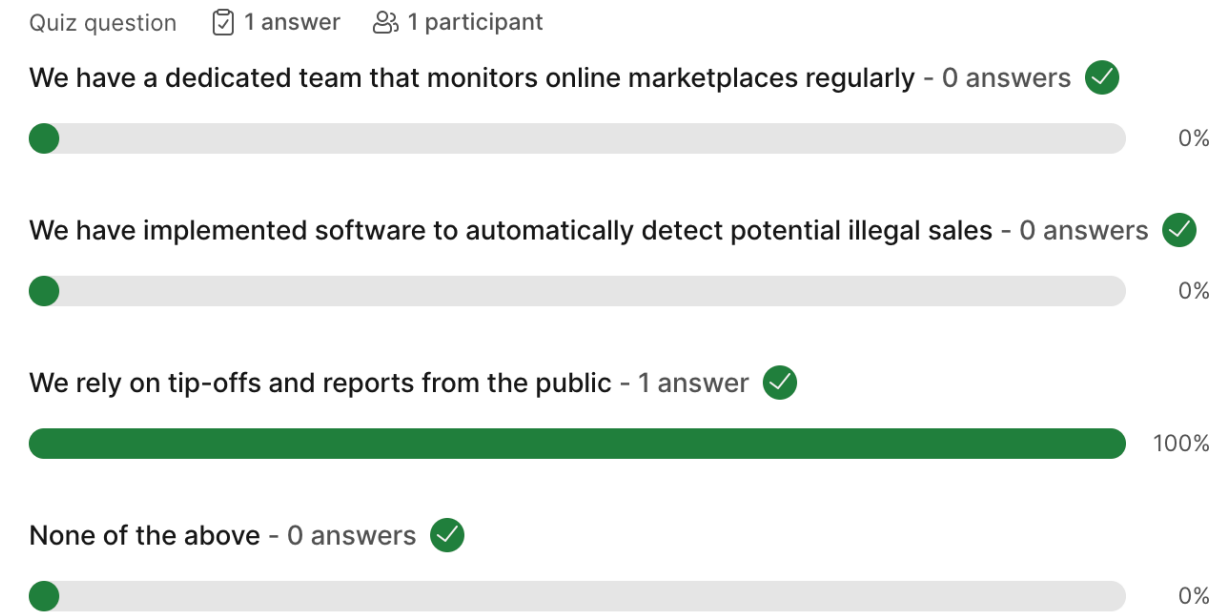


Figure 42. Measures you currently have in place to monitor and combat illegal online trade of ODS and HFCs.

Q2: How can we improve international cooperation in combating illegal trade in ODS and HFCs?

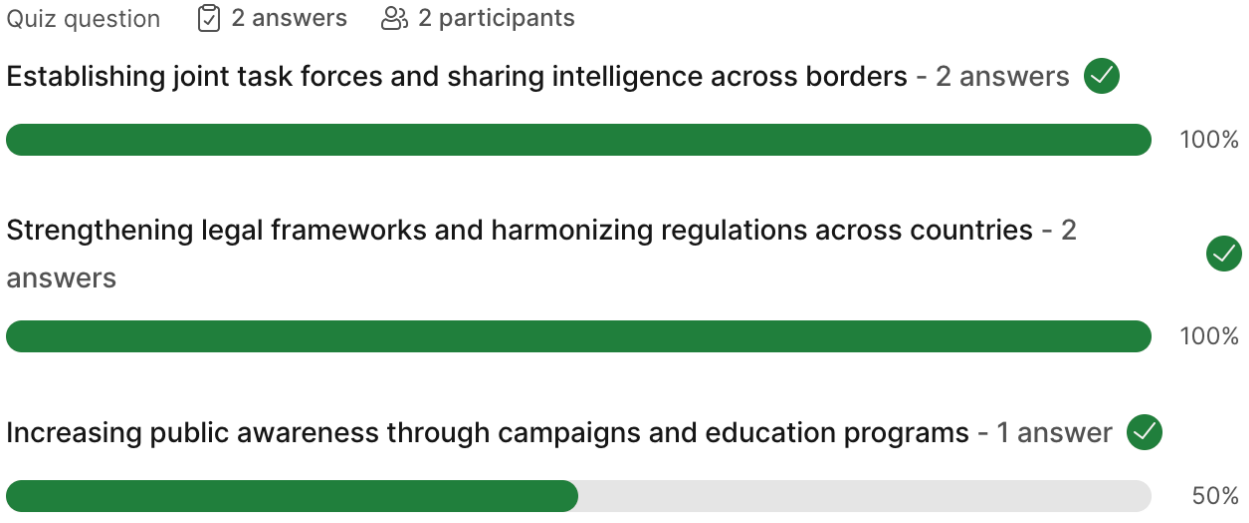


Figure 43. How can improved the international cooperation in combating illegal trade in ODS and HFCs.

Q3: What challenges do you face when investigating online illegal trade in ODS and HFCs?

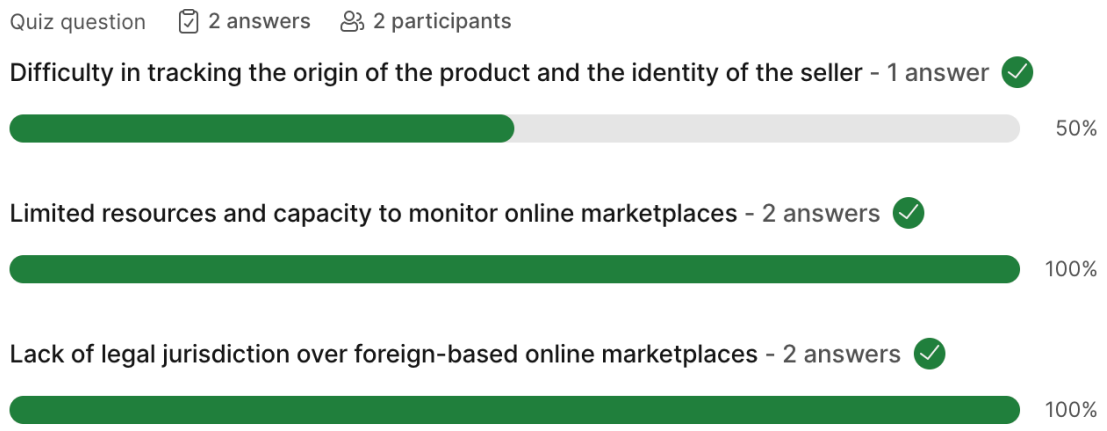


Figure 44. Challenges you face when investigating online illegal trade in ODS and HFCs.

Q4: How can we enhance the effectiveness of preventive measures against illegal online trade of ODS and HFCs?

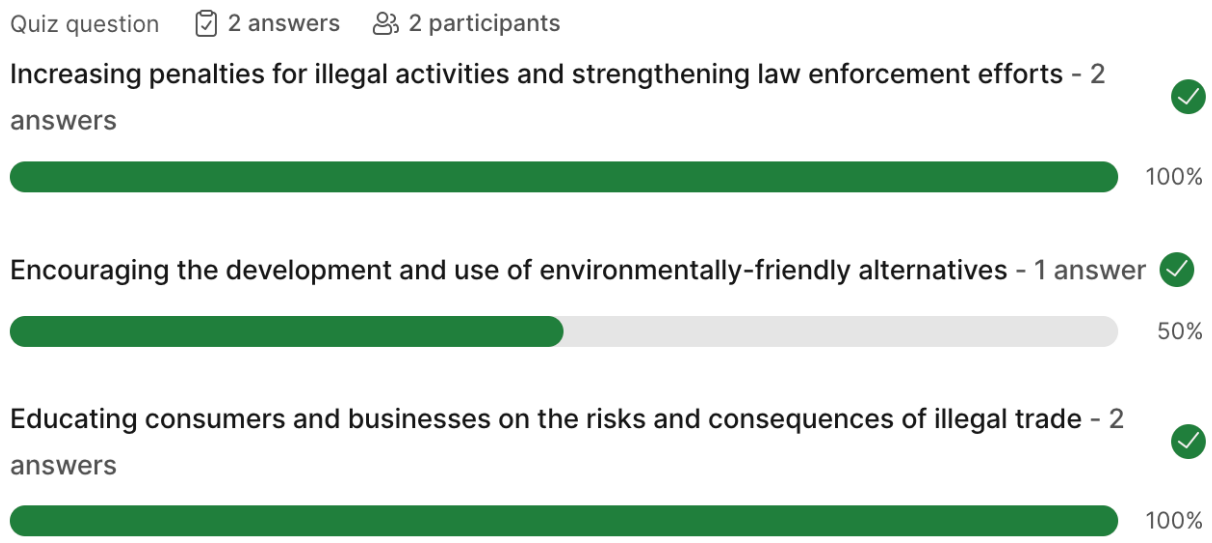


Figure 45. How can we enhance the effectiveness of preventive measures against illegal online trade of ODS and HFCs.

Q5: How can we improve communication and collaboration between law enforcement agencies and other stakeholders in combating illegal online trade of ODS and HFCs?

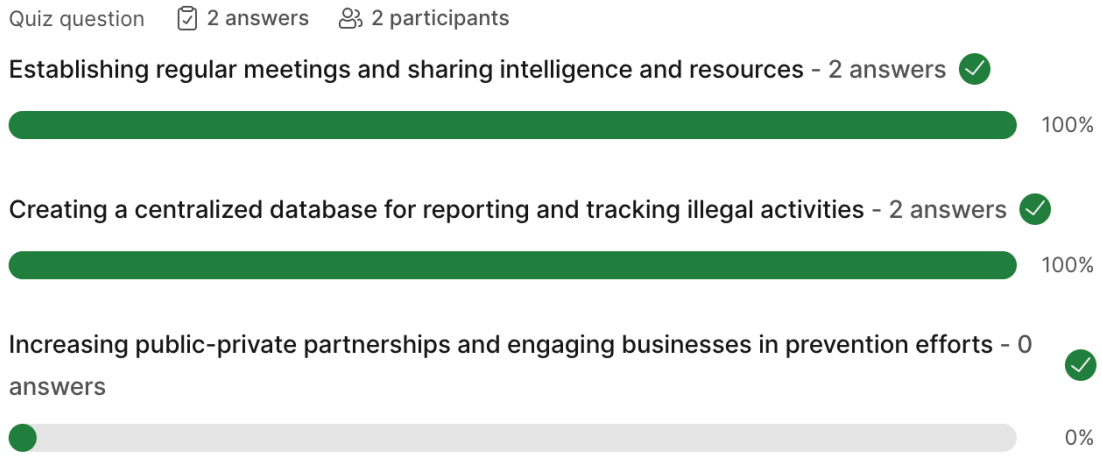


Figure 46. How can we improve communication and collaboration between law enforcement agencies and other stakeholders in combating illegal online trade of ODS and HFCs.

Annex C: Form used to collect End-users' Requirements

30 minutes

Evaluation Form for the Requirements of the PERIVALLON Project

Thank you for paticipating in the 1st Workshop organised by KEMEA. During the workshop presented the draft scenarios of the PUCs and the user requirements. Please fill this evaluation form to provide your feedback, in order to prioritize the requirements based on the MoSCoW method.

* Required

General

1. Please enter your organisation. *

2. Please enter your role in the organisation. *

3. Please enter your country. *

Functional Requirements

Please from scale 1 to 4 choose:
Won't: not a priority (1) , Could: important (2) , Should: serious (3) , Must: critical (4)

4. Ability to acquire high-resolution satellite images and aerial photography data.

*

1	2	3	4

5. Automated image processing and analysis to detect potential waste disposal sites. *

1	2	3	4

6. Integration with ground-based sensors, such as drones and cameras, to verify the presence of waste. *

1	2	3	4

7. Ability to identify patterns and anomalies in the data that may indicate the presence of waste. *

1	2	3	4

8. Machine learning algorithms that can learn from data and improve the accuracy of detection. *

1	2	3	4

9. Automated notifications and alerts when new potential waste disposal sites are identified. *

1	2	3	4

10. Ability to track the location, volume, and type of waste detected. *

1	2	3	4

11. Integration with GIS and mapping tools to visualize the location of waste disposal sites. *

1	2	3	4

12. Cloud-based architecture for scalability and accessibility. *

1	2	3	4

13. Multi-language support for global use. *

1	2	3	4

14. Integration with local government databases to cross-check known waste sites. *

1	2	3	4

15. Customizable data analysis dashboards to view trends and data insights. *

1	2	3	4

16. Ability to compare data from different time periods to identify changes in waste patterns. *

1	2	3	4

17. Data encryption and secure data transfer. *

1	2	3	4

18. Ability to manage users and roles with appropriate permissions. *

1	2	3	4

19. Integration with social media and citizen reporting channels for real-time alerts. *

1	2	3	4

20. Machine learning algorithms to identify different types of waste, such as hazardous waste, organic waste, or electronic waste. *

1	2	3	4

21. Geo-fencing features to alert when a waste site has been tampered with or increased. *

1	2	3	4

22. Real-time monitoring and updates of waste sites. *

1	2	3	4

23. Integration with drones to create 3D models and better understand waste site features. *

1	2	3	4

24. Historical data analysis to identify long-term waste trends. *

1	2	3	4

25. Integration with existing environmental regulations and laws for disposal. *

1	2	3	4

26. Automated reporting for regulatory compliance. *

1	2	3	4

27. Automated trend analysis for identification of hotspots and trends. *

1	2	3	4

28. Ability to detect waste in remote or inaccessible areas. *

1	2	3	4

29. Ability to generate heatmaps to indicate the density of waste sites. *

1	2	3	4

30. Ability to track waste volume and monitor how it changes over time. *

1	2	3	4

31. Integration with weather forecasts to understand how changes in weather might affect waste patterns. *

1	2	3	4

32. Collaboration with local communities to share data and promote awareness. *

1	2	3	4

33. Integration with mobile applications for easier access to real-time data. *

1	2	3	4

34. Automated identification of waste sources. *

1	2	3	4

35. Ability to analyze waste data by geographic regions, proximity to bodies of water, and other environmental factors. *

1	2	3	4

36. Capability to run offline analysis and data validation. *

1	2	3	4

37. Automated notification to law enforcement agencies in case of hazardous waste. *

1	2	3	4

38. Integration with third-party data providers for additional data sources. *

1	2	3	4

39. Ability to export data in a variety of formats for analysis and visualization. *

1	2	3	4

40. Alarms will be generated when a vessel is observed with a suspicious direction towards ports or configurable coastal areas of interest. *

1	2	3	4

41. Machine learning algorithms to identify sources of waste. *

1	2	3	4

42. Integration with IoT sensors and networks. *

1	2	3	4

43. Automated workflows and decision-making systems for waste site responses. *

1	2	3	4

44. Integration with machine vision to recognize waste objects. *

1	2	3	4

45. Use of multispectral sensors to identify different types of waste. *

1	2	3	4

46. Ability to identify illegal waste dumping from land, sea, or air vehicles. *

1	2	3	4

47. Identification of changes in topography, vegetation, and soil color that may indicate illegal waste dumping. *

1	2	3	4

48. Analysis of soil and groundwater samples to identify the presence of contaminants. *

1	2	3	4

49. Integration with models that simulate the spread of contaminants. *

1	2	3	4

50. Capability to track the origin and destination of waste transportation vehicles. *

1	2	3	4

51. Identification of illegal waste export or import across national borders. *

1	2	3	4

52. Integration with blockchain to create a trusted and tamper-proof record of waste disposal activities. *

1	2	3	4

53. Automated reporting for funding purposes. *

1	2	3	4

54. Machine learning algorithms to predict potential waste dumping locations. *

1	2	3	4

55. Integration with fleet management systems to optimize waste disposal routes. *

1	2	3	4

56. Automated notification of waste disposal trucks. *

1	2	3	4

57. AIS data automatic cross-check against public AIS data providers and alarm in case of variance. *

1	2	3	4

58. Regarding the automatic detection of suspicious vessels, also estimate possible route and both departure and arrival points, in order to optimize response. *

1	2	3	4

59. Regarding the automatic detection of suspicious vessels, route analysis should be based not only on vessel type, but also take into account freight type, vessels' flag. *

1	2	3	4

60. Incorporate automatic services (e.g. detection of suspicious vessels) and classify risks according to their objective (e.g. smuggling, trafficking). *

1	2	3	4

61. Risk investigator service for identifying risk factors. *

1	2	3	4

62. Rapid detection of both an accidental or intentional incident which could lead to a contamination in surface water or groundwater. *

1	2	3	4

63. Priority rank needs to assign to the incident. A high priority ensures immediate and strict intervention or close monitoring. A low priority, it may be sufficient to monitor the contamination or ensure it is reported. *

1	2	3	4

64. Further comments that you like to share.

Non Functional Requirements

Please from scale 1 to 4 choose:

Won't: not a priority (1) , Could: important (2) , Should: serious (3) , Must: critical (4)

65. Accessibility: The platform should be accessible to all users, including those with disabilities, through various devices and channels. *

1	2	3	4

66. Accuracy: The platform should provide accurate data analysis and identification of waste disposal sites. *

1	2	3	4

67. Adaptability: The platform should be adaptable to changing environmental policies and regulations. *

1	2	3	4

68. Auditability: The platform should have a comprehensive audit trail to enable traceability of all activities and data. *

1	2	3	4

69. Availability: The platform should be available 24/7 to enable prompt response to incidents. *

1	2	3	4

70. Availability: The platform should be available to authorized users 24/7, with minimal downtime for maintenance or upgrades. *

1	2	3	4

71. Compatibility: The platform should be compatible with various operating systems, devices, and software. *

1	2	3	4

72. Compliance with Standards: The platform should comply with relevant industry standards and best practices. *

1	2	3	4

73. Compliance: The platform should comply with all relevant regulations and data protection laws, including GDPR, HIPAA, and others. *

1	2	3	4

74. Data Privacy: The platform should have robust data privacy measures to ensure the protection. *

1	2	3	4

75. Data Quality: The platform should have mechanisms in place to ensure the accuracy, completeness, and integrity of the data collected and processed. *

1	2	3	4

76. Disaster Recovery: The platform should have a disaster recovery plan to ensure business continuity in case of disasters. *

1	2	3	4

77. Error Handling: The platform should have proper error handling mechanisms to ensure accurate data processing and analysis. *

1	2	3	4

78. Error handling: The platform should have robust error handling mechanisms to detect and recover from any errors or exceptions that occur during processing. *

1	2	3	4

79. Extensibility: The platform should be extensible to allow future enhancements and upgrades to accommodate changing environmental policies and regulations. *

1	2	3	4

80. Flexibility: The platform should be flexible to accommodate different use cases and scenarios. *

1	2	3	4

81. Interoperability with External Systems: The platform should be able to integrate with external systems and databases, such as law enforcement and regulatory agencies. *

1	2	3	4

82. Maintainability: The platform should be easy to maintain and update to ensure continued functionality and performance. *

1	2	3	4

83. Performance Metrics: The platform should be able to measure and report on performance metrics, such as response time and data processing time. *

1	2	3	4

84. Performance monitoring: The platform should be able to monitor its own performance and provide alerts to system administrators if any issues are detected. *

1	2	3	4

85. Performance testing: The platform should undergo performance testing to ensure that it can handle the anticipated volume of data and processing demands. *

1	2	3	4

86. Performance: The platform should be able to process and analyze data quickly and efficiently to enable prompt response to incidents. *

1	2	3	4

87. Portability: The platform should be able to run on different hardware, operating systems, and cloud environments. *

1	2	3	4

88. Precision: The platform should provide precise location and size information of waste disposal sites.
*

1	2	3	4

89. Reliability: The platform should be available and functioning at all times to enable prompt response to incidents. *

1	2	3	4

90. Reliability: The platform should be reliable and able to detect and recover from any system failures or errors. *

1	2	3	4

91. Resilience: The platform should be able to recover from system failures or crashes. *

1	2	3	4

92. Scalability: The platform should be able to handle large amounts of data as more waste disposal sites are identified. *

1	2	3	4

93. Security testing: The platform should undergo security testing to identify and address any vulnerabilities or weaknesses in the system's security measures. *

1	2	3	4

94. Security: The platform should have robust security measures in place to protect the data collected and processed, including access controls, encryption, and other security protocols. *

1	2	3	4

95. Security: The platform should have robust security measures to ensure the confidentiality and integrity of sensitive data. *

1	2	3	4

96. Speed of response: The platform should provide rapid response to reported incidents and site identification. *

1	2	3	4

97. Training: The platform should offer training to users to enable them to effectively use the platform. *

1	2	3	4

98. Transparency: The platform should provide transparency in all activities and data processing. *

1	2	3	4

99. Usability for Different User Groups: The platform should be user-friendly and easy to use for all types of users, such as government agencies, non-governmental organizations, and the general public, with clear and intuitive user interfaces. *

1	2	3	4

100. Usability testing: The platform should undergo usability testing to ensure that it is easy to use and understand for authorized users. *

1	2	3	4

101. User Support: The platform should have a robust user support system to address user queries and concerns. *

1	2	3	4

102. Versioning: The platform should maintain a version control system to enable proper management and tracking of changes made to the data. *

1	2	3	4

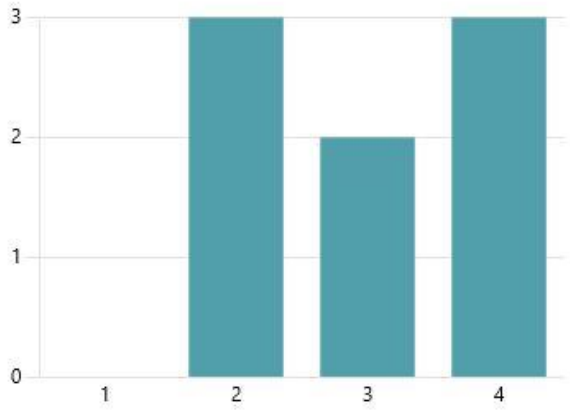
103. Further comments that you like to share.

Annex D: Prioritisation of the Requirements based on the MoScOw method by the end-users

4. Ability to acquire high-resolution satellite images and aerial photography data. (0 point)

More Details

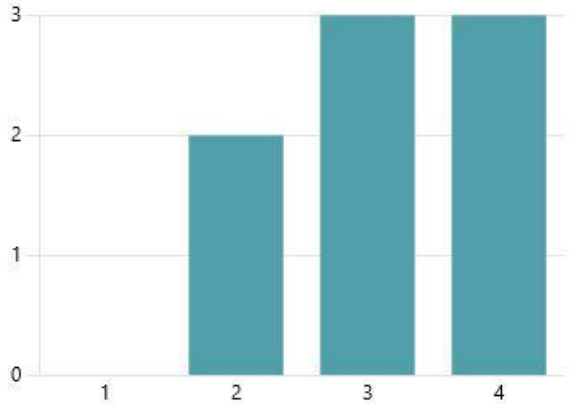
3.00
Average Rating



5. Automated image processing and analysis to detect potential waste disposal sites. (0 point)

More Details

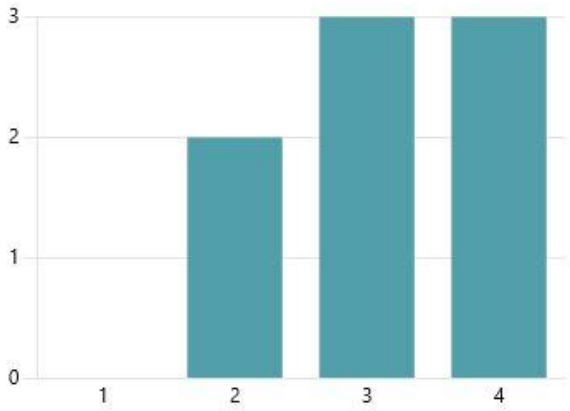
3.13
Average Rating



6. Integration with ground-based sensors, such as drones and cameras, to verify the presence of waste. (0 point)

More Details

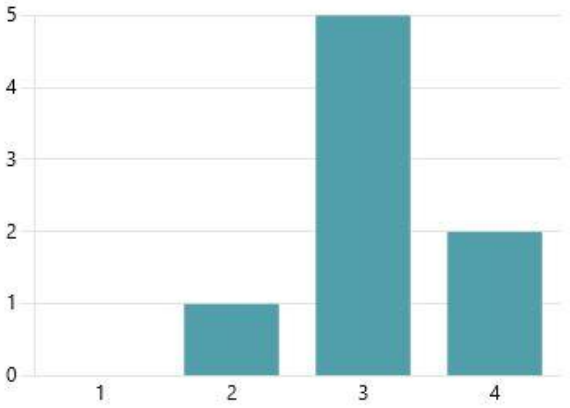
3.13
Average Rating



7. Ability to identify patterns and anomalies in the data that may indicate the presence of waste. (0 point)

More Details

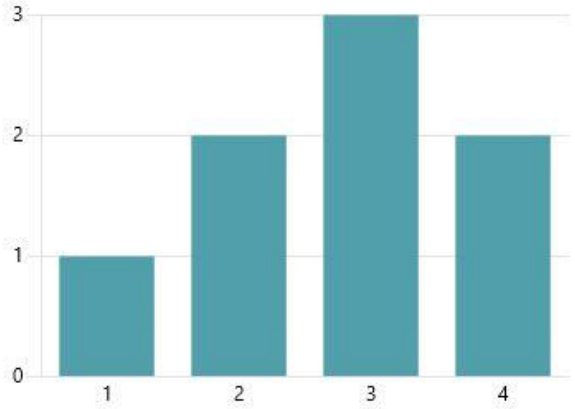
3.13
Average Rating



8. Machine learning algorithms that can learn from data and improve the accuracy of detection. (0 point)

More Details

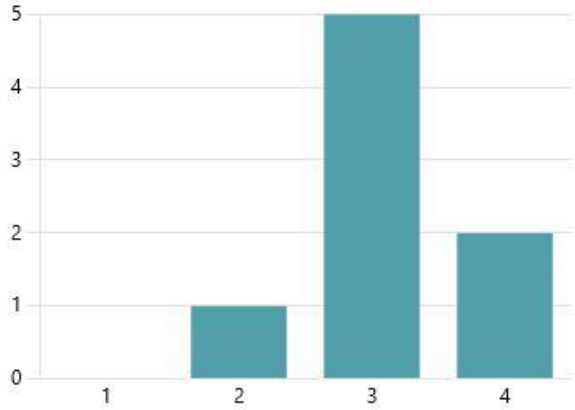
2.75
Average Rating



9. Automated notifications and alerts when new potential waste disposal sites are identified. (0 point)

More Details

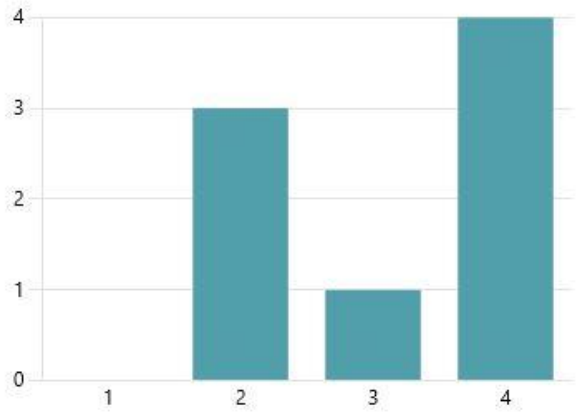
3.13
Average Rating



10. Ability to track the location, volume, and type of waste detected. (0 point)

More Details

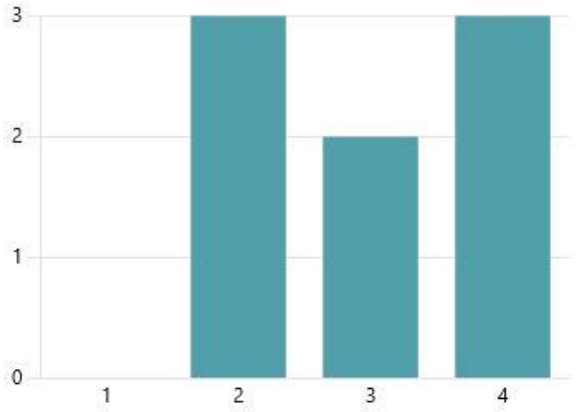
3.13
Average Rating



11. Integration with GIS and mapping tools to visualize the location of waste disposal sites. (0 point)

More Details

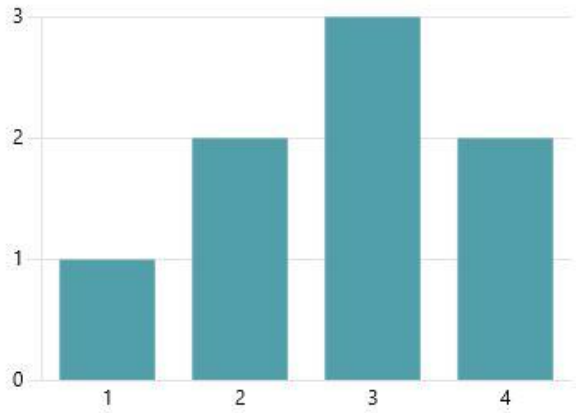
3.00
Average Rating



12. Cloud-based architecture for scalability and accessibility. (0 point)

More Details

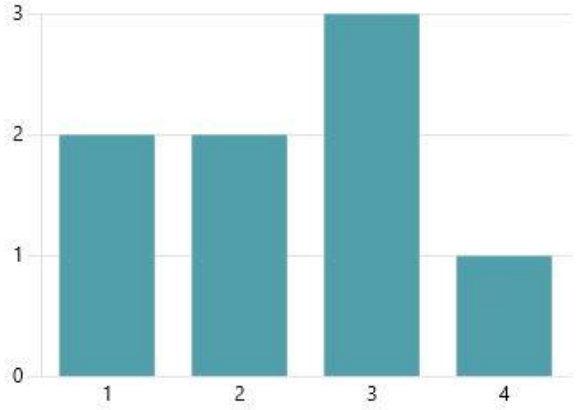
2.75
Average Rating



13. Multi-language support for global use. (0 point)

More Details

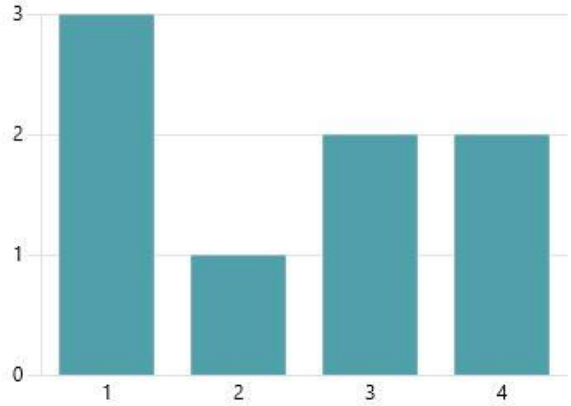
2.38
Average Rating



14. Integration with local government databases to cross-check known waste sites. (0 point)

More Details

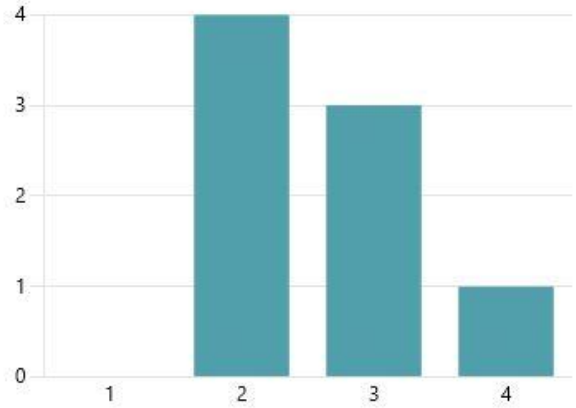
2.38
Average Rating



15. Customizable data analysis dashboards to view trends and data insights. (0 point)

More Details

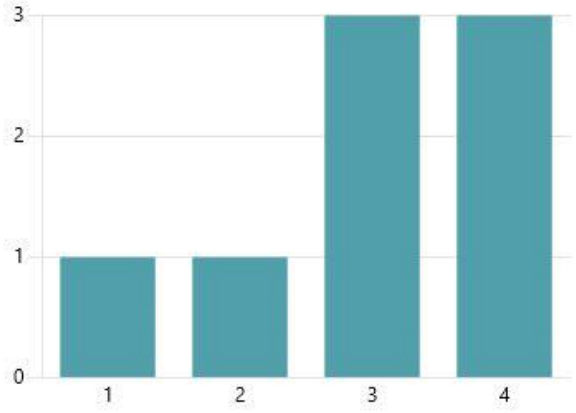
2.63
Average Rating



16. Ability to compare data from different time periods to identify changes in waste patterns. (0 point)

More Details

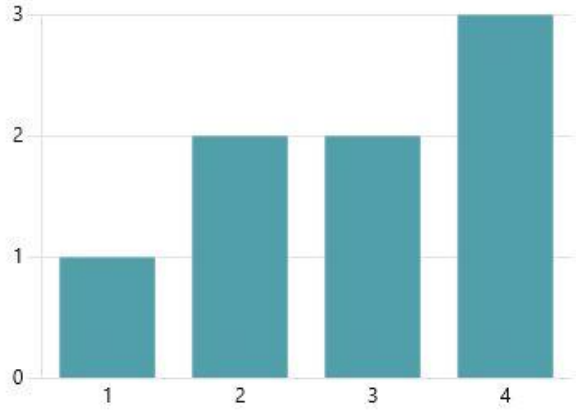
3.00
Average Rating



17. Data encryption and secure data transfer. (0 point)

More Details

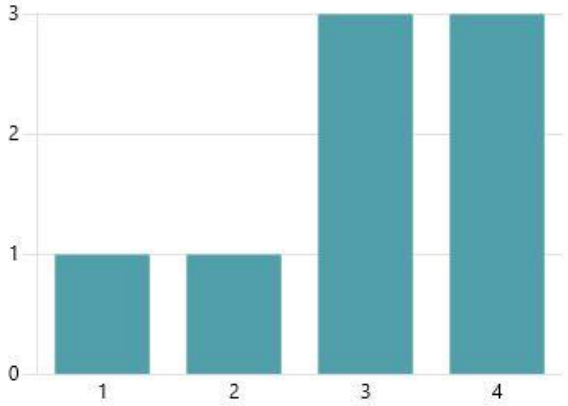
2.88
Average Rating



18. Ability to manage users and roles with appropriate permissions. (0 point)

More Details

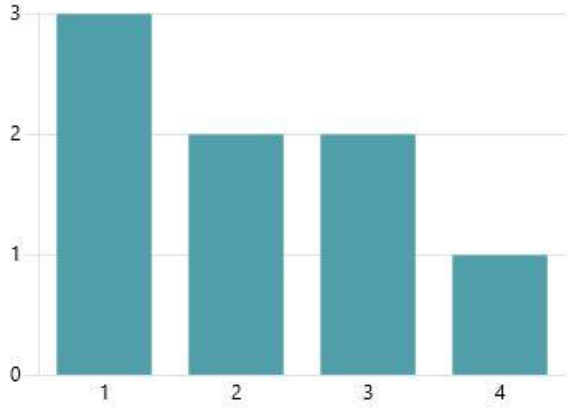
3.00
Average Rating



19. Integration with social media and citizen reporting channels for real-time alerts. (0 point)

More Details

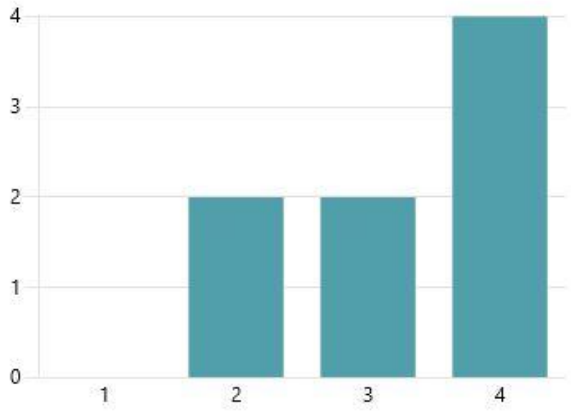
2.13
Average Rating



20. Machine learning algorithms to identify different types of waste, such as hazardous waste, organic waste, or electronic waste. (0 point)

More Details

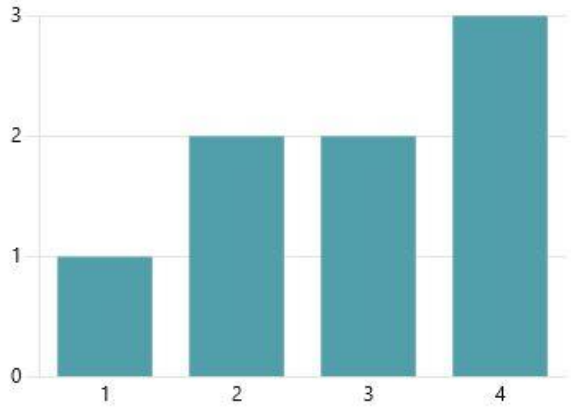
3.25
Average Rating



21. Geo-fencing features to alert when a waste site has been tampered with or increased. (0 point)

More Details

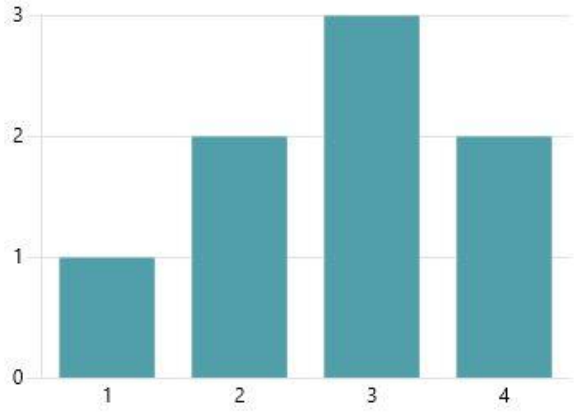
2.88
Average Rating



22. Real-time monitoring and updates of waste sites. (0 point)

More Details

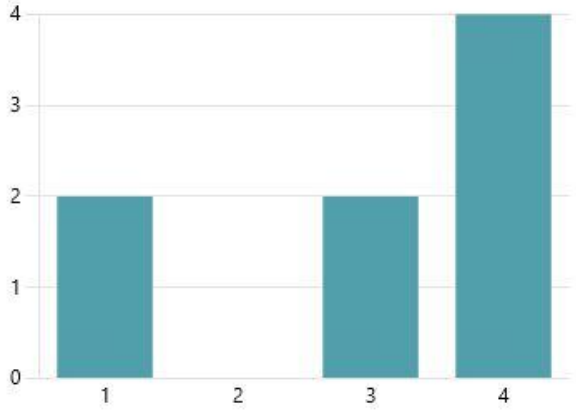
2.75
Average Rating



23. Integration with drones to create 3D models and better understand waste site features. (0 point)

More Details

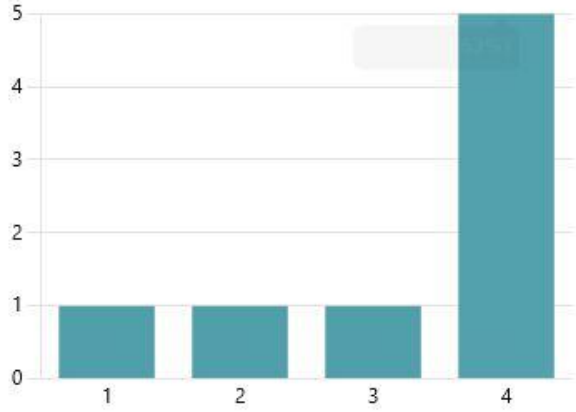
3.00
Average Rating



24. Historical data analysis to identify long-term waste trends. (0 point)

More Details

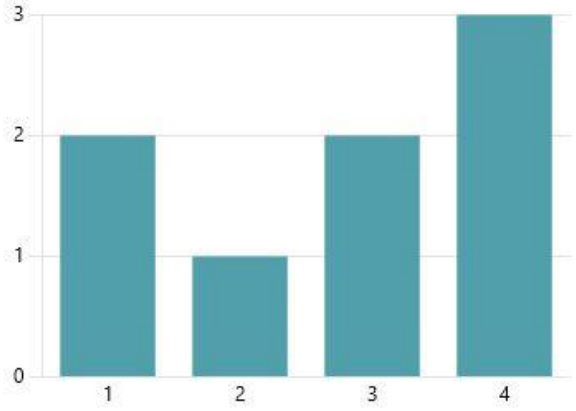
3.25
Average Rating



25. Integration with existing environmental regulations and laws for disposal. (0 point)

More Details

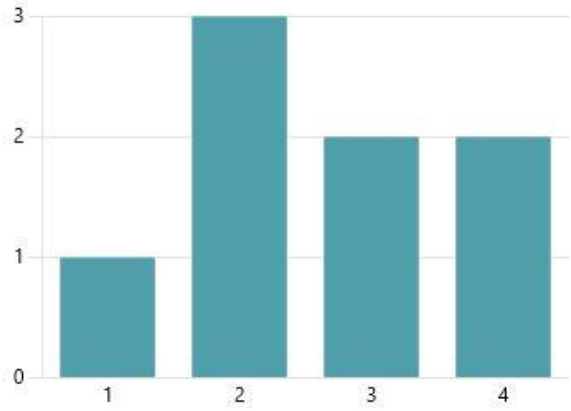
2.75
Average Rating



26. Automated reporting for regulatory compliance. (0 point)

More Details

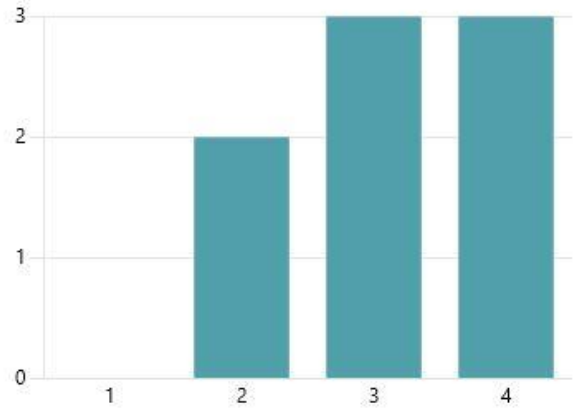
2.63
Average Rating



27. Automated trend analysis for identification of hotspots and trends. (0 point)

More Details

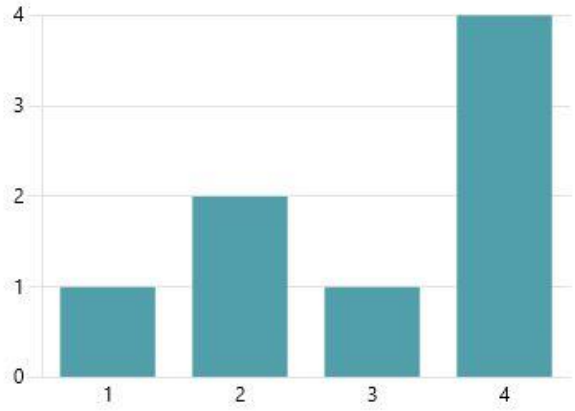
3.13
Average Rating



28. Ability to detect waste in remote or inaccessible areas. (0 point)

More Details

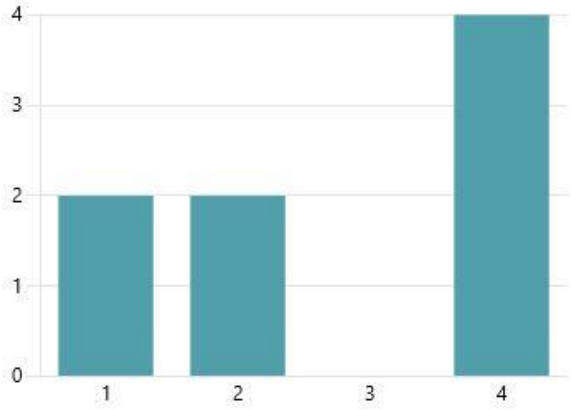
3.00
Average Rating



29. Ability to generate heatmaps to indicate the density of waste sites. (0 point)

More Details

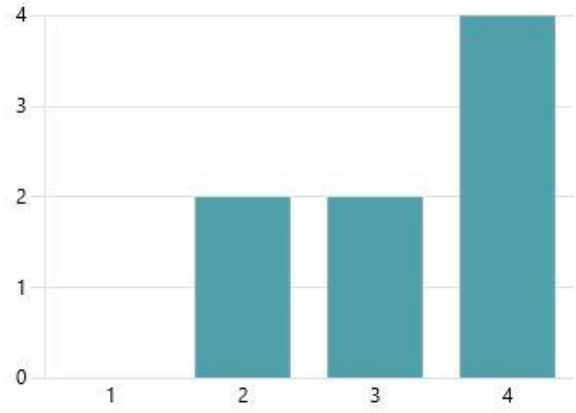
2.75
Average Rating



30. Ability to track waste volume and monitor how it changes over time. (0 point)

More Details

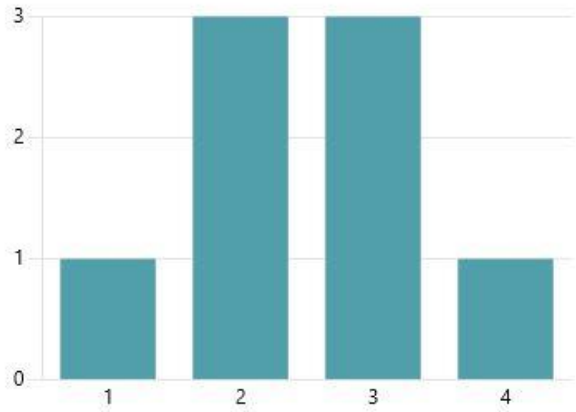
3.25
Average Rating



31. Integration with weather forecasts to understand how changes in weather might affect waste patterns. (0 point)

More Details

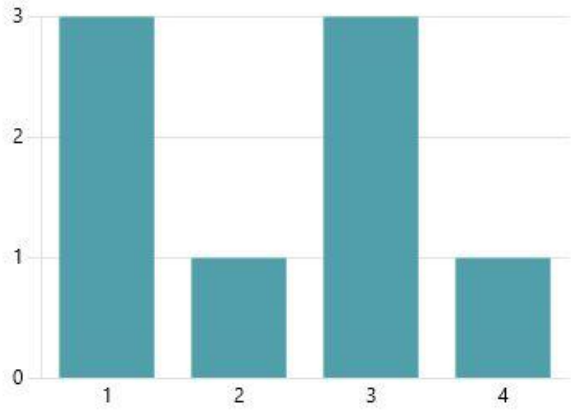
2.50
Average Rating



32. Collaboration with local communities to share data and promote awareness. (0 point)

More Details

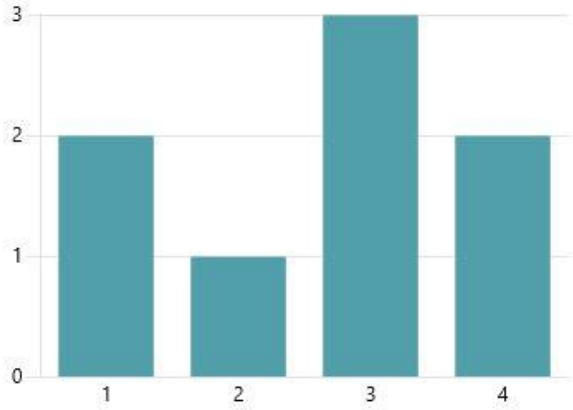
2.25
Average Rating



33. Integration with mobile applications for easier access to real-time data. (0 point)

More Details

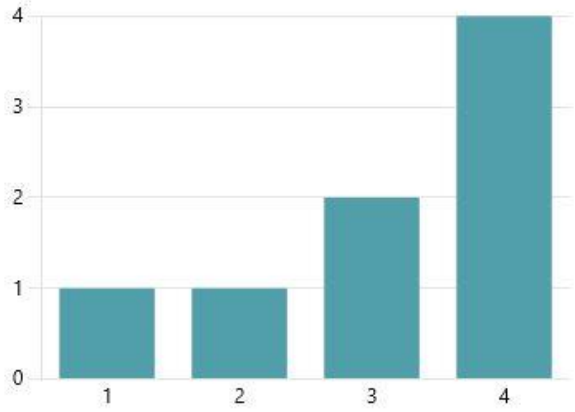
2.63
Average Rating



34. Automated identification of waste sources. (0 point)

More Details

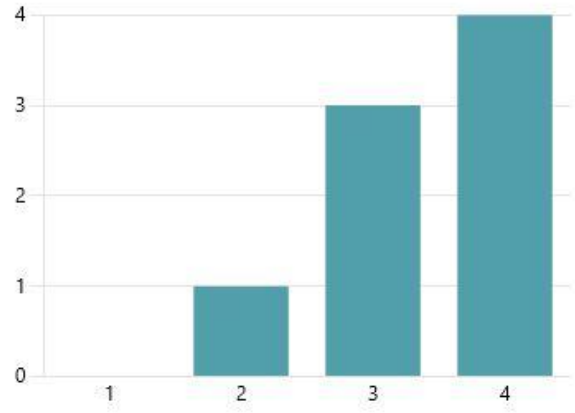
3.13
Average Rating



35. Ability to analyze waste data by geographic regions, proximity to bodies of water, and other environmental factors. (0 point)

More Details

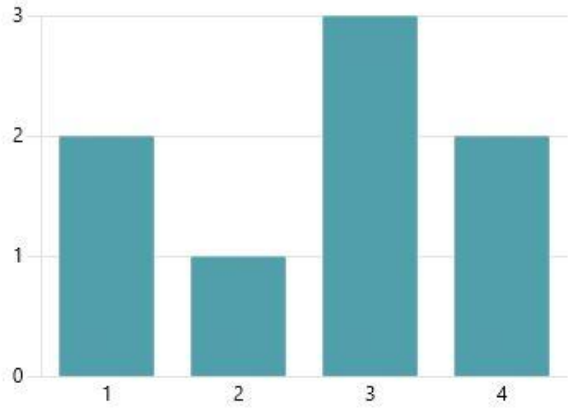
3.38
Average Rating



36. Capability to run offline analysis and data validation. (0 point)

More Details

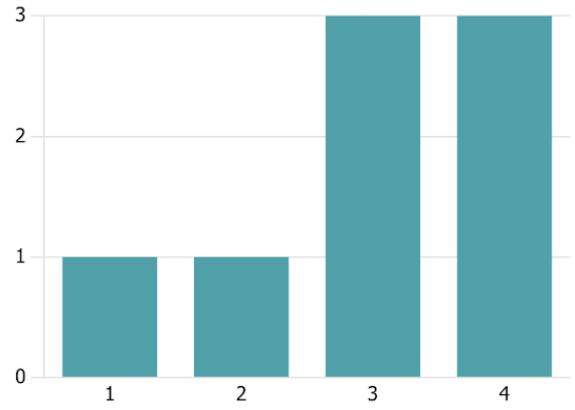
2.63
Average Rating



37. Automated notification to law enforcement agencies in case of hazardous waste. (0 βαθμός)

Περισσότερες λεπτομέρειες

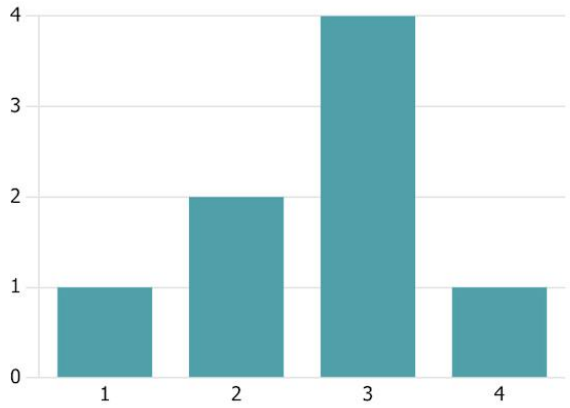
3.00
Μέση αξιολόγηση



38. Integration with third-party data providers for additional data sources. (0 βαθμός)

Περισσότερες λεπτομέρειες

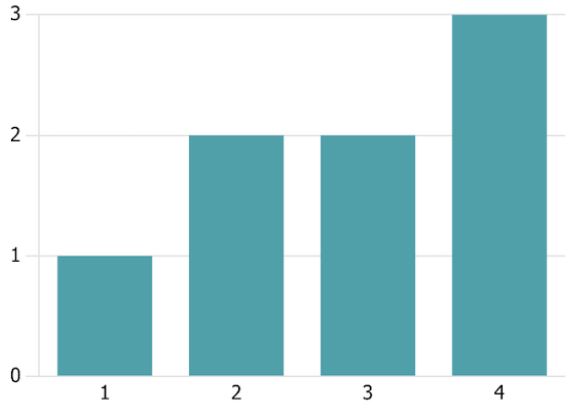
2.63
Μέση αξιολόγηση



39. Ability to export data in a variety of formats for analysis and visualization. (0 βαθμός)

Περισσότερες λεπτομέρειες

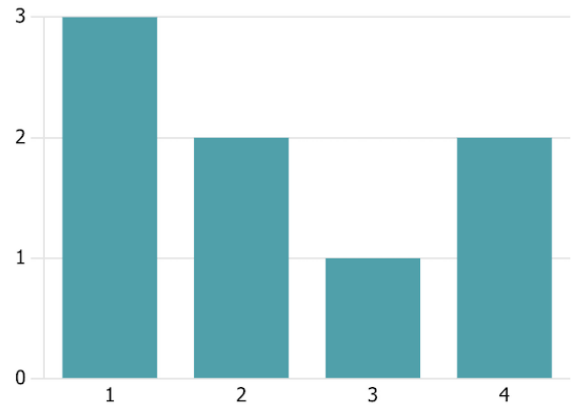
2.88
Μέση αξιολόγηση



40. Alarms will be generated when a vessel is observed with a suspicious direction towards ports or configurable coastal areas of interest. (0 βαθμός)

Περισσότερες λεπτομέρειες

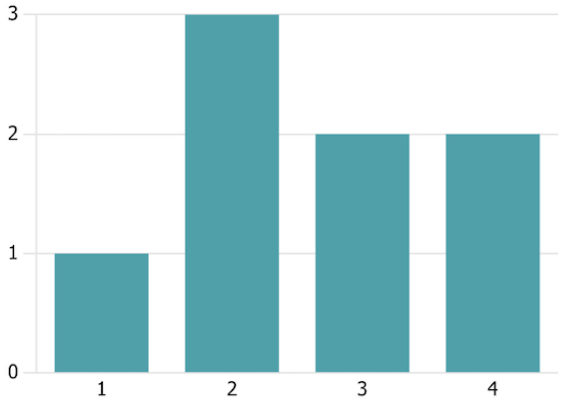
2.25
Μέση αξιολόγηση



41. Machine learning algorithms to identify sources of waste. (0 βαθμός)

Περισσότερες λεπτομέρειες

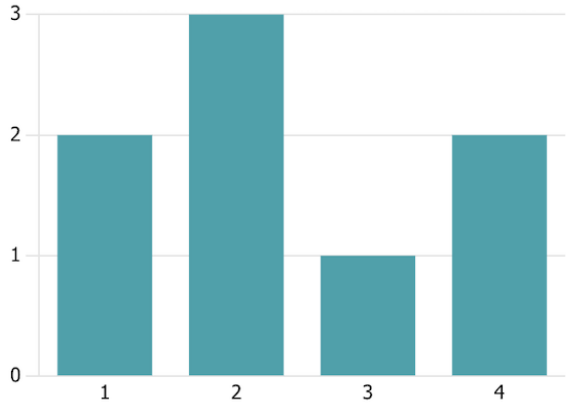
2.63
Μέση αξιολόγηση



42. Integration with IoT sensors and networks. (0 βαθμός)

Περισσότερες λεπτομέρειες

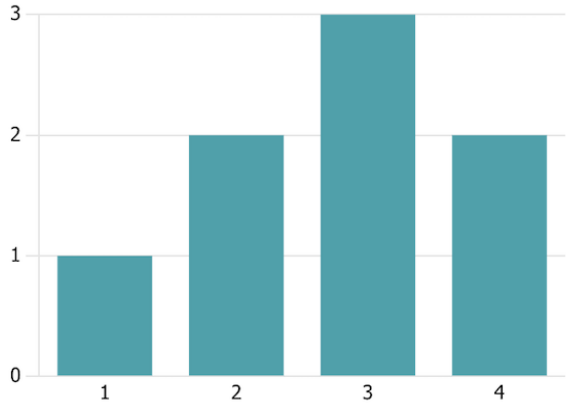
2.38
Μέση αξιολόγηση



43. Automated workflows and decision-making systems for waste site responses. (0 βαθμός)

Περισσότερες λεπτομέρειες

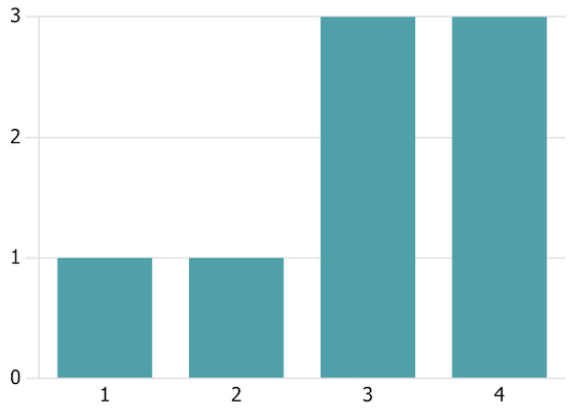
2.75
Μέση αξιολόγηση



44. Integration with machine vision to recognize waste objects. (0 βαθμός)

Περισσότερες λεπτομέρειες

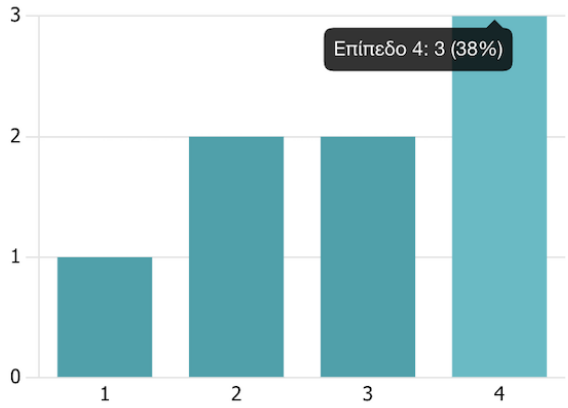
3.00
Μέση αξιολόγηση



45. Use of multispectral sensors to identify different types of waste. (0 βαθμός)

Περισσότερες λεπτομέρειες

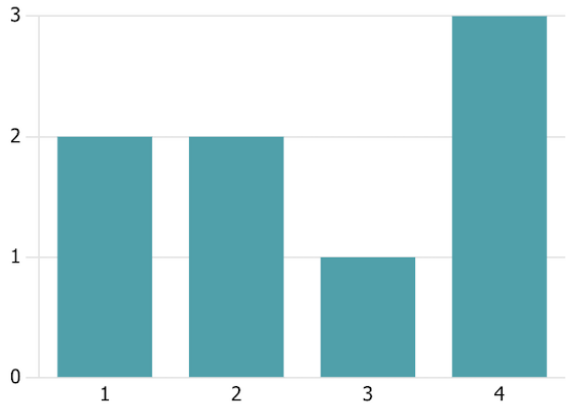
2.88
Μέση αξιολόγηση



46. Ability to identify illegal waste dumping from land, sea, or air vehicles. (0 βαθμός)

Περισσότερες λεπτομέρειες

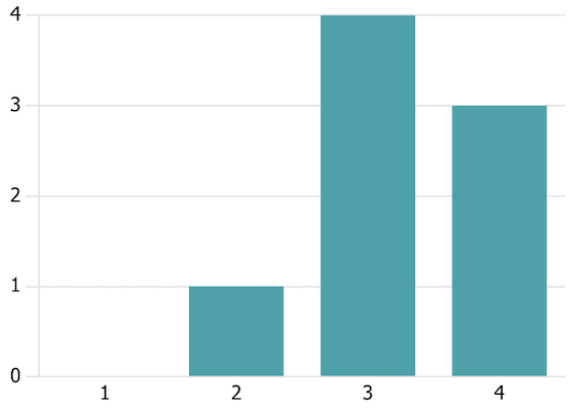
2.63
Μέση αξιολόγηση



47. Identification of changes in topography, vegetation, and soil color that may indicate illegal waste dumping. (0 βαθμός)

Περισσότερες λεπτομέρειες

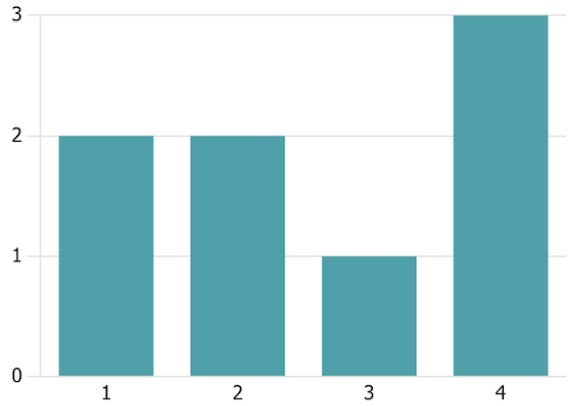
3.25
Μέση αξιολόγηση



48. Analysis of soil and groundwater samples to identify the presence of contaminants. (0 βαθμός)

Περισσότερες λεπτομέρειες

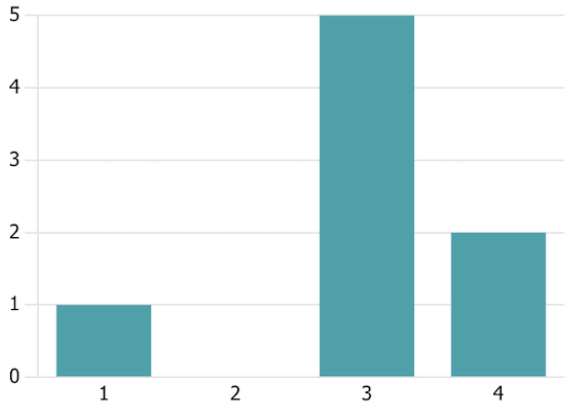
2.63
Μέση αξιολόγηση



49. Integration with models that simulate the spread of contaminants. (0 βαθμός)

Περισσότερες λεπτομέρειες

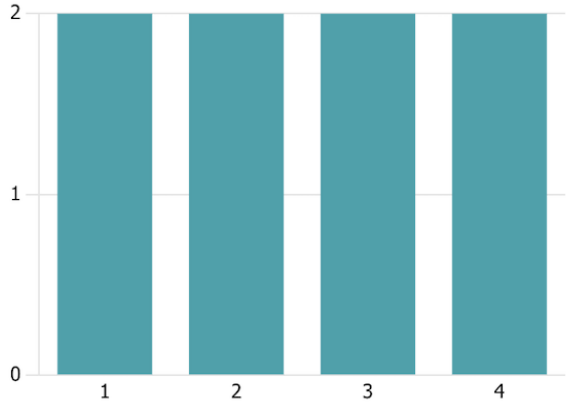
3.00
Μέση αξιολόγηση



50. Capability to track the origin and destination of waste transportation vehicles. (0 βαθμός)

Περισσότερες λεπτομέρειες

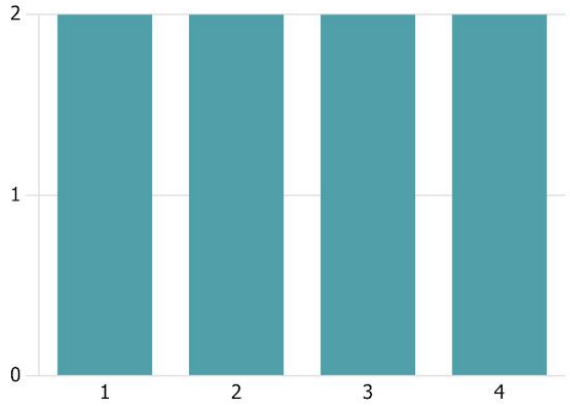
2.50
Μέση αξιολόγηση



51. Identification of illegal waste export or import across national borders. (0 βαθμός)

Περισσότερες λεπτομέρειες

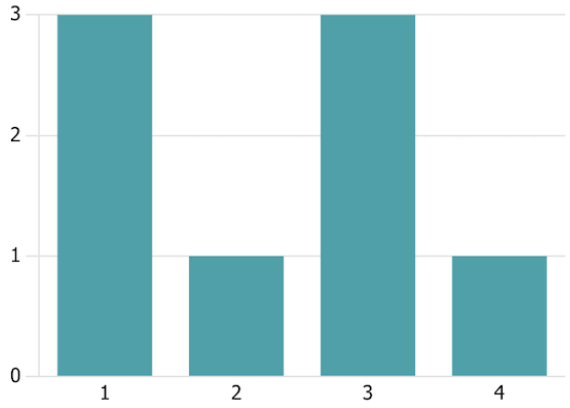
2.50
Μέση αξιολόγηση



52. Integration with blockchain to create a trusted and tamper-proof record of waste disposal activities. (0 βαθμός)

Περισσότερες λεπτομέρειες

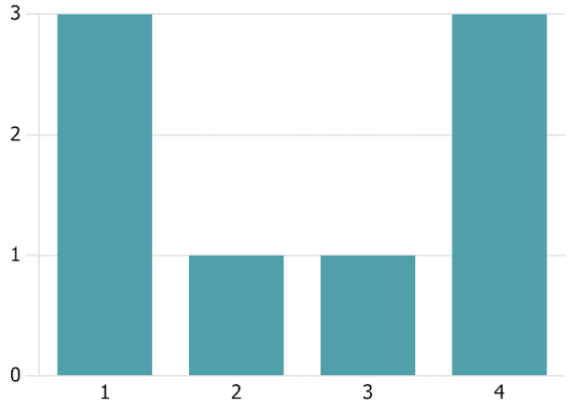
2.25
Μέση αξιολόγηση



53. Automated reporting for funding purposes. (0 βαθμός)

Περισσότερες λεπτομέρειες

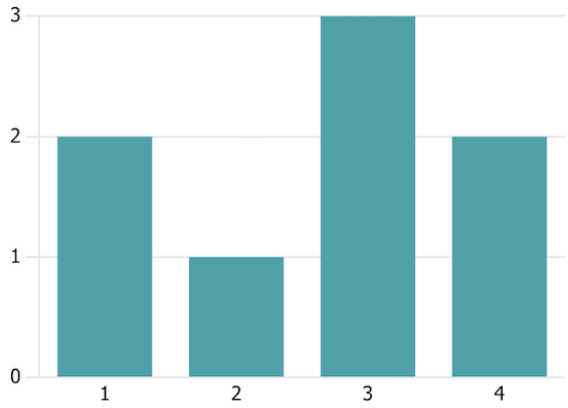
2.50
Μέση αξιολόγηση



54. Machine learning algorithms to predict potential waste dumping locations. (0 βαθμός)

Περισσότερες λεπτομέρειες

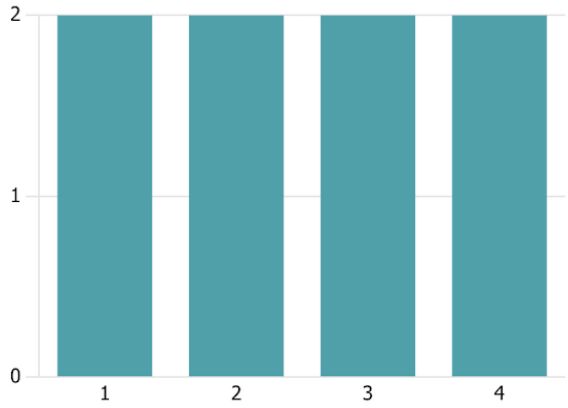
2.63
Μέση αξιολόγηση



55. Integration with fleet management systems to optimize waste disposal routes. (0 βαθμός)

Περισσότερες λεπτομέρειες

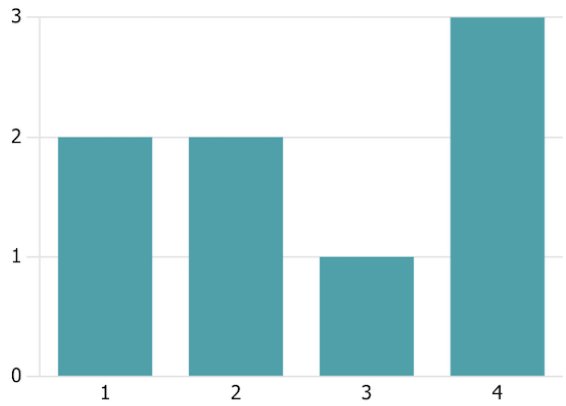
2.50
Μέση αξιολόγηση



56. Automated notification of waste disposal trucks. (0 βαθμός)

Περισσότερες λεπτομέρειες

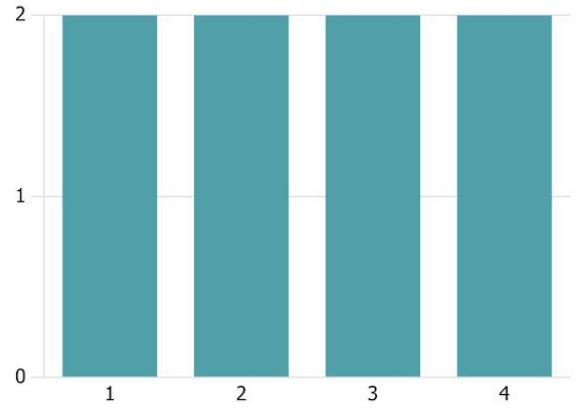
2.63
Μέση αξιολόγηση



57. AIS data automatic cross-check against public AIS data providers and alarm in case of variance. (0 βαθμός)

Περισσότερες λεπτομέρειες

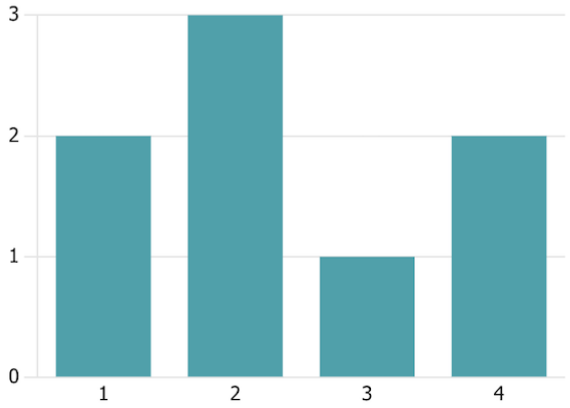
2.50
Μέση αξιολόγηση



58. Regarding the automatic detection of suspicious vessels, also estimate possible route and both departure and arrival points, in order to optimize response. (0 βαθμός)

Περισσότερες λεπτομέρειες

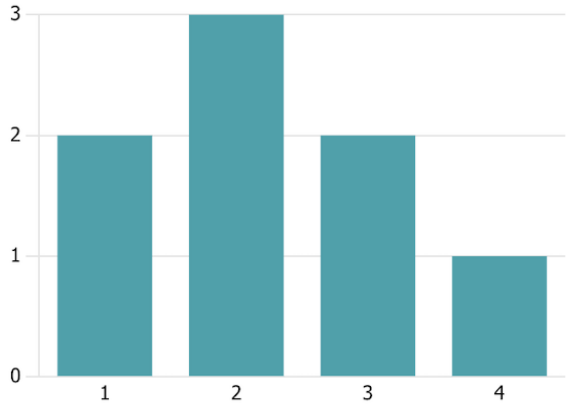
2.38
Μέση αξιολόγηση



59. Regarding the automatic detection of suspicious vessels, route analysis should be based not only on vessel type, but also take into account freight type, vessels' flag. (0 βαθμός)

Περισσότερες λεπτομέρειες

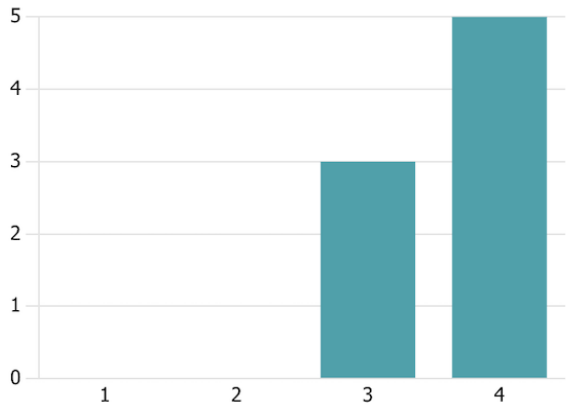
2.25
Μέση αξιολόγηση



66. Accuracy: The platform should provide accurate data analysis and identification of waste disposal sites. (0 βαθμός)

Περισσότερες λεπτομέρειες

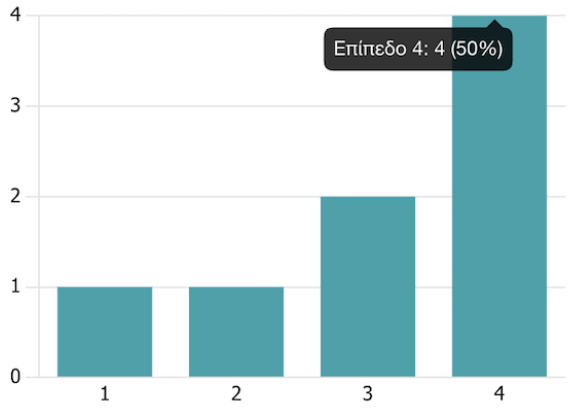
3.63
Μέση αξιολόγηση



67. Adaptability: The platform should be adaptable to changing environmental policies and regulations. (0 βαθμός)

Περισσότερες λεπτομέρειες

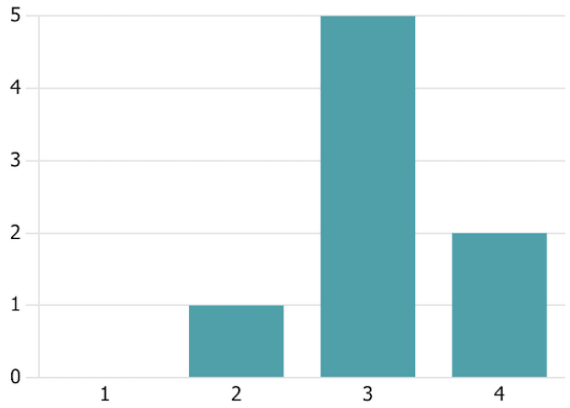
3.13
Μέση αξιολόγηση



68. Auditability: The platform should have a comprehensive audit trail to enable traceability of all activities and data. (0 βαθμός)

Περισσότερες λεπτομέρειες

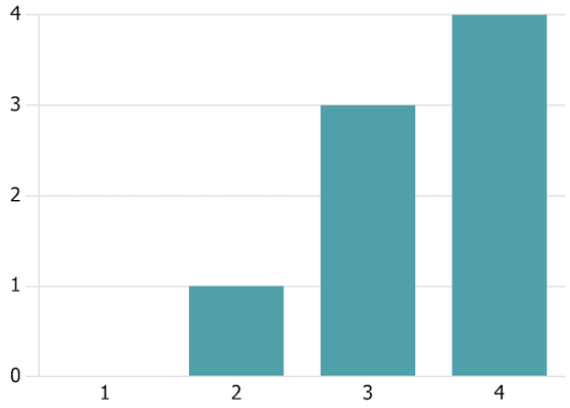
3.13
Μέση αξιολόγηση



69. Availability: The platform should be available 24/7 to enable prompt response to incidents. (0 βαθμός)

Περισσότερες λεπτομέρειες

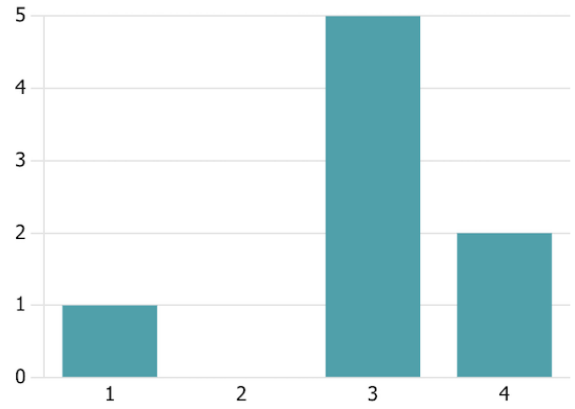
3.38
Μέση αξιολόγηση



70. Availability: The platform should be available to authorized users 24/7, with minimal downtime for maintenance or upgrades. (0 βαθμός)

Περισσότερες λεπτομέρειες

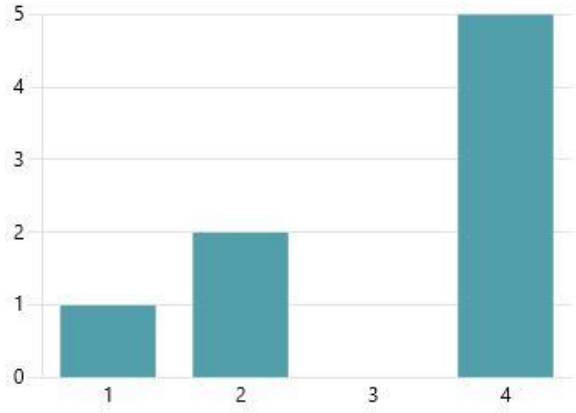
3.00
Μέση αξιολόγηση



71. Compatibility: The platform should be compatible with various operating systems, devices, and software. (0 point)

More Details

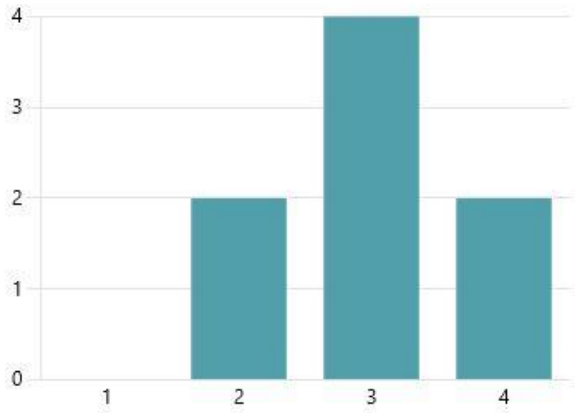
3.13
Average Rating



72. Compliance with Standards: The platform should comply with relevant industry standards and best practices. (0 point)

More Details

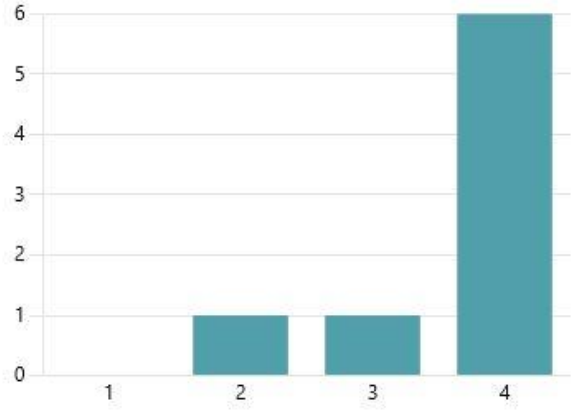
3.00
Average Rating



73. Compliance: The platform should comply with all relevant regulations and data protection laws, including GDPR, HIPAA, and others. (0 point)

More Details

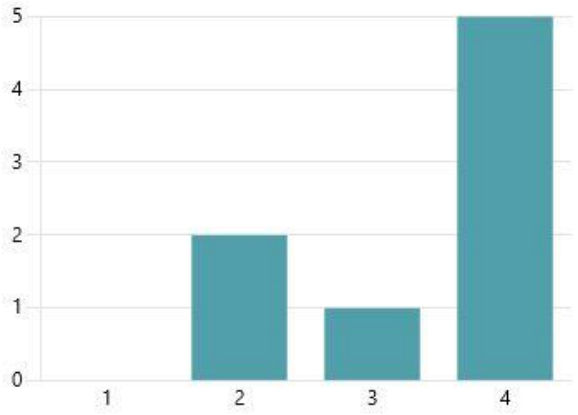
3.63
Average Rating



74. Data Privacy: The platform should have robust data privacy measures to ensure the protection. (0 point)

More Details

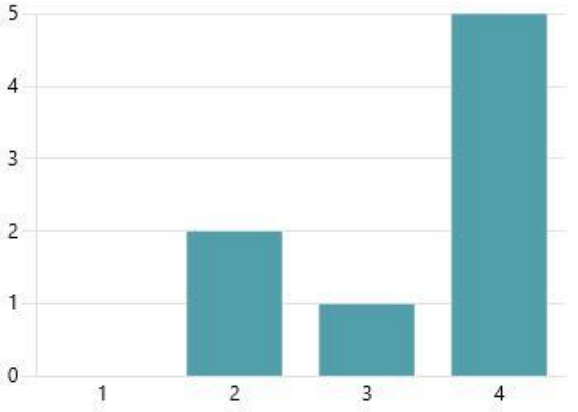
3.38
Average Rating



75. Data Quality: The platform should have mechanisms in place to ensure the accuracy, completeness, and integrity of the data collected and processed. (0 point)

More Details

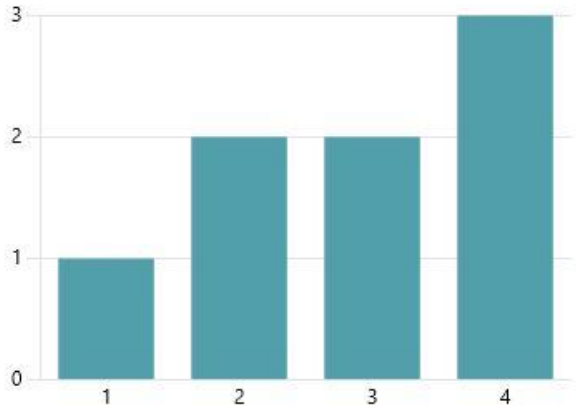
3.38
Average Rating



76. Disaster Recovery: The platform should have a disaster recovery plan to ensure business continuity in case of disasters. (0 point)

More Details

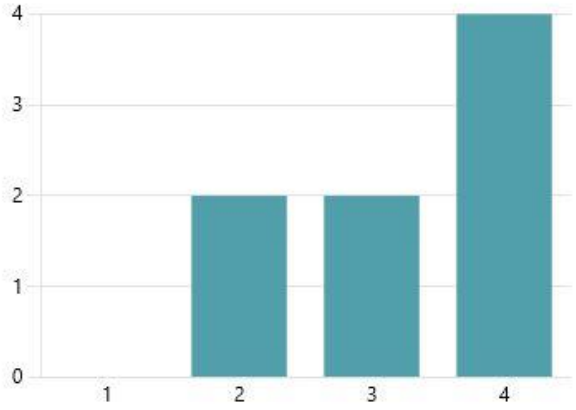
2.88
Average Rating



77. Error Handling: The platform should have proper error handling mechanisms to ensure accurate data processing and analysis. (0 point)

More Details

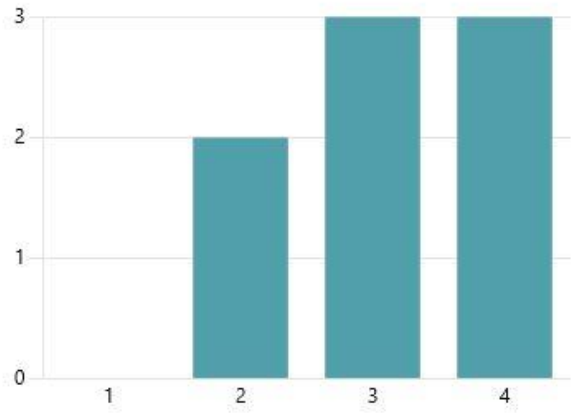
3.25
Average Rating



78. Error handling: The platform should have robust error handling mechanisms to detect and recover from any errors or exceptions that occur during processing. (0 point)

More Details

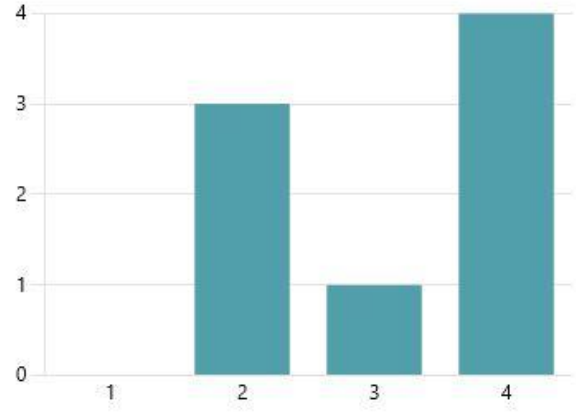
3.13
Average Rating



79. Extensibility: The platform should be extensible to allow future enhancements and upgrades to accommodate changing environmental policies and regulations. (0 point)

More Details

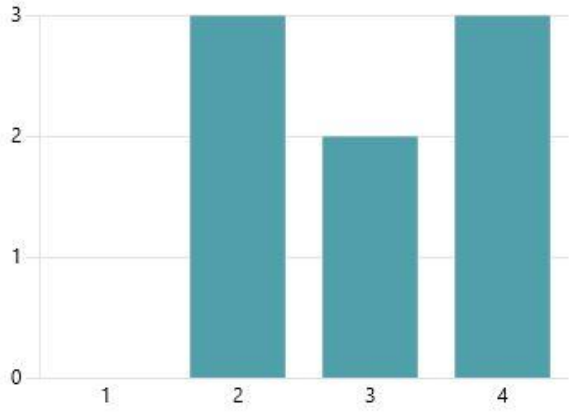
3.13
Average Rating



80. Flexibility: The platform should be flexible to accommodate different use cases and scenarios. (0 point)

More Details

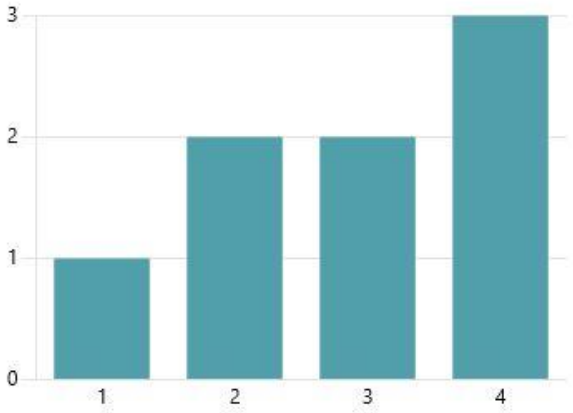
3.00
Average Rating



81. Interoperability with External Systems: The platform should be able to integrate with external systems and databases, such as law enforcement and regulatory agencies. (0 point)

More Details

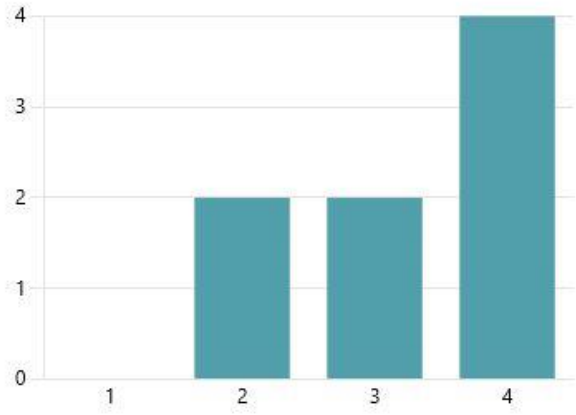
2.88
Average Rating



82. Maintainability: The platform should be easy to maintain and update to ensure continued functionality and performance. (0 point)

More Details

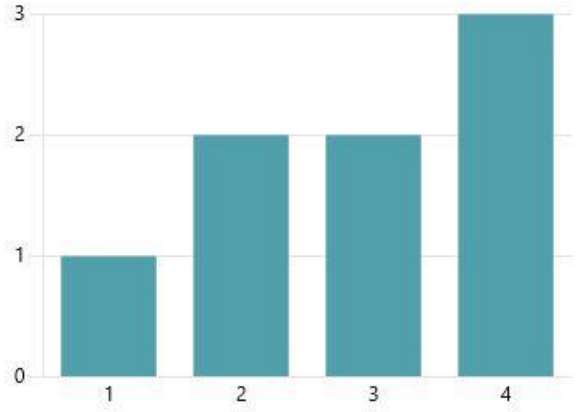
3.25
Average Rating



83. Performance Metrics: The platform should be able to measure and report on performance metrics, such as response time and data processing time. (0 point)

More Details

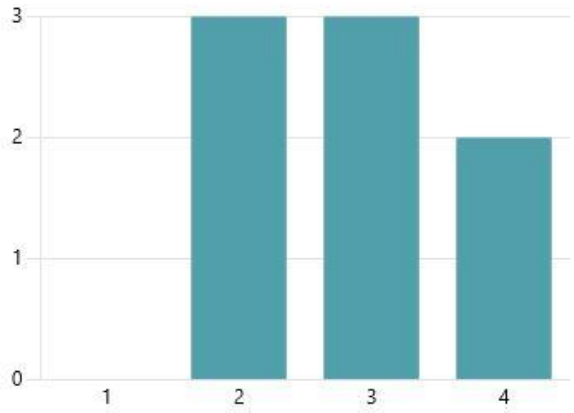
2.88
Average Rating



84. Performance monitoring: The platform should be able to monitor its own performance and provide alerts to system administrators if any issues are detected. (0 point)

More Details

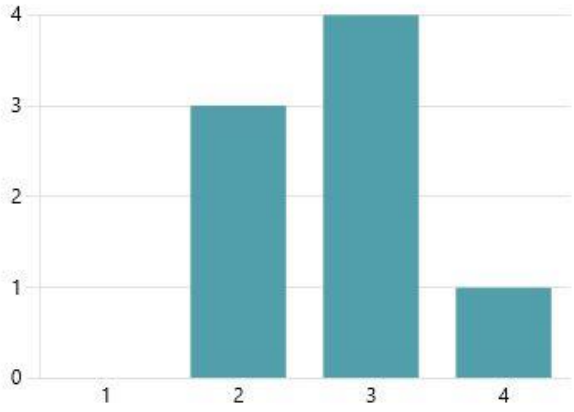
2.88
Average Rating



85. Performance testing: The platform should undergo performance testing to ensure that it can handle the anticipated volume of data and processing demands. (0 point)

More Details

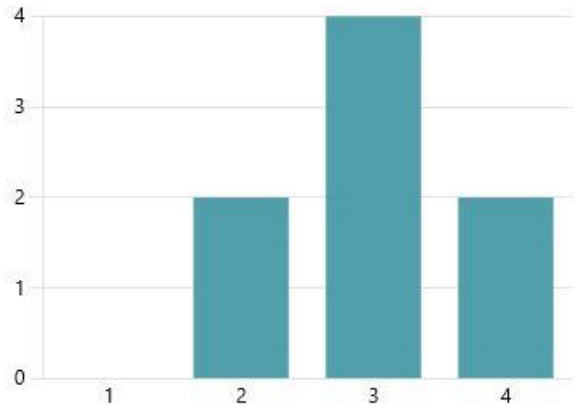
2.75
Average Rating



86. Performance: The platform should be able to process and analyze data quickly and efficiently to enable prompt response to incidents. (0 point)

More Details

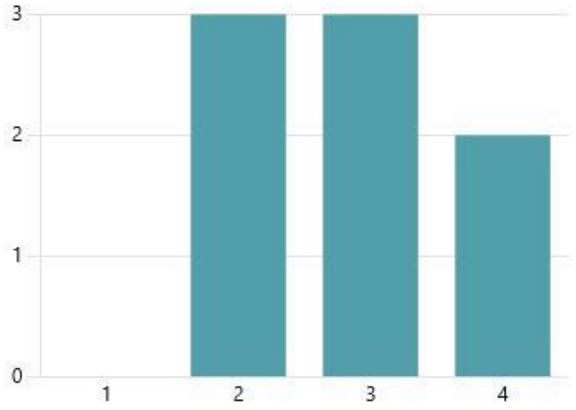
3.00
Average Rating



87. Portability: The platform should be able to run on different hardware, operating systems, and cloud environments. (0 point)

More Details

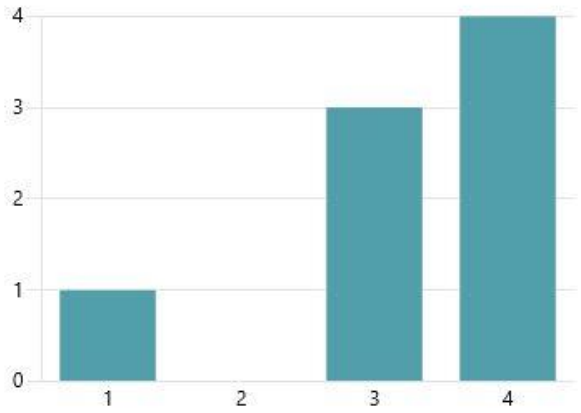
2.88
Average Rating



88. Precision: The platform should provide precise location and size information of waste disposal sites. (0 point)

More Details

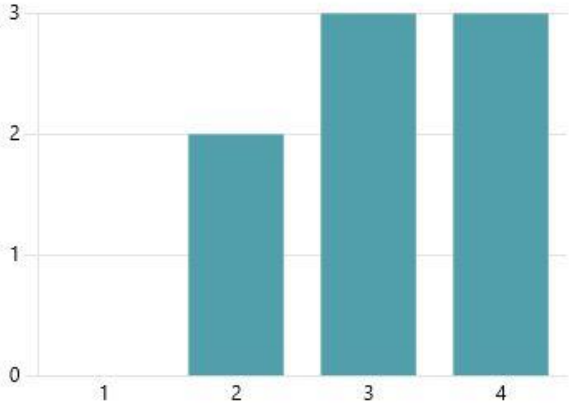
3.25
Average Rating



89. Reliability: The platform should be available and functioning at all times to enable prompt response to incidents. (0 point)

More Details

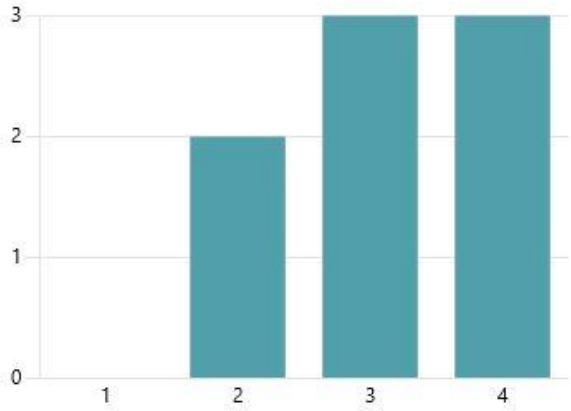
3.13
Average Rating



90. Reliability: The platform should be reliable and able to detect and recover from any system failures or errors. (0 point)

More Details

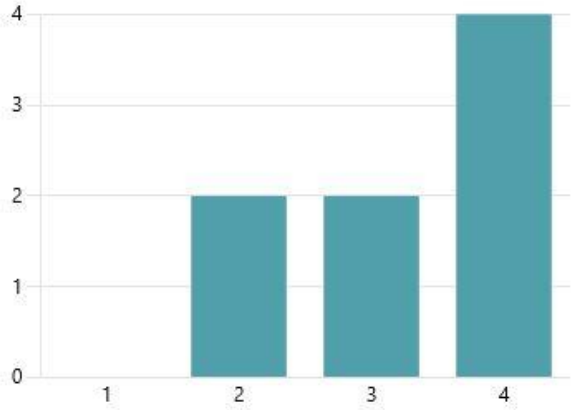
3.13
Average Rating



91. Resilience: The platform should be able to recover from system failures or crashes. (0 point)

More Details

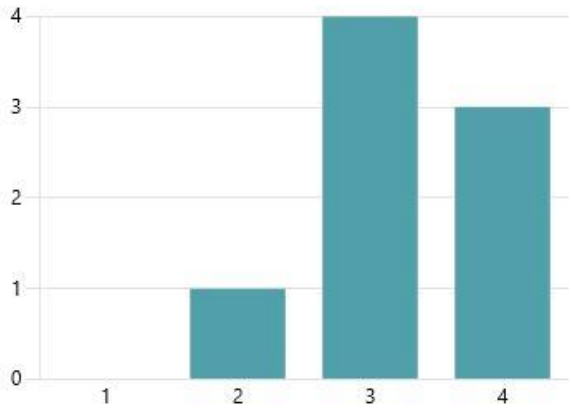
3.25
Average Rating



92. Scalability: The platform should be able to handle large amounts of data as more waste disposal sites are identified. (0 point)

More Details

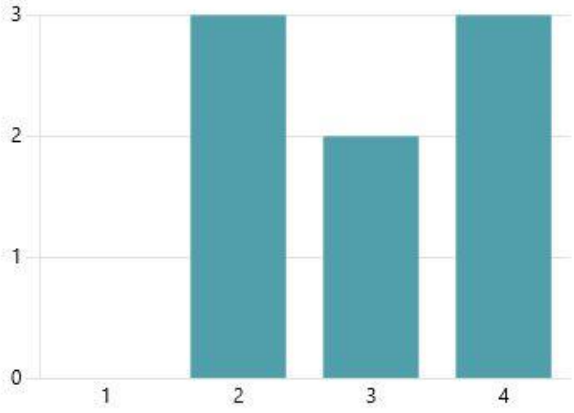
3.25
Average Rating



93. Security testing: The platform should undergo security testing to identify and address any vulnerabilities or weaknesses in the system's security measures. (0 point)

More Details

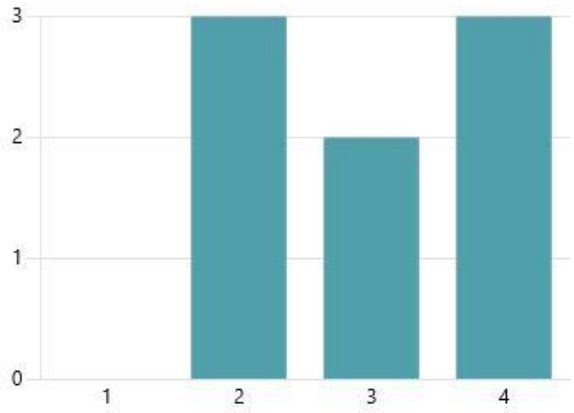
3.00
Average Rating



94. Security: The platform should have robust security measures in place to protect the data collected and processed, including access controls, encryption, and other security protocols. (0 point)

More Details

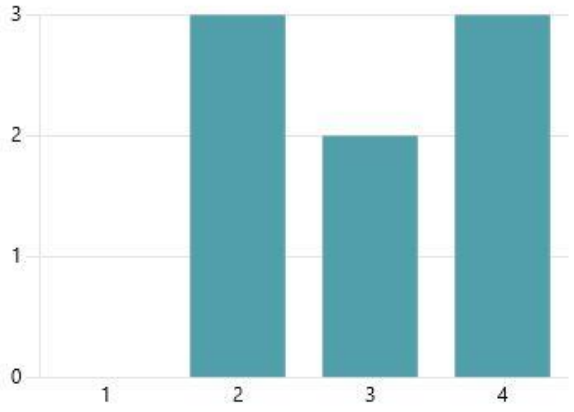
3.00
Average Rating



95. Security: The platform should have robust security measures to ensure the confidentiality and integrity of sensitive data. (0 point)

More Details

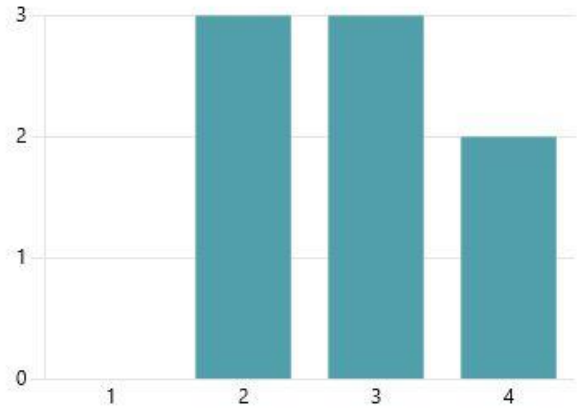
3.00
Average Rating



96. Speed of response: The platform should provide rapid response to reported incidents and site identification. (0 point)

More Details

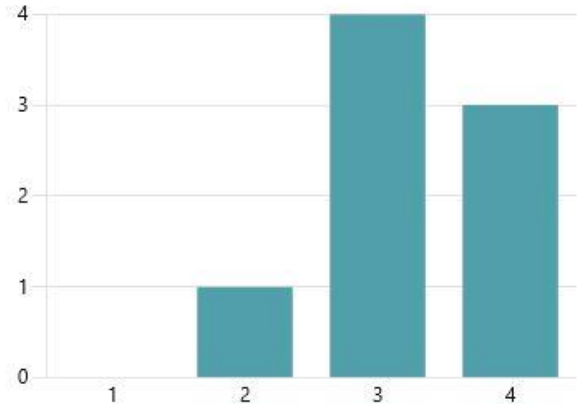
2.88
Average Rating



97. Training: The platform should offer training to users to enable them to effectively use the platform. (0 point)

More Details

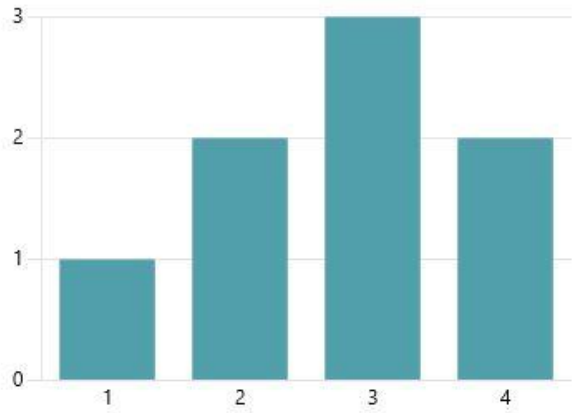
3.25
Average Rating



98. Transparency: The platform should provide transparency in all activities and data processing. (0 point)

More Details

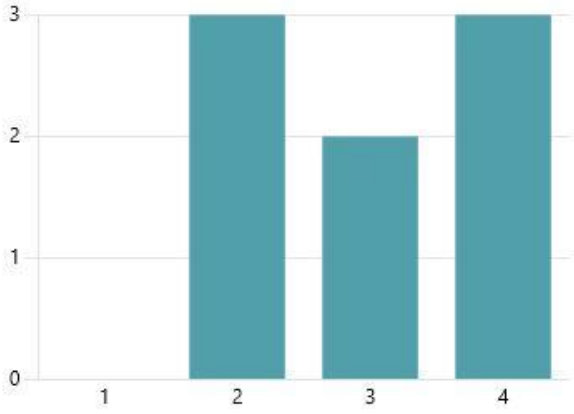
2.75
Average Rating



99. Usability for Different User Groups: The platform should be user-friendly and easy to use for all types of users, such as government agencies, non-governmental organizations, and the general public, with clear and intuitive user interfaces. (0 point)

More Details

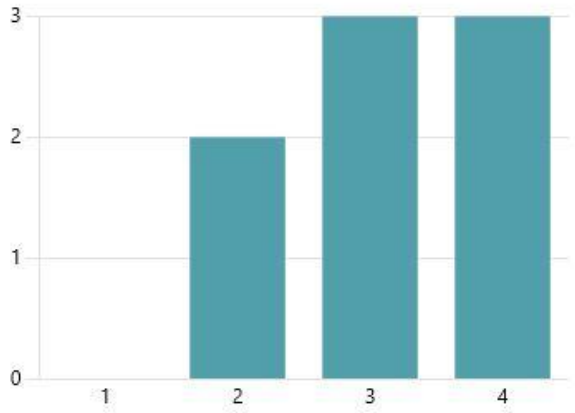
3.00
Average Rating



100. Usability testing: The platform should undergo usability testing to ensure that it is easy to use and understand for authorized users. (0 point)

More Details

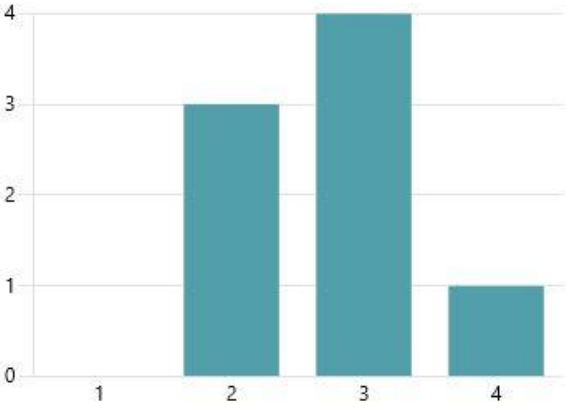
3.13
Average Rating



101. User Support: The platform should have a robust user support system to address user queries and concerns. (0 point)

More Details

2.75
Average Rating



102. Versioning: The platform should maintain a version control system to enable proper management and tracking of changes made to the data. (0 point)

More Details

2.75
Average Rating