

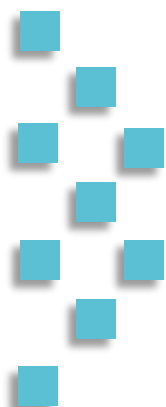


## D1.3 Requirements for innovation

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## Project Consortium



## Executive Summary

Fiware4Water intends to link the water sector to the FIWARE smart solution platform by demonstrating its capabilities and the potential of its interoperable and standardised interfaces for both water sector end-users (cities, water utilities, water authorities, citizens and consumers), and solution providers (private utilities, SMEs, developers). From the outset of the project it is important to understand, identify, and describe the use cases of the FIWARE-compliant Smart Water Applications that are to be developed, aiming to address the challenges identified at the four demo cases studied.

This deliverable documents the activities conducted within Task 1.3 - Requirements for Innovation. The main purpose of this task was the identification of the corresponding necessity/demands in the Water Sector regarding Open Source platforms, sharing data and used protocols, data representation formats, and so on. The objective was to get an overview of the technologies required as well as the blocking points to adopt them in the water sector. This has been implemented through a survey which was shared between different actors (private and public companies, universities, sensors providers) in the water sector not only at the level of Europe but also Worldwide. Additionally, we conducted direct telephone contacts with major stakeholders (e.g. World Bank, UN, The Nature Conservancy) in development of water projects around the world.

This deliverable presents the statistical analysis of the received answers in an anonymised way. This analysis will be the base (together with the results of tasks 1.1 and 1.2) to identify the corresponding Gaps in Task 1.4 and we also extracted the corresponding implementation strategy to be adopted in the subsequent Work Packages: definition of a General Fiware4Water Reference Architecture (F4W-RA) in WP2 and implementation of the strategy in each of the 4 Demo Cases in WP3/WP4.

## Related Deliverables

The conclusion obtained on this document will be the basis for unification procedure to be developed inside the Task1.4 which concludes with the generation of D1.4 - Gap analysis and final Requirements. Additionally, this document share with D1.1 and D1.2 the methodology to obtain the data from the users and stakeholders.

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## List of Acronyms/Glossary

<b>API</b>	Application Programming Interface
<b>CIM</b>	Context Information Management
<b>CSV</b>	Comma-Separated Values
<b>DK/NA</b>	Don't Know / No Answer
<b>ETSI</b>	European Telecommunications Standards Institute
<b>F4W</b>	Fiware4Water project
<b>GDPR</b>	General Data Protection Regulation
<b>GIS</b>	Geographic Information System
<b>GS</b>	Group Specification
<b>HTTP</b>	Hypertext Transfer Protocol
<b>HTTPS</b>	Hypertext Transfer Protocol Secure
<b>ICT</b>	Information and Communication Technology
<b>IoT</b>	Internet of Things
<b>JSON</b>	JavaScript Object Notation
<b>LoRaWAN</b>	Long Range Wide Area Network
<b>MQTT</b>	MQ Telemetry Transport
<b>NB-IoT</b>	Narrowband Internet of Things
<b>OPC-UA</b>	Open Platform Communications – User Agent
<b>PPP</b>	Public-Private Partnership
<b>SDR</b>	Socially Desirable Response
<b>SEO</b>	Search Engine Optimization
<b>SME</b>	Small-Medium Enterprise
<b>STD</b>	Standard Deviation
<b>XML</b>	Extensible Markup Language



## I. Introduction

FIWARE is an open IT platform which was created under the Public-Private Partnership Program on the Future Internet (FI-PPP) launched by the European Commission in 2011. Since its creation, this community has evolved and is today a global ecosystem of developers, innovation centres, accelerators, cities, SMEs and start-ups. It facilitates the development of innovative digital solutions.

Regarding the water sector, the IT development of applications and management tools using Big Data is quite late, especially because it is a very fragmented sector and because of persisting problems regarding systems interoperability, data standardization, semantics and formats exchanges.

Fiware4Water therefore intends to link the water sector to the FIWARE IT platform. Several interfaces and tools will be developed for the benefit of all the end users of the water sector and will be demonstrated through 4 demo cases in Europe:

- Water Supply System of the City of Athens (GR),
- Drinking water distribution network of the city of Cannes (FR),
- Amsterdam Wastewater Treatment Plant (NL),
- Smart meters for the citizens of Great Torrington (UK).

One of the objectives of the project is to offer an open architecture that can be used by water utilities as well as third parties to develop solutions and applications. To achieve a high degree of innovation under the constraint that water utilities won't share their data is as follows. By providing representative data of specific fields (smart meter readings, time series of flow/pressure of water distribution networks, etc.) in a standardized form, third parties can develop new ideas of how to use this data to solve specific problems (e. g. leak detection). But this needs some requirements, like:

- Opinion of companies towards open source platforms,
- Collecting representative data,
- Pre-processing and standardization of the data to being integrated into the context management at the top of FIWARE
- Technical information about data and interoperability

This document describes the results of the investigation about which open source platforms are already used by the water sector, what gaps and restrictions are the water sector aware of and what is the sector's opinion about sharing water-related data and the experience which the sector has in using data models. With the aim of accessing this information, a questionnaire (See Annex A) was created to obtain further insight as to how best focus project activities regarding the future development of the open source enabling technology in water management. In return, the participants would be maintained fully informed of subsequent developments and invited at a later stage of the project to contribute further to the activities of the consortium.

The methodology employed was the aforementioned questionnaire placed on SurveyMonkey. Thirty-nine participants from fourteen different countries completed the survey, the results of which are presented

in this document. After briefly describing the use of open source enabling technology in water management, the target groups for this particular study, and the motivations for using a questionnaire, the results of the analysis are presented, and conclusions are drawn. In coordination with the findings of D1.1 and D1.2, this document seeks to permit Fiware4Water to be able to adapt its approach in a way that the results of the initiative can be truly effective in the short, medium and long-term.

The targets of this research were the utility, the supplier (drinking water and wastewater). Additionally, companies developing hard- and software solutions as well as consulting companies were addressed with the survey.

## II. Background

### II.1. Objectives

Open source avoids vendor lock-in, promotes cost effectiveness, and contributes to the building of economies of scale and data economy. FIWARE Technology is open source which resolves this vendor lock-in problem as well as allows cost effectiveness of the services developed with this technology. So far, little progress has been made on developing specific water-related applications using FIWARE Technology, due to fragmentation of the water sector, restrained by licensed platforms and lagging behind other sectors (e.g. telecommunications) regarding interoperability, standardisation, cross-domain cooperation and data exchange. And we think that together we can solve pressing issues on the Water Sector with the use of this technology.

In order to be able to meet these challenges, experience in dealing with open source is required from water supply companies, hardware and software manufacturers and consulting firms. The following three topics are in particular focus:

1. Open Source Platforms
2. Sharing of water-related data
3. Technical information about data and interoperability

Companies were asked about this in a survey.

#### **Open Source Platforms**

In order to reach companies for the application of FIWARE, it is first of all very important to understand to what extent companies already use Open Source solutions. For which purposes are Open Source solutions used? If yes, which ones? Or are there certain restrictions or conditions that prevent or complicate an application? The answers to these questions form the basis for a successful dissemination strategy, in order to be able to convince companies to use FIWARE in the future.

### Sharing of water-related data

Regardless of the capabilities and services that FIWARE includes, in the future we want to provide standardized and anonymous data sets that allow anyone to analyse and work with it. The reason is that the datasets are interesting for different users:

- Training purposes at universities that want to improve the education of their students.
- Consulting and software companies that can develop new tools on the basis of real-world data
- Use the data sets as reference data sets for benchmarks, e.g. to compare the performance of different leakage detection algorithms.

For example, a dataset can be a multi-year time series of the water consumption of a city at a resolution of one hour. A university can use such data to show students how the water demand of a city fluctuates seasonally and can use it to calculate various water management parameters for training purposes. Consulting and software companies can use such data to develop models for predicting water demand. Especially for the development of analysis tools, the data basis is of crucial importance. Real-world data is always preferable to synthetically generated data. Start-ups in particular usually have good ideas, but fail due to the availability of real-world data in order to test their prototypes sufficiently.

The aim of FIWARE is to create an added value for everyone with such data sets. Therefore, one topic of the survey is to ask utilities to share their water-related data with Fiware4Water.

### Technical information about data and interoperability

FIWARE Technology is such a flexible technology that can be assembled to operate with different technologies. Each Water Utility has its own sensors, treatments and already collects data. This is its legacy system where the data is already connected. There are specific components inside the FIWARE Technology to translate the legacy data representation model and APIs to the FIWARE Standards Data Models and ETSI GS CIM Application Programming Interface. In case that a legacy system uses a different representation model and/or API that it is not covered in the FIWARE Technology at the moment, it will be resolved during the execution of the Fiware4Water project, in fact this is one of the reasons of one of the questions.

## II.2. The target participants

Water is a vital resource. The presence of water and its management contributed to the creation of ancient civilizations. Furthermore, these civilizations emerged due to innovations in water management (e.g. irrigation for agriculture, water transportation via aqueducts to supply large cities, wastewater systems to evacuate sewage from cities and so on).

Nowadays, there is huge demand for freshwater. Although, society has enough freshwater resources, the distribution in time and space of this resource is not resolved in the same form around the world [2]. There are several reasons for this including inadequate quality of freshwater, economic levels, lack of

resources and so on. Fortunately, we also know what it takes to solve these problems employing methodologies of automation to clean the water and implement continuous sensing of water quality. Innovation in the water sector can help one to find ways to overcome these constraints. Therefore, innovation requires the development of concrete research challenges in all aspects of water management.

Fiware4Water encourages the rapid adoption of smart technologies within the water sector to create an open innovation approach based on FIWARE architecture and standard data models in order to allow the sharing of data, real-time policy-making as well as developing ground-breaking technology from scratch to be integrated in a standard platform.

For this purpose, the target audience of this questionnaire were the representatives of the specific open source communities or companies that are interested in the creation of specific innovation services in the Water Sector. This involves all the FIWARE Ecosystem list, consisting of start-ups, SMEs, companies, institutions, individuals and other stakeholders closely involved with FIWARE and interested in the water sector. Additionally, all the contacts in the FIWARE newsletter list were approached especially entrepreneurs interested in and/or working with FIWARE who have explained to the project consortium their desire to work in the water sector. Moreover, other target participants approached correspond to the contact list of the different ICT and IoT events in which FIWARE4WATER have participated, such as Smart City Expo World Congress, FIWARE Global Summit, Smart Country Convention, IoT Solutions World Congress and Hannover Messe, to name a few. Finally, we took into consideration the FIWARE Lead Magnets, split into the four domains FIWARE is most active: Smart Cities, Smart Industry, Smart AgriFood, and Smart Energy.

### II.3. The survey methodology employed

The creation of a technical survey, in which the compilation of information about what is taking into account by interviewees, is not so easy. If usually, it is difficult to obtain simple information through surveys, trying to get concrete technical details about the technology and implementation details of the responders is still more complicated. The way that the questions are phrased was taking into consideration in order to obtain clear technical information and increase the possible impact on how we can obtain a concrete technical requirements list such as Jeanne, Shaughnessy, and Zechmeister (2011) [1] explained. Thus, surveys' questions were written with clear, conscious and unambiguous vocabulary. The questions therefore have to be respondent-friendly for the purpose of the study. Rühlemann (2014) [10] pointed out when defining what he named as 'recipient design' that the language used must be fully comprehensible to the target audience.

The efficiency and trustworthiness of surveys results are only valid as the measures taken with regards to a questionnaire's preparation and dissemination. The reason to develop this activity must be clear. The main purpose is to get a valid information from the water sector. This information must help us to obtain valid conclusions and formulate concrete architectural requirements that may or may not have been taken in previous studies obtained from secondary sources.

The fact that all interviewees will answer the same questions provide the methodology of questionnaires with the capacity to observe unbiased tendencies. Questions can be asked in different ways. We can obtain immediate answers through face to face interviews, but we are not offering interviewees enough time to provide a complete and concrete answer or even precise one. These disadvantages are also presented in telephone interviews. On the other side, the generation of questionnaires and the distribution of them through different channels resolve these disadvantages, providing all the time that it is needed to provide a precise answer to the questions.

It is well known that the surveys play an important role in the marketing research [7]. Even in technical research and extraction of corresponding requirements, they are taking huge reference, but there is a frequent concern about the collected information through surveys, trustworthiness. What about the results of the survey if respondents may not respond truthfully but simply provide answers to finish the survey as soon as possible that make them look good. This phenomenon is called socially desirable responding (SDR). This phenomenon introduces rare variation in scale scores, which compromises the validity of survey data. Consequently, we need to design the survey in a way that we can trust the obtained information.

The questions included in the survey (See: Annex A) were designed with the purpose to resolve the SDR phenomenon [8] as well as obtain precise information to be used afterwards by the technical partners of Fiware4Water to generate valid architectural requirements. The validity of the responses is obtained through the design of proper questions schema with partial redundant expected information which provide us trustworthiness about the results obtained. Besides, we apply many of the recommendations suggested by Owens in order to design a proper email survey [9]. Moreover, other important factor in the SDR is the cross-cultural/cross-national interviewees due to differences in the conceptual information of the questions how it was mentioned by Deborah Owens, Charles Pettijohn and Bruce D. Keillor [11]. Based on these findings, we made a translation to different languages (English, Portuguese, French, Spanish, German, and Dutch) to resolve the ambiguity in cross-cultural/cross-national implications.

Additionally, the questions were asked employing a clear, unambiguous vocabulary. They were composed by:

- a set of multi-choice, close-ended questions with an open-ended option in order to add a limited amount of extra information,
- some specific open-ended question to discover the responses give spontaneously,
- a set of YES/NO variety thus permitting the responders to complete the survey in a short period of time. At certain points of the questionnaire, participants could add a limited amount of extra information if they felt the need to do so.

The use of open-ended questions has disadvantages in comparison to close-ended, it is needed an extensive analysis of the requested information as well as the interviewees need more time to resolve the questions which in some cases is counterproductive to complete the questionnaire. On the other side close-ended questions provide concise responses to the questions because they are redirected to the responses, but we lose the spontaneity, flexibility, and expressivity of the interviewees. We try to resolve this dichotomy with a mix of open- and close-ended questions just to get the best of the 2 options. Finally, the multiple-choice questions, where designed in order that the wording of some of the items is worded in the opposite direction to evade response bias.

Next step, for the purpose to extract the requirements we adopted Pareto Analysis. It is based on the observation that obtained results are not distributed evenly and that some inputs contribute more than others especially when we have multiple-choice options [3]. It is referred to as the “80/20 rule,” a concept introduced by Vilfredo Pareto [4]. The current explanation of the Pareto analysis is focused on the set of efforts (products, customers, business units) that produce most of the results (revenues, profits, answers, ...) [5]. It has lot of implications due to it suggests that most efforts are not efficient and should be reduced, especially when we are talking about a proper generation of requirements. The strategic objective consists in the maximization of the efforts that produce most of the results. It is vastly well-known that most of the software projects does not implement all the requirements and therefore it is needed some kind of

prioritization activity on them [6]. Pareto Analysis helps us to identify and prioritize the requirements that will have the biggest advantages.

Furthermore, we applied strict ethical practices in the questionnaire, observing the established EU data protection legislation to prevent the existence of privacy infringements. Interviewees were required to sign an Agreement to Participate after having read an explanation of the project itself. It produces a clear explanation about why the information is so important for us, what their participation consisted of, how they are involved in future communications and dissemination activities, and a description of their legal rights.

Finally, for this deliverable, interviewees were encouraged by e-mail (and in a few cases by phone or face-to-face) to participate by entering SurveyMonkey (<https://www.surveymonkey.com>). This is an effective web-based method in that it permits one to obtain input from many geographical areas in a relatively short period of time and with very few overheads. The results, if the questionnaire is well designed, are easy to collate and the data is readily accessible for study and the drawing of conclusions. Eliminating the recording of answers by interviewers in situ avoids the problem of human error when noting the replies. Additionally, SurveyMonkey is compliant with the GDPR [12] through the implementation of processes to protect customer data.

### III. Results of the analysis

The survey created by the Fiware4Water consortium sought to be both comprehensible and relevant to the different types of entity approached in the European countries of Belgium, France, Germany, Greece, Netherlands, Romania, Spain, Turkey, The United Kingdom together with non-European states such as Argentina, Brazil, EEUU, Tunisia and Bangladesh. As has been stated in Section II.2, different innovation operators were contacted (mainly from the water sector) together with a number of representatives from other related sectors very focused on innovation activities. We have received answers from 39 responders, from which 33 provide answers to the majority of the technical questions contained in the questionnaire. The analysis of the representatives gives us the following result:

- 34 participants were from the water sector
- 16 were representatives of digital service development
- 7 were hardware/technology providers
- 5 participants were from the research and innovation sector
- 1 was involved in weather forecasting.
- 1 were agriculture
- 1 worked in the energy sector.
- 1 worked in transportation sector
- 1 worked in the telecommunication sector

Nevertheless, we observed that some representatives are belonging to several categories because the total number of the previous list (67) is different to the total number of received responses 39. Finally, we

have to admit that the number of responses obtained in the questionnaires has been low therefore it may not represent all end-users. In this case, the results obtained present a bias and the Pareto Analysis may not be relevant for all questions.

In the following section, the results are discussed from a global as well as from a European point of view.

### III.1. The employment of Open Source Platform

#### Q1.1: For what purpose would you use an open source platform? (Multiple answers possible)

33 responders from a total of 39 indicated 182 purposes of using open source platforms in the following percentages:

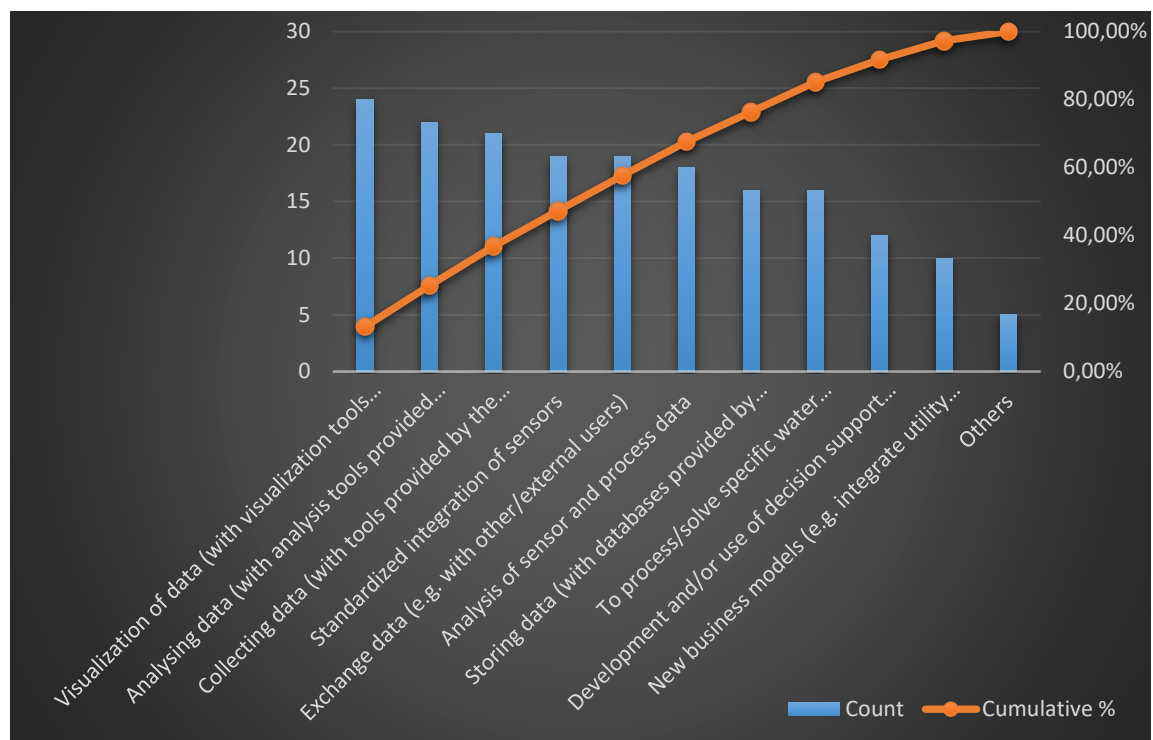


Figure 1: For what purpose would you use an open source platform?



*Table 1: Comparison between current standardization performed in standardization bodies and De facto standardization*

PURPOSE OF USING OPEN SOURCE PLATFORMS	NUMBER OF RESPONDERS INDICATING THIS SOLUTION	PERCENTAGE OF RESPONDERS INDICATING THIS SOLUTION
Visualization of data (with visualization tools provided by the platform)	24	72.73%
Analysing data (with analysis tools provided by the platform)	22	66.67%
Collecting data (with tools provided by the platform)	21	63.64%
Standardized integration of sensors	19	57.58%
Exchange data (e.g. with other/external users)	19	57.58%
Analysis of sensor and process data	18	54.55%
Storing data (with databases provided by the platform)	16	48.48%
To process/solve specific water management issues (improving services, serious gaming, consumer interaction)	16	48.48%
Development and/or use of decision support tools (e.g. tools that recommend a specific pump timetable) and models	12	36.36%
New business models (e.g. integrate utility bills and services)	10	30.30%
Others	5	15.15%

In this first question, the 33 participants indicate their intention to use open source platforms. *Figure 1* represents the absolute values of each purpose as well as the cumulative percentages of these purposes. For example, 24 interviewees indicated that they use open source platform for visualization of data. This constitutes 13.19% of all the purposes indicated but demonstrates that 72.73% of those questioned use open source platforms for visualization of data. (See the second table).

The results demonstrate that almost the same number employ an open source platform for the purpose of **Visualization of Data** (25 interviewees, 13.19% responses, 72.73% users' responses), **Data Analysis** (22 interviewees, 12.09% responses, 66.67% users' responses), and **Collecting Data** (21 interviewees, 11.54% responses, 63.64% users' responses). A smaller number, (19 interviewees, 10.44% responses, 57.58% users' responses) employ **Standardized Integration of Sensors** and **Data Exchange**. Finally, close to these values, we see that the **Analysis of Sensors and Process Data** (18 interviewees, 9.89% responses, 54.55% users' responses), **Storing Data** (16 interviewees, 8.79% responses, 48.48% users' responses) and **Process/Solve Specific Water Management Issues** (16 interviewees, 8.79% responses, 48.48% users' responses) cover the 80% of all the responses.

This means that the purpose of using open source platforms is very distributed with not a clear winner purpose. In the meanwhile, the proliferation of open source platforms for different purposes and the adoption of these solutions is extended into the interviewees. Besides, this also demonstrates that open source solutions are well anchor in the common culture because a large part of participants use at least one open source solution. Additionally, the result shows that the adoptions of open source platforms could serve various needs in the water sector.

The results cannot be described as surprising but do provide a first example of the importance of develop an open source platform covering these purposes in the water sector.



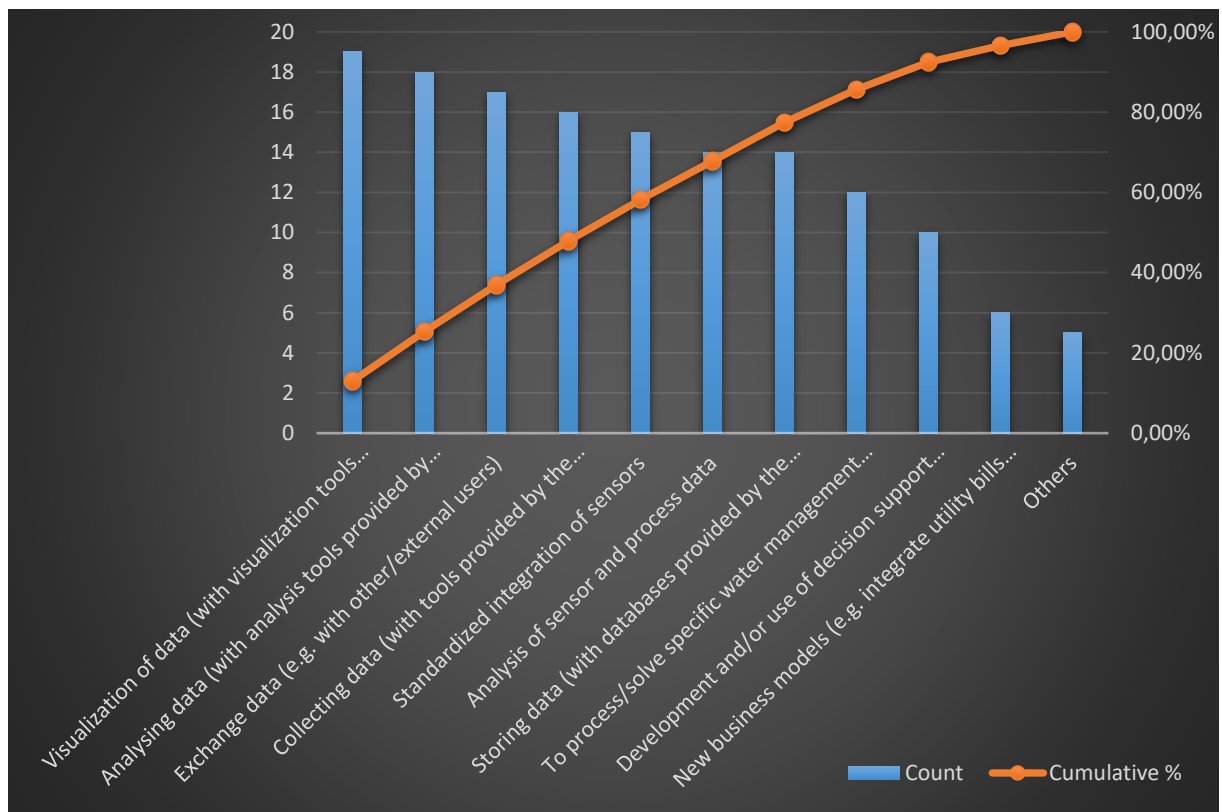


Figure 2: For what purpose would you use an open source platform? (in Europe)

## III.2. The concerns in the use of Open Source platforms

### Q1.2: What are your concerns in using open source platforms? (Multiple answers possible)

33 responders from a total of 39 indicated 51 concerns in using open source platforms in the following percentages:

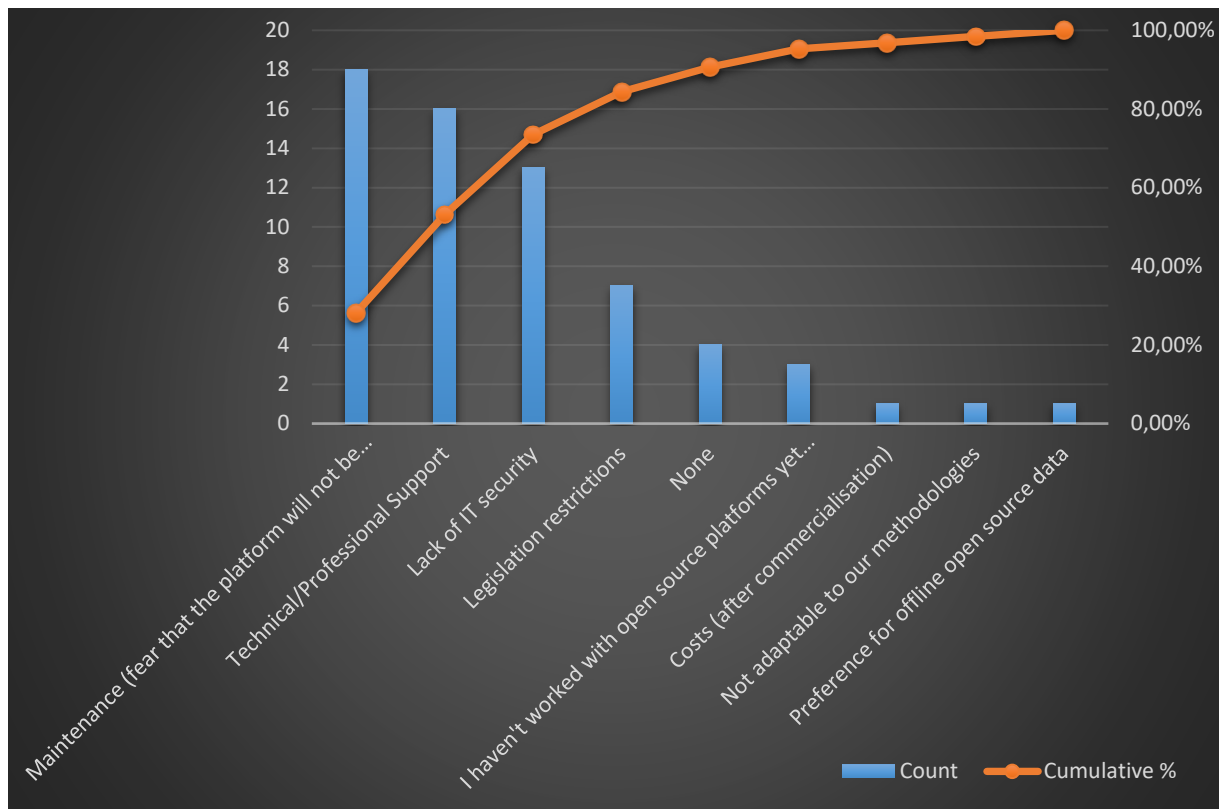


Figure 3: What are your concerns in using open source platforms?

Table 2: Concerns in the use of Open Source platforms

CONCERNS	NUMBER OF RESPONDERS INDICATING THIS SOLUTION	PERCENTAGE OF RESPONDERS INDICATING THIS SOLUTION
Maintenance (fear that the platform will not be further developed in the future)	18	54.55%
Technical/Professional Support	16	48.48%
Lack of IT security	13	39.39%
Legislation restrictions	7	21.21%
None	4	12.12%
I haven't worked with open source platforms yet and have general concerns about them.	3	9.09%
Costs (after commercialisation)	1	3.03%
Not adaptable to our methodologies	1	3.03%
Preference for offline open source data	1	3.03%

Of the 33 interviewees approached, 18 (28% all the concerns, 54.55% all users' responses) mentioned that the main problem is the **Maintenance of the Platform**, especially the fear that the platform will be discontinued in the future. **Technical/Professional Support**, a vital aspect for developing a production base solution, is reached as well high concerns with a number of 16 responses (25% all the concerns, 48.48% all users' responses) and it is related with the Maintenance of the platform. The next concerns that we can observe is the **Lack of IT Security** with 13 responses (20.3% all the concerns, 39.39% all users' responses).

responses). The use of Open Source components has reported a considerable time reduction in the working activities of developers. Nevertheless, they are seen as a giant risk due to security problems, especially when they are not properly maintained. People think because data model or source code are available online, it is easier to hack it. It is generally false for wild spread open source solution and when security update a regularly made. Additionally, the fact that the code is open, provide the effect that there are “more eyes” on it to find any security issue. Finally, to cover the 80% of the cases, the interviewees have indicated that the **Legislation Restrictions** is a concern in the adoption of Open Source Platform with 7 responses (10.94% all the concerns, 21.21% all users’ responses).

The results are reproduced in Europe in the same line with these four concerns, which means that the main concerns are the same at the Global Level and Local European Level at least for the responses that we have obtained in the questionnaire.

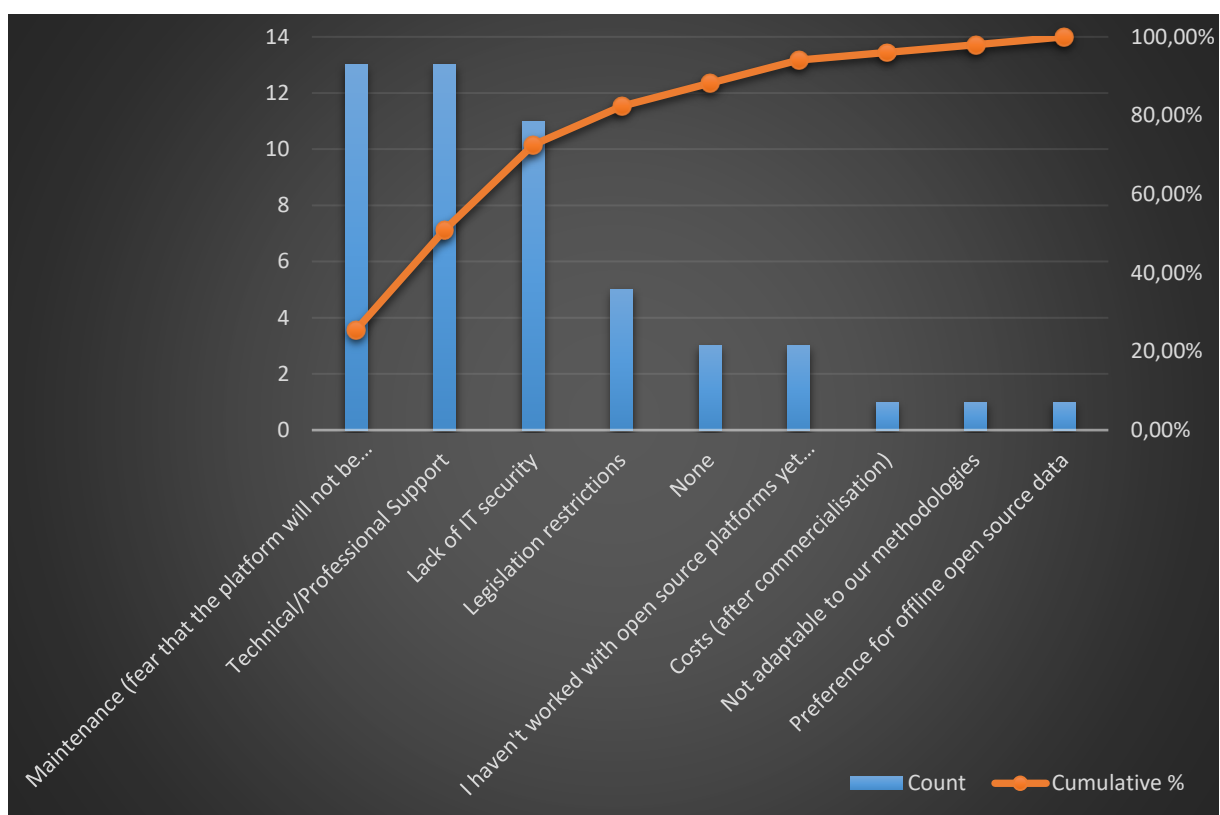


Figure 4: What are your concerns in using open source platforms? (in Europe)

### III.3. The employment of Open Source platforms

Q1.3: If you already use open source platforms, which one do you use and what do you use it for? (Please specify three different platforms maximum)

On average, the interviewees respond with a huge variety of open source platform due to the fact that was an open question. We receive only responses from 13 users with 20 different platforms. The unique values of the responses were the following table.

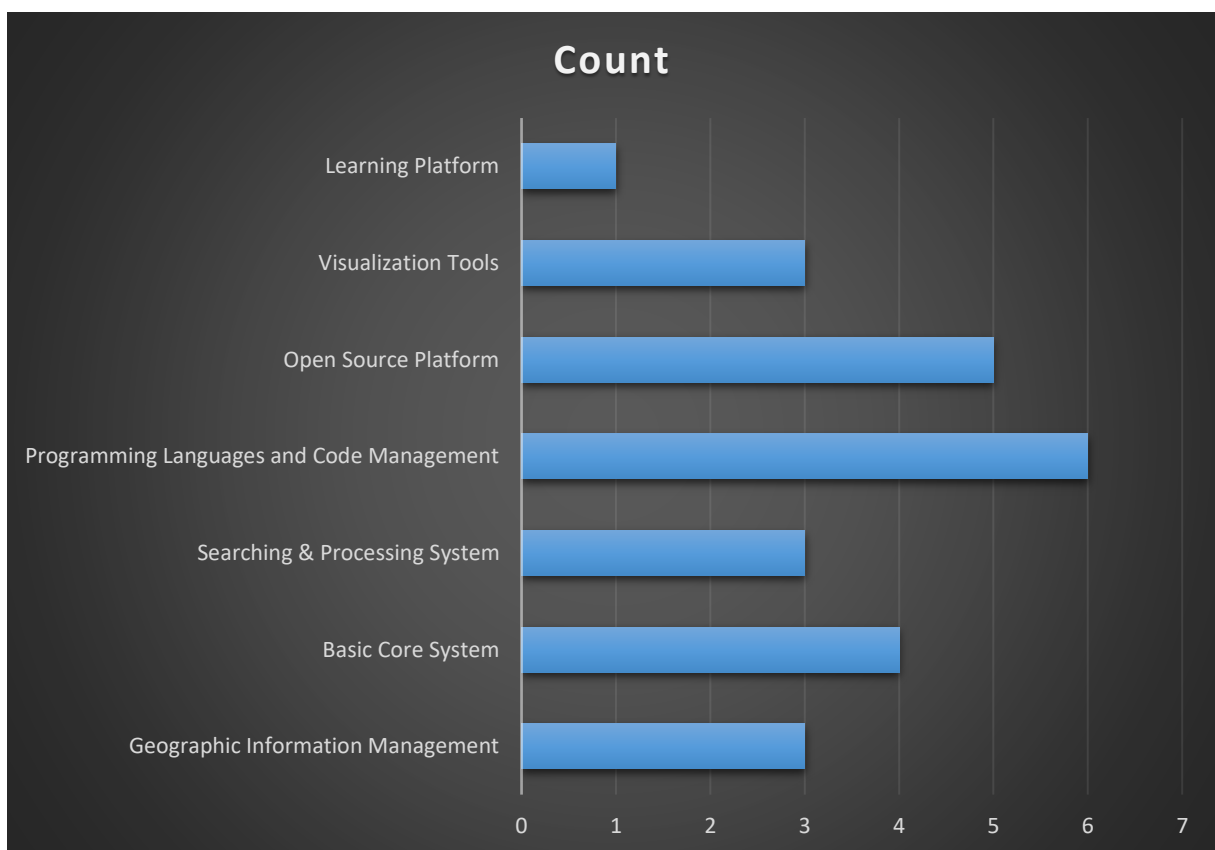
To make a better analysis of the results, we have categorized the answers in function of the purpose of the different platforms (e.g. FIWARE, Apache Hadoop/Spark, OpenStack, ...) and/or solutions (e.g. MongoDB, Grafana, ...). Taking into account this classification, the corresponding classes created with the corresponding values can be shown in the following table.

*Table 3: Open Source platforms*

Classification	Platform	Responses	Response Percentage	Total response	Total response percentage
<b>Geographic Information Management</b>	QGIS	1	4%	3	12%
	PostGIS	1	4%		
	MapServer	1	4%		
<b>Basic Core System</b>	Docker	1	4%	4	16%
	Kubernetes	1	4%		
	Linux(Ubuntu, CentOS)	1	4%		
	OpenStack	1	4%		
<b>Searching &amp; Processing System</b>	Apache Spark/Hadoop	1	4%	3	12%
	Elastic Search	1	4%		
	MongoDB	1	4%		
<b>Programming Languages and Code Management</b>	Python	1	4%	6	24%
	R	3	12%		
	PhreeqC	1	4%		
	Gitlab	1	4%		
<b>Open Source Platform</b>	FIWARE	3	12%	5	20%
	Helix Sandbox	1	4%		
	Sentilo	1	4%		
<b>Visualization Tools</b>	Grafana	2	8%	3	12%
	OpenLayers	1	4%		

Learning Platform	Moodle	1	4%	1	4%
TOTAL		25	100%	25	100%

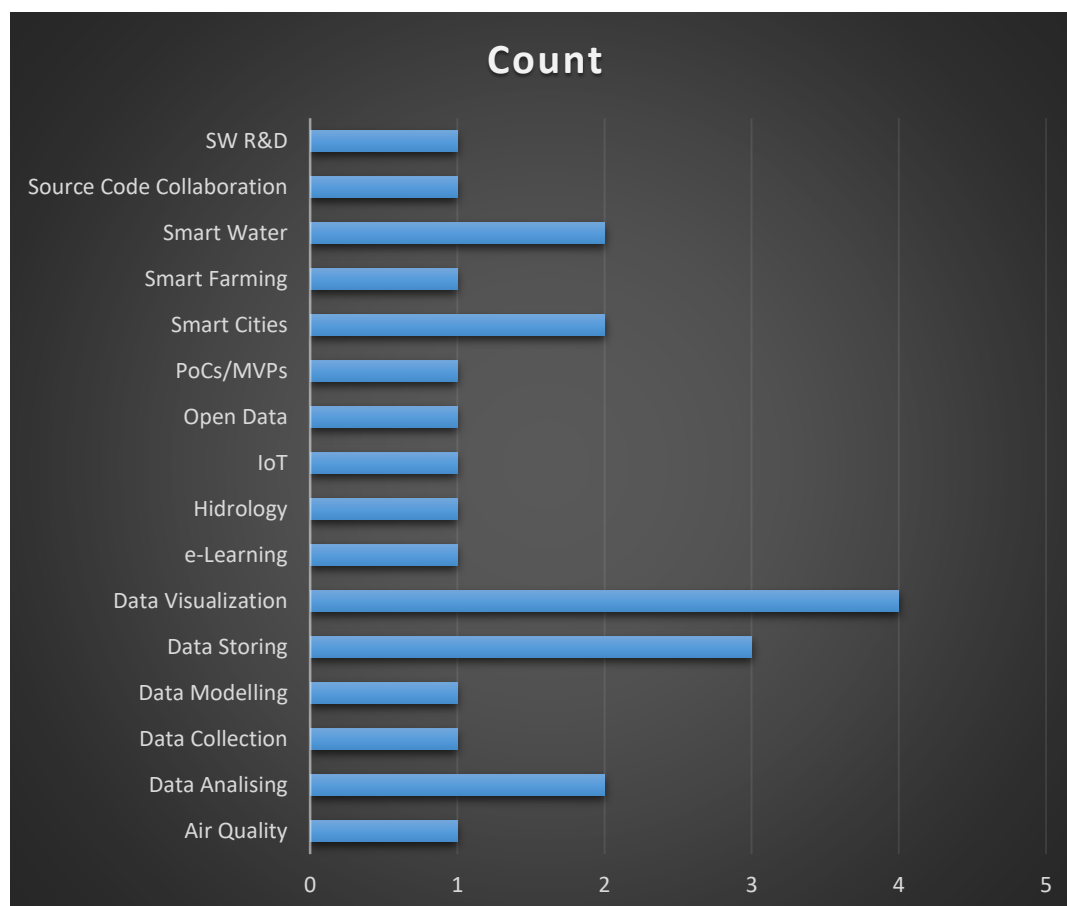
The results with regards to this classification, show us that **Programming Language and Code Management** is the most important set to Open Source Platforms with a total of 6 responses (24% all open source platforms, 46.15% all users' responses). The next category corresponds to the **Open Source Platforms** with 5 responses (20% all open source platforms, 38.46% all users' responses) followed by the **Basic Core System** category with 4 responses (16% all open source platforms, 30.77% all users' responses). Then and in equal numbers of cases (3 responses, 12% all open source platforms, 23.08% all users' responses), we can observe the categories **Geographic Information Management**, **Searching & Processing System**, and **Visualization Tools**. All of these categories cover 96% of all responses.



*Figure 5: Employment of Open Source platforms*

Finally, we have to mention that this question might introduce a bias. This is clear a constraint on the analysis of this question. For example, someone using spatial data infrastructure should use several open source tools, same for data visualization, data analysis, data storage, search engine, OS, and so on. Nevertheless, for the sample that we manage, we define this classification. With other sample, probably the classification would be different. The problem would be resolved through a closed-ended question but with all open source solution in the market, which would be impractical. Additionally, we wanted to offer freedom to the interviewees in order to discover the responses given spontaneously. This led us to design this question in a multi-choice open-ended one just to get the answer from the users.

If we analyse the purpose of the use of these Open Source Platforms, the responses are a little bit different. The more important usage is **Data Visualization** with 4 responses (16.67% all usages) followed by **Data Storing** with 3 responses (12.50% all usages) and then **Data Analysing**, **Smart Water**, and **Smart Cities** with 2 responses (8.33% all usages).



*Figure 6: Employment of Open Source platforms (classified)*

The conclusion of this dichotomy is that the interviewees are using specific Open Source Platforms but with a final usage direct or indirectly supported by these Open Source Platforms. Nevertheless, we can see some common patterns in the use of **Data Visualization**, **Data Analysing** and **Data Storing** together with the **Data Modelling** and **Data Collection**.

### III.4. Factors to use and Open Source Platform

#### Q1.4: What are the factors that would you trigger to use an Open Source Platform? (Multiple answers possible)

33 responders from a total of 39 indicated 153 factors to trigger the use of an Open Source Platform in the following percentages:

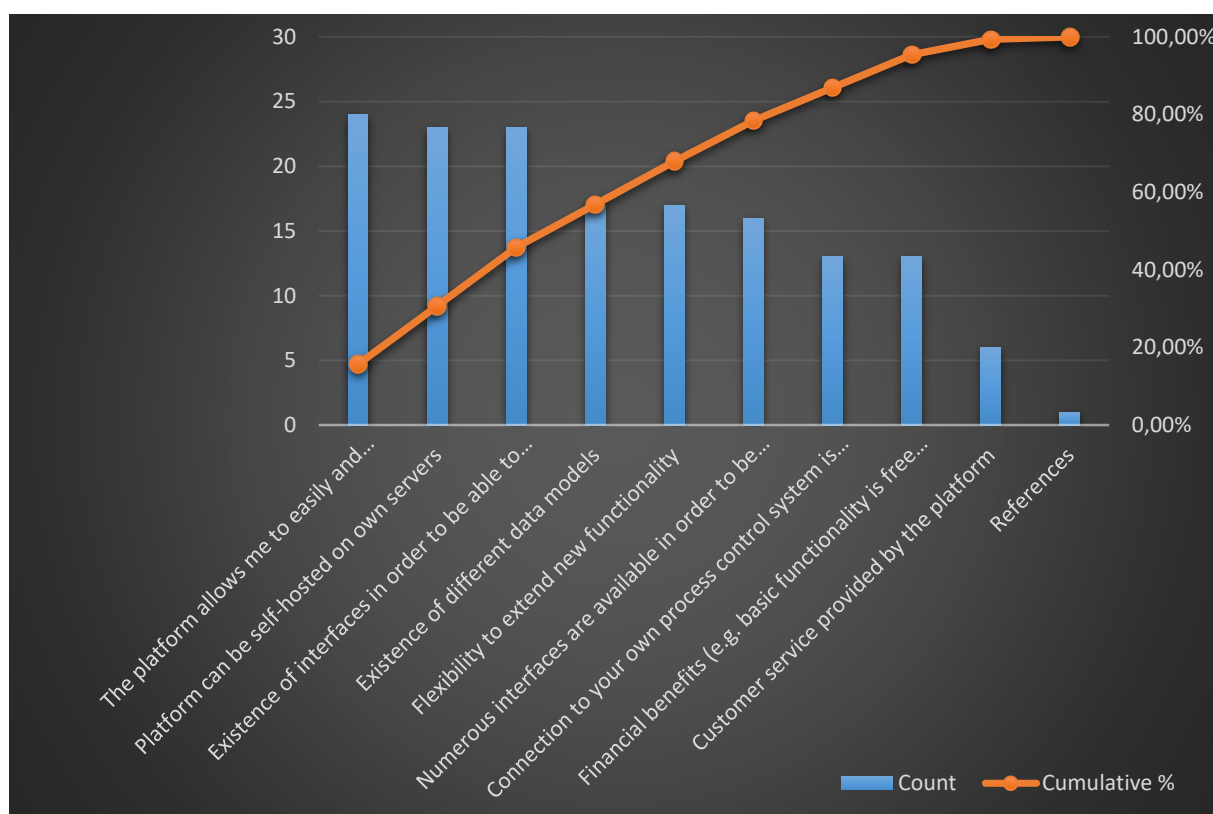


Figure 7: What are the factors that would you trigger to use an Open Source Platform?

Table 4: Different factor to trigger the use of Open Source platforms

FACTORS TO TRIGGER THE USE OF AN OPEN SOURCE PLATFORM	NUMBER OF RESPONDERS INDICATING THIS SOLUTION	PERCENTAGE OF RESPONDERS INDICATING THIS SOLUTION
The platform allows me to easily and uncomplicatedly integrate with different data sources (company sensors, weather forecasts, gauging/flow rates, groundwater measuring points, rain radar, ...).	24	72.73%
Platform can be self-hosted on own servers	23	69.70%
Existence of interfaces in order to be able to integrate already existing analysis and visualization tools (like a Geographic Information System, GIS)	23	69.70%
Existence of different data models	17	51.52%

Flexibility to extend new functionality	17	51.52%
Numerous interfaces are available in order to be able to integrate a wide variety of sensors	16	48.48%
Connection to your own process control system is possible	13	39.39%
Financial benefits (e.g. basic functionality is free to use)	13	39.39%
Customer service provided by the platform	6	18.18%
References	1	3.03%

On average, the interviewees responded that the most important factor is the **Ease integration with difference data sources** with 24 responses (15.69% responses, 72.73% users' responses). Very close to this factor, we can see that the **Deployment of the platform in their own premises** and **Facility to integrate the open source platform with Data Analysis and Data Visualization tools** are the next important factors for the interviewees with 23 responses (15.03% responses, 69.70% users' responses). Hereafter, interviewees mention that the **Existence of Data Models** and the **Facility to extend the Open Source Platform** with new functionalities are important factors to trigger the use of it with 17 responses (11.11% responses, 51.52% of the users' responses). Finally, interviewees respond that the **Existence of several interfaces to integrate a wide variety of sensors** is a relevant factor with 16 responses (10.46%, 48.48% of all users' responses). These factors explain 78.43% of all provided factors. It is relevant to mention that the most important factor is the Integration with different data sources because we can consider that sensors are another source of data, therefore they represent the 26.14% of all the factors.

The results are similar in Europe just switching some order on them as we can see in the following figure.

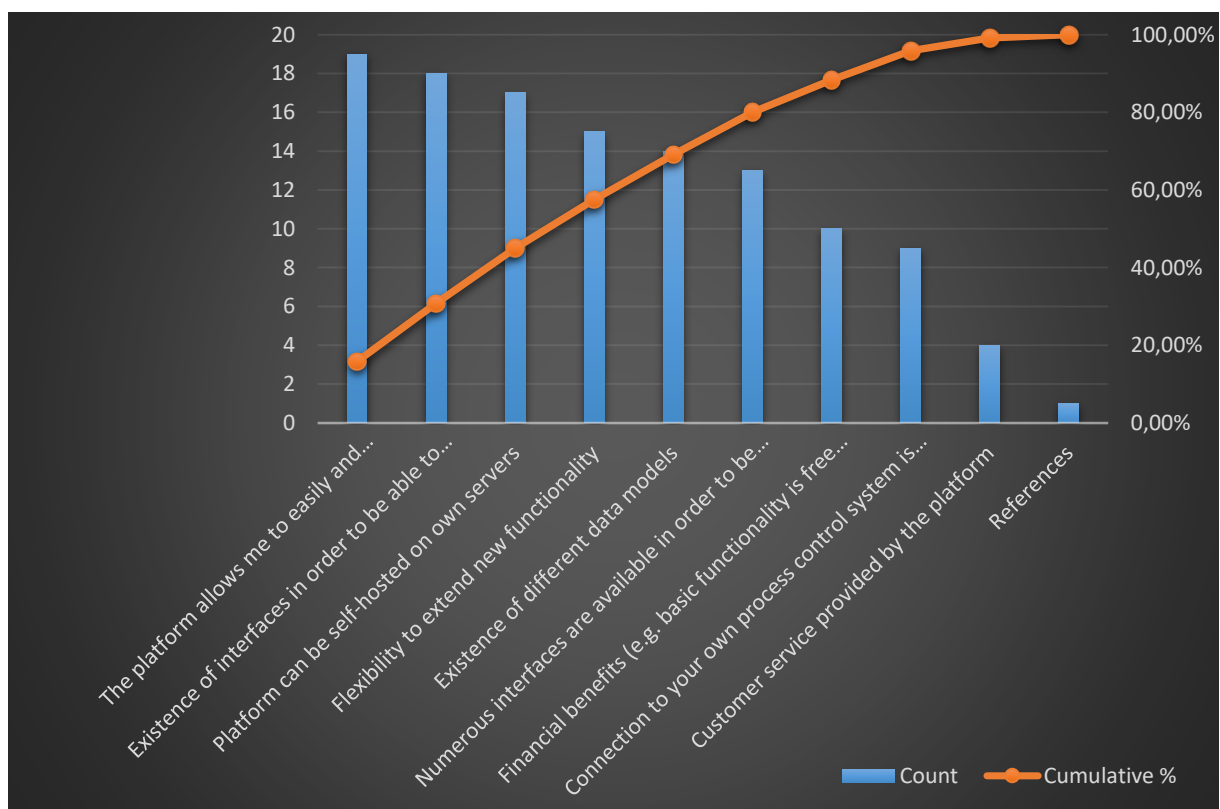


Figure 8: What are the factors that would you trigger to use an Open Source Platform? (in Europe)

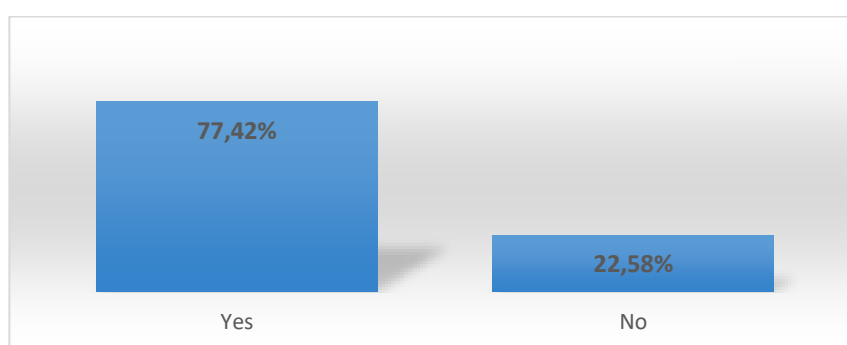


### III.5. Sharing datasets for Fiware4Water Challenge

The following questions (Q2.1, Q2.2, Q2.3, and Q2.4) try to get details about the sectors in which the interviewees want to innovate as well as possibility to get some data models used by them for our Fiware4Water Challenge. The question Q2.1 could be clearly SDR effect, therefore we decide to include the other questions just to dismiss this effect. It means that the interviewees have to provide double-confirmation to the information, both affirmative and positive to prevent this SDR effect.

#### **Q2.1: Are you interested in solving a problem by sharing one or more datasets related to the Water Sector?**

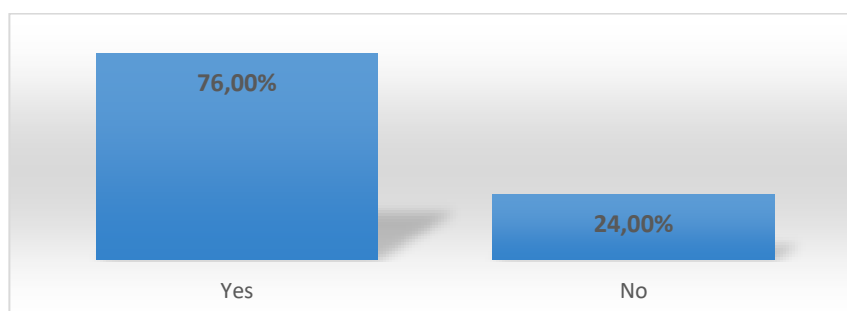
31 respondents indicated whether they are interested in solving a problem by providing one or more data sets related to the water sector. The percentage distribution is as follows:



*Figure 9: Are you interested in solving a problem by sharing one or more datasets related to the Water Sector?*

The most notable conclusion that can be drawn from the answers to this question is that there is a huge potential of support Fiware4Water Challenges due to more than **70%** of the interviewees are interested to share their own data related to the Water Sector to resolve a specific problem. The results of this question together with the information that we extract from the Q4.2 will help us to contact these interviewees in order to request support in the preparation of the Fiware4Water Challenges as well as definition of the proper problem to resolve, with the intention to resolve specific use cases that these interviewees have with their data.

The results are similar if we focus only in European countries as we can see in the following figure.



*Figure 10: Are you interested in solving a problem by sharing one or more datasets related to the Water Sector? (in Europe)*

### III.6. Innovation in the Water Sector

#### Q2.2: If the answer is yes, in which Value Chain of the Water sector would you want to innovate? (Multiple answers are possible)

24 responders from a total of 33 (72.72%) indicated 102 different value chain in which they can innovate. This gives us the information that the interviewees are really interested to create new services as well as they probably are open-mind to analyse the results provided in the project. It helps us to create proper communication channels with them as well as keep them informed about the technological aspects of the Fiware4Water (architectural definition, data models, new connectors and so on). The results obtained are shown in the following figure:

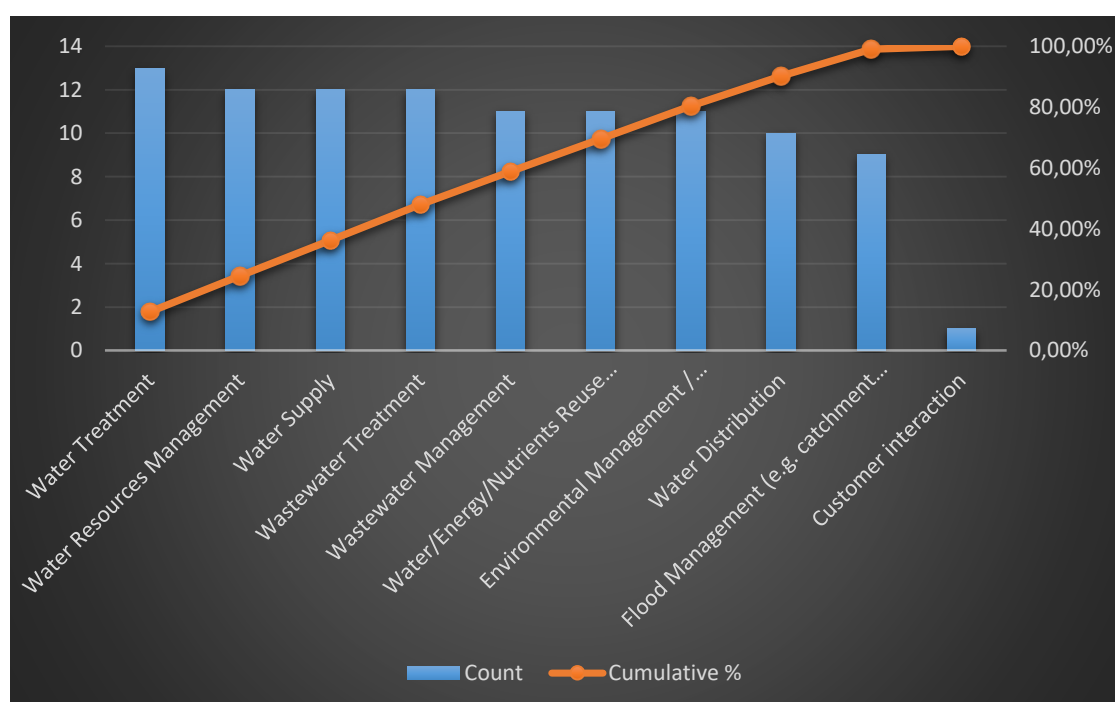


Figure 11: In which Value Chain of the Water sector would you want to innovate?

Table 5: Value Chain innovation in the Water Sector

INNOVATION IN THE WATER SECTOR	NUMBER OF RESPONDERS INDICATING THIS SOLUTION	PERCENTAGE OF RESPONDERS INDICATING THIS SOLUTION
Water Treatment	13	54.17%
Water Resources Management	12	50.00%
Water Supply	12	50.00%
Wastewater Treatment	12	50.00%
Wastewater Management	11	45.83%

Water/Energy/Nutrients Reuse (circular economy)	11	45.83%
Environmental Management / Ecosystem Services	11	45.83%
Water Distribution	10	41.67%
Flood Management (e.g. catchment management)	9	37.50%
Customer interaction	1	4.17%

It is a multi-choice close-ended question with an open-ended (Other option) choice in case that interviewees cannot find the proper value chain in the close-ended options. Additionally, the interviewees can select multiple choices of the options. The final result shows us a very distributed response in different water sectors. Due to there is no really differences between the different responses with a Median of 11 responses and STD of 3.43, we have to consider all the responses except Customer interaction, although they represent 99.02% of all the cases. Therefore, the possible value chain in the water sector in which the interviewees want to innovate can be focused in (ordered firstly by the number of responses and secondly alphabetically):

- **Water Treatment**
- **Water Resources Management**
- **Water Supply**
- **Wastewater Treatment**
- **Wastewater Management**
- **Water/Energy/Nutrients Reuse (circular economy)**
- **Environmental Management / Ecosystem Services**
- **Water Distribution**
- **Flood Management (e.g. catchment management)**

The results are similar if we analyse them only in European countries with minimum order change in case of **Wastewater Management** and **Water/Energy/Nutrients Reuse (circular economy)** as we can see in the following figure:

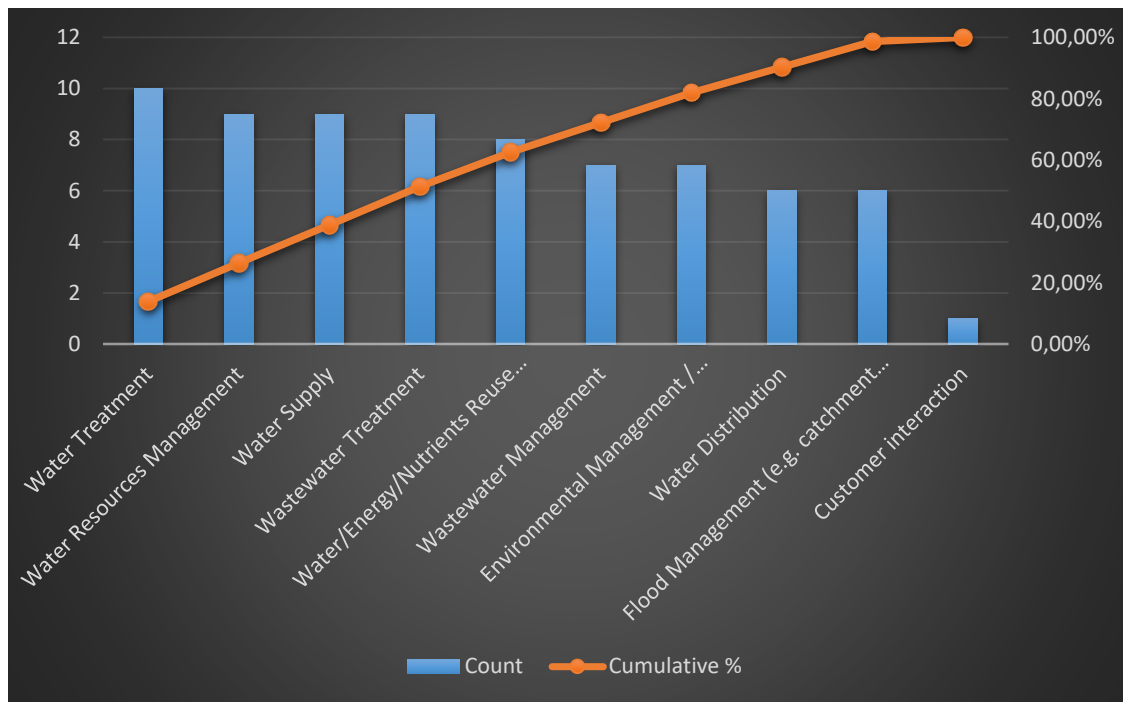
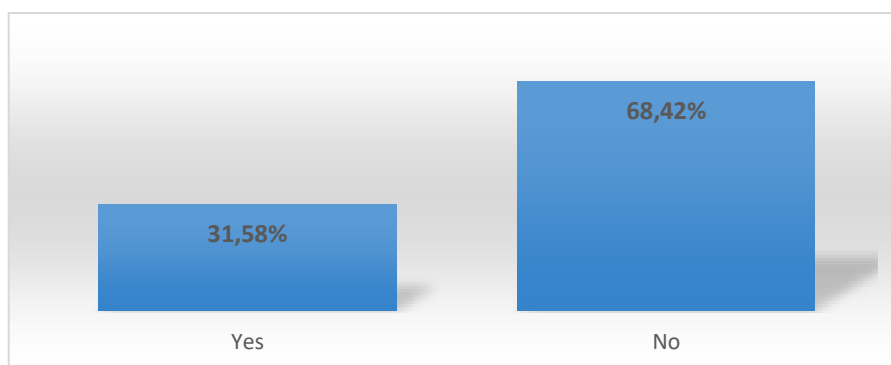


Figure 12: In which Value Chain of the Water sector would you want to innovate? (in Europe)

### III.7. Sharing questionnaire to others Current demand for Smart applications in Wastewater

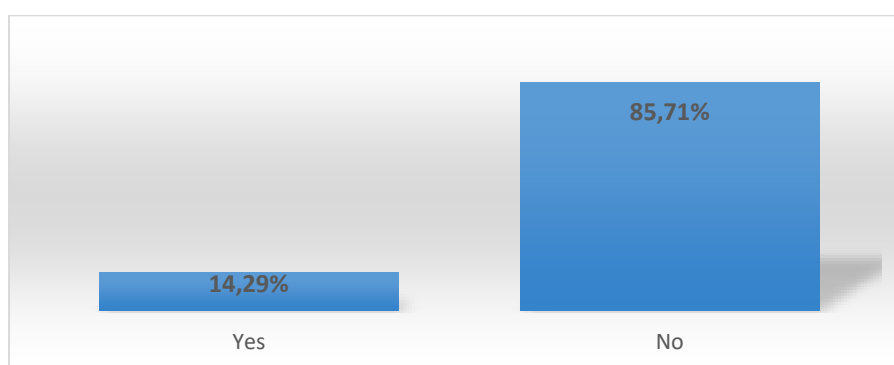
**Q2.3: If the answer is no, can you refer us to an institution that would be interested in being part of cooperating with Fiware4Water by forwarding this email to them and copying us on it**

Another yes and no question to get us much as possible collaboration from the interviewees. In colocation with the Q4.2, we extract a list of possible helpers in the configuration of the corresponding Fiware4Water users' network and collaborate with them in the success of the technical achievement of the project. The interesting information that we extract from this question is that even the interviewees that have answer "No" in the previous question, **31.58%** of them would be interested to help us to find a proper person that potentially could cooperate with us in the project. This information will be used by the Fiware4Water Communication team just to contact them and get some feedback about the project as well to keep them informed about the results of the project. Additionally, we will request them to share the information towards those third parties that maybe could be interested in the result of our project. It is clear that the success ratio of those communication activities could be low (or even very low) but it will help us in our SEO activities to improve our communication strategy during the execution of the project.



*Figure 13: Share the questionnaire with third parties*

What it is relevant is that we obtain less affirmative response in case of European countries (**14.29%**).

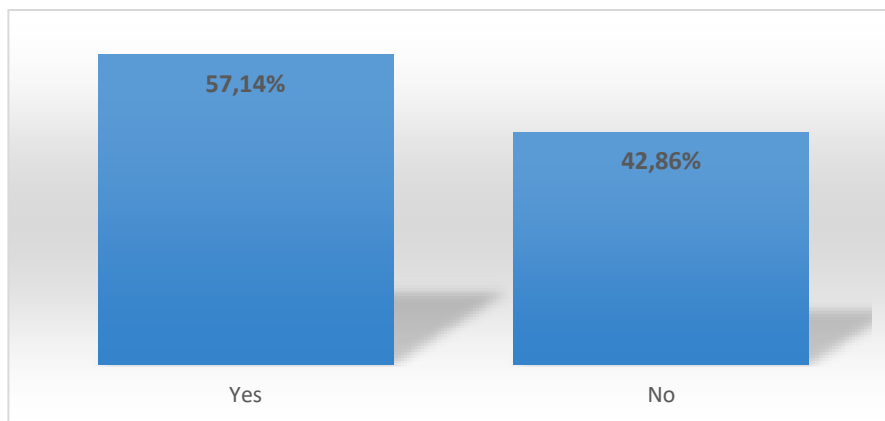


*Figure 14: Share the questionnaire with third parties (in Europe)*

### III.8. Provide Fiware4Water Challenges requirements

#### **Q2.4: Are you willing to provide one or more Challenges to Fiware4Water?**

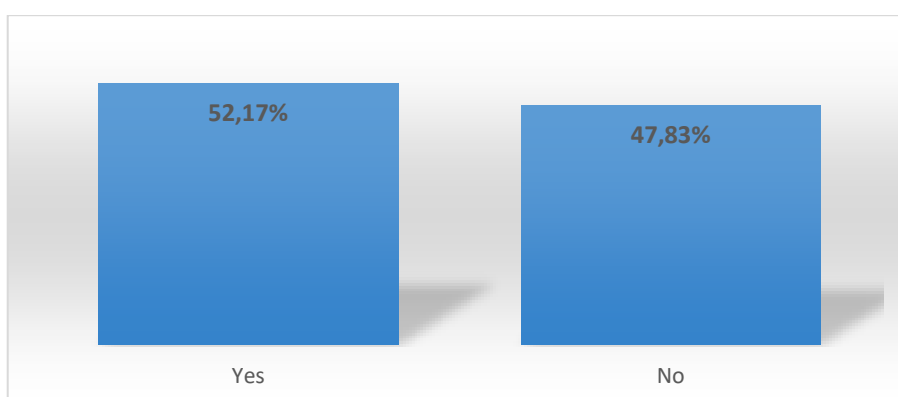
Another yes and no question which the purpose to extract the list of interviewees that can help us to create some challenges for our Fiware4Water Hackathon. We receive 28 responses to the questions (71.80% all answers) and from them **57.14%** were interested to provide some requirements or even some concrete challenges that can help us in the definition of the challenge.



*Figure 15: Are you willing to provide one or more Challenges to Fiware4Water?*

But it is even more relevant that these challenges also help us to improve the list of requirements that potentially will be needed to implement in our Fiware4Water Architecture. This information will be analysed again in the Q4.2 in order to extract contact list to contact them by the Fiware4Water Communication team in order to help us in the configuration and organization of the Fiware4Water Challenges.

If we analyse the data in Europe, we obtain a similar pattern (**52.17%**).



*Figure 16: Are you willing to provide one or more Challenges to Fiware4Water? (in Europe)*

### III.9. Types of data format currently employed

#### Q3.1: Which data format are you using to represent your data? (Multiple Answers possible)

This is a direct question with 3 fixed values (XML, JSON and Plain Text – CSV – Excel file) plus an open option (Other) to provide free choice option. Multiple selections were possible on it. We received 31 answers from a total of 39, indicating 63 different data formats, distributed in the following way:

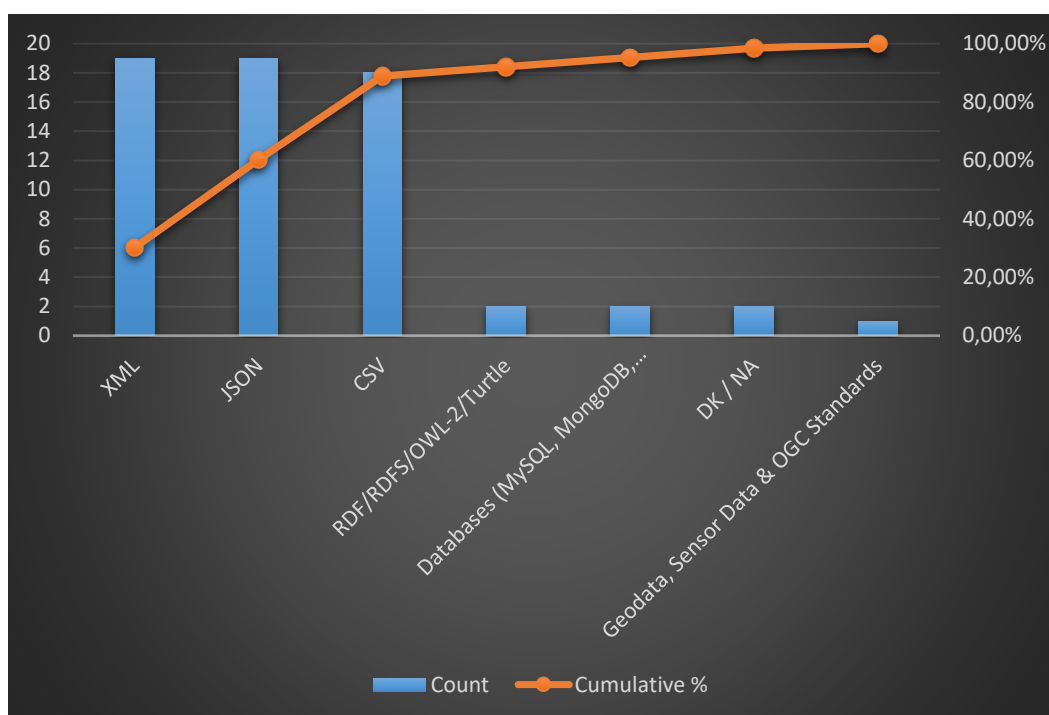


Figure 17: Which data format are you using to represent your data?

Table 6: Different data format used

DATA FORMATS	NUMBER OF RESPONDERS INDICATING THIS SOLUTION	PERCENTAGE OF RESPONDERS INDICATING THIS SOLUTION
XML	19	61.29%
JSON	19	61.29%
CSV (Excel files, CSV Format, and Plain Text)	18	58.07%
RDF/RDFS/OWL-2/Turtle	2	6.45%
Databases (MySQL, MongoDB, SQLite, MSAccess, Oracle)	2	6.45%
DK / NA	2	6.45%
Geodata, Sensor Data & OGC Standards	1	3.23%

We can mention that the most common responses were related to the 3 fixed options cover 88.89% of the responses. The answers provided here, produce a clear broad reflection of current data format because it is a mirroring of the main technologies that we can find in the market, taking into account that this questionnaire was filled out for experts and very skilled public. On average, the interviewees responded equally **XML** and **JSON** format with 19 responses each one (30.16% answers, 61.29% all users' responses) follow by **Plain Text – CSV – Excel File** with 18 responses (28.57% answers, 58.06% all users' responses). They represent 88.89% of all answers.

The analysis is the same if we apply it with the European countries.

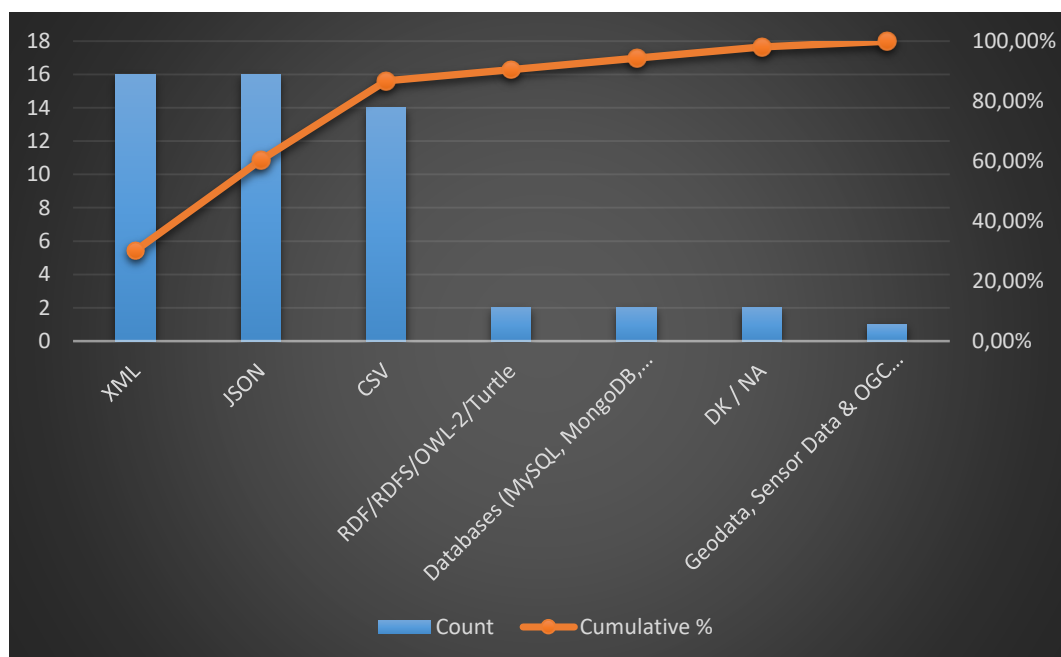


Figure 18: Which data format are you using to represent your data? (in Europe)

### III.10. Types of protocols currently employed

#### Q3.2: Which protocol are you using to send data? (Multiple Answers possible)

This is another direct question with 4 fixed values (HTTP/HTTPS, LWM2M, LoRaWAN, OPC-UA and Sigfox) plus an open option (Other) to provide free choice of any possible option. Multiple selections were possible on it. We received 29 answers from 39 indicating 53 different options, distributed in the following way:



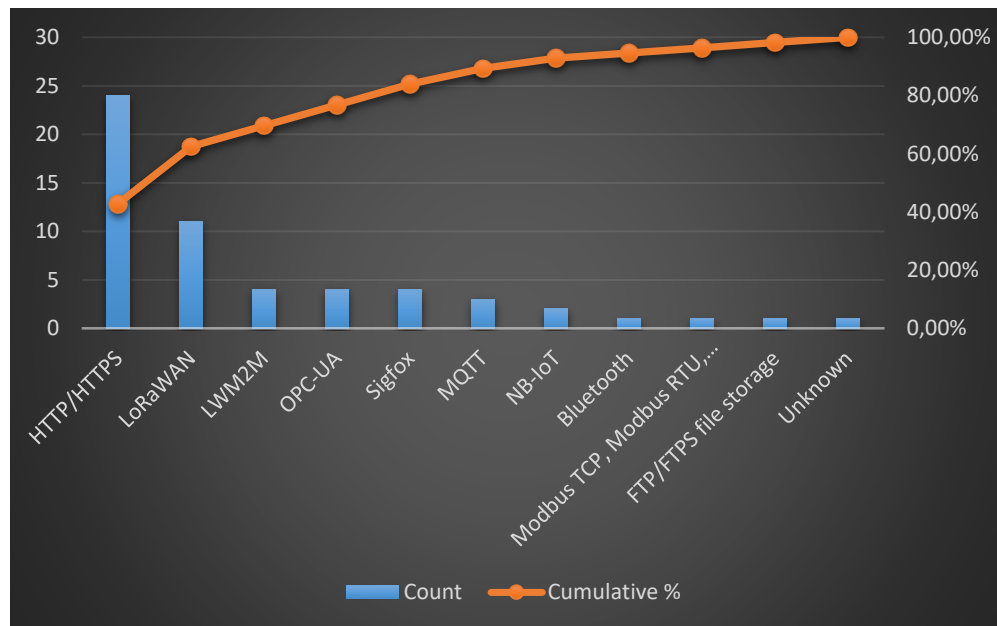


Figure 19: Which protocols are you using to send data?

Table 7: Different protocols used

PROTOCOLs	NUMBER OF RESPONDERS INDICATING THIS SOLUTION	PERCENTAGE OF RESPONDERS INDICATING THIS SOLUTION
HTTP/HTTPS	24	82.76%
LoRaWAN	11	37.93%
LWM2M	4	13.79%
OPC-UA	4	13.79%
Sigfox	4	13.79%
MQTT	3	10.34%
NB-IoT	2	6.90%
Bluetooth	1	3.45%
Modbus TCP, Modbus RTU, Profibus	1	3.45%
FTP/FTPS file storage	1	3.45%
Unknown	1	3.45%

Whilst the first question of this group (Q3.1) survey sought to establish which data format is used by the interviewees, this question was intended to reveal which transport protocol is been used by them. It is not surprising that the most important protocol is **HTTP/HTTPS** (application protocol) with 24 responses (42.86% responses, 82.76% all users' responses). The next protocol that was identified by the users is

**LoRaWAN** (network layer protocol) with 11 responses (19.64% responses, 37.93% users' responses). And finally, with the same number of responses, we can observe **LWM2M** (application protocol), **OPC-UA** (machine to machine communication protocol), and **Sigfox** (network layer protocol) with 4 responses each one (7.14% responses, 13.79% users' responses). These transport protocols represent 83.93% of all responses.

The results are similar in case of Europe with the difference that **LWM2M**, **MQTT** and **NB-IoT** are the last one with 2 responses each one (4.35% responses). The rest are the same, **HTTP/HTTPS**, **LoRaWAN**, **OPC-UA**, and **Sigfox** order by number of responses.

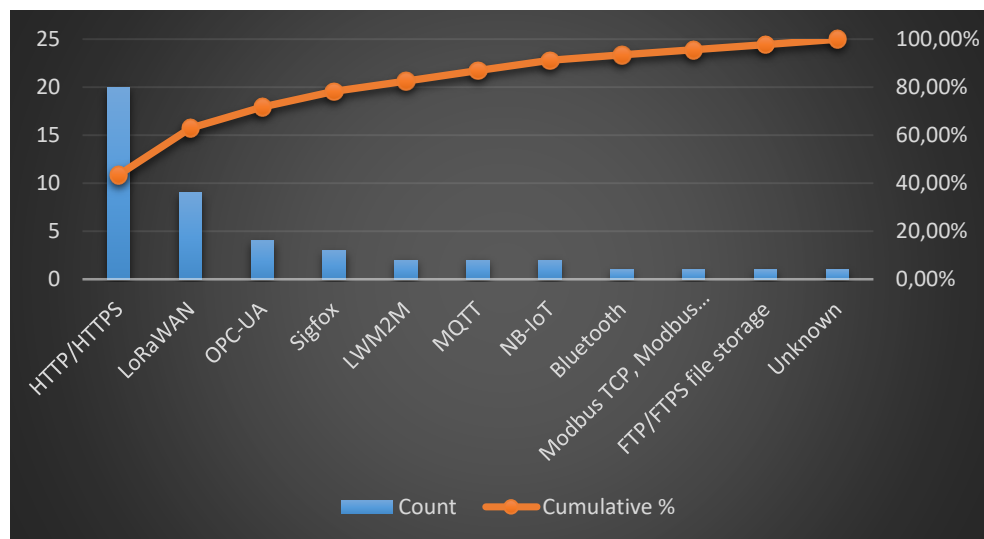
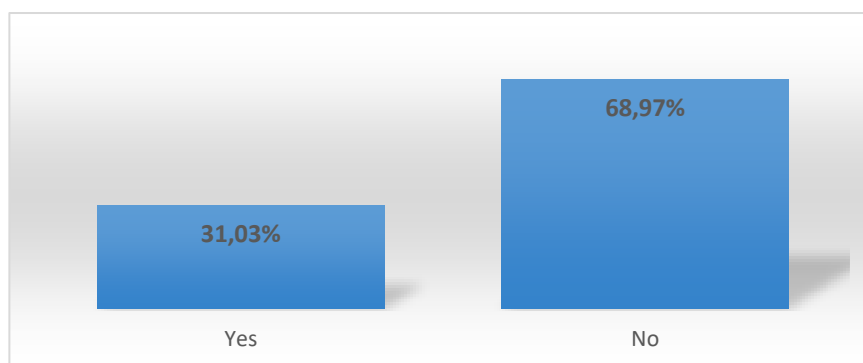


Figure 20: Which protocols are you using to send data? (in Europe)

### III.11. Currently use of standard data models

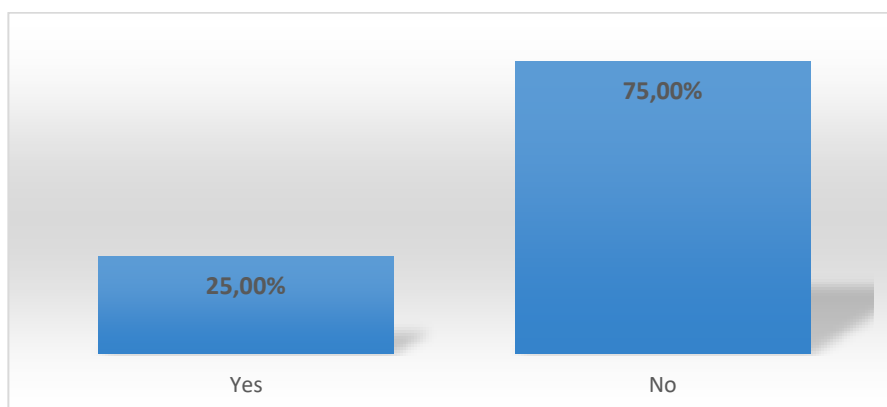
#### Q3.3: Are you using any standard data model for your data?

Another yes and no question which the purpose to extract the list of interviewees that can help us to identify potential future clients of the Fiware4Water data models. We receive 29 responses from 39 to the questions and from them **31.03%** mentioned that they are using standard data models for their data. This information joined to the Q3.5 gives us the confirmation that the main lack of using data models is the ignorance of the proper standard data model. This is a good opportunity to share the activity of the project inside these stakeholders.



*Figure 21: Are you using any standard data model for your data?*

In case of European countries, the result is similar with a **25%** of the responses. A good opportunity to disseminate the Fiware4Water Data Models to them.



*Figure 22: Are you using any standard data model for your data? (in Europe)*

#### **Q3.4: In case affirmative, may you provide us name and link to that standard data model?**

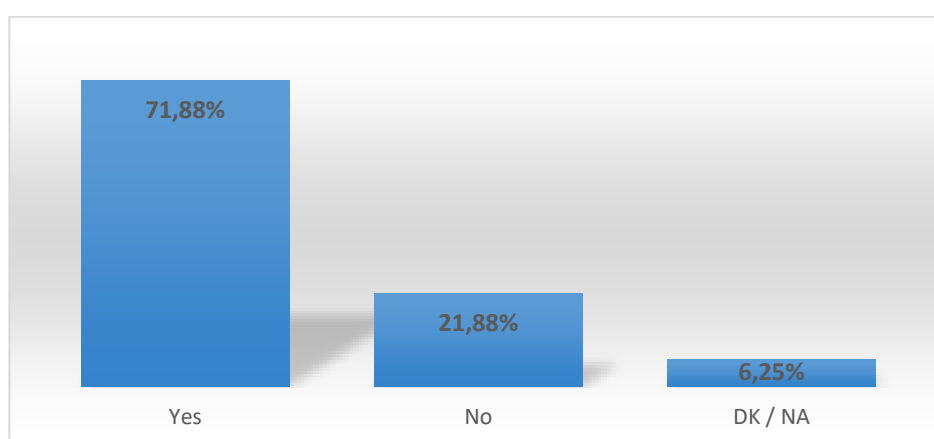
This is an open question with a universe objective of possible 29 responses (from the Q3.3) from which we obtained only 5 responses (Sandre, NGSI, NGSI-LD, Own Data Model, and Data Dictionary Urban Water), only **17.24%** of the cases. This is a relative very low rating response that probably means that either the interviewee does not know the information or cannot/do not want to provide this information. This should be something to be analysed during the execution of the project, mainly through some dissemination activities about the Fiware4Water Data Models created during the project.

Due to the simple is very tight it is not making sense to analyse the results because data are too scatter. It is clear that there is different level of data model (e.g. W3C, OGC, NGSI-LD, SAREF, Sandre, Inspire data model, Data Dictionary Urban Water, etc...) which are really common and generally user do not know they use a specific data model. This point will be investigated in the D1.4

## III.12. Requirements for the Fiware4Water Standard Data Models

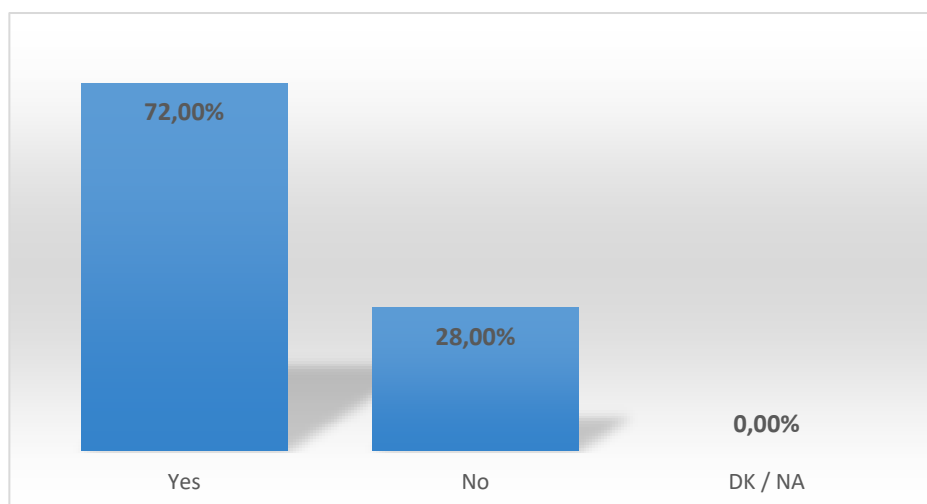
### Q3.5: Are you interested to use the standardized models developed in Fiware4Water?

A “Yes” and “No” question with “Don’t Know/No Answer” option which the purpose to extract the list of interviewees that can be interested in the publication of the Fiware4Water data models. We receive 32 responses to the questions and from them **71.88%** were interested to use the Fiware4Water Data Models. This is a very significant information because huge number of interviewees are interested in the result of the project. It helps us to define a proper communication campaign redirected to these possible stakeholders of the Fiware4Water Data Models together with the information that we extract from the Q4.2.



*Figure 23: Interested in using Fiware4Water Standard Data Models*

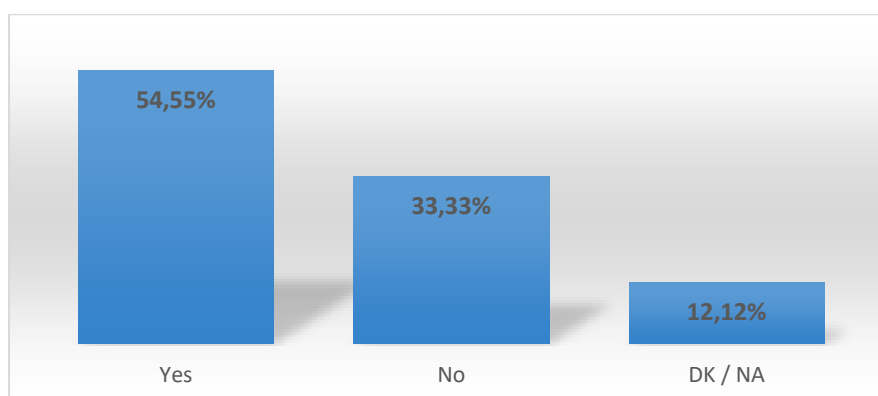
The results are very similar, **71.43%**, if we focus the answers to the European countries with a total of 25 received answers.



*Figure 24: Interested in using Fiware4Water Standard Data Models (in Europe)*

**Q3.6: If you want to use the new standardized developed models from Fiware4Water, are you interested to provide us requirements form those models?**

This is a “Yes” and “No” question with a universe objective of possible 32 responses (from the Q3.5) from which we obtained 29 responses, 90.63% of the cases. Form them, we obtained an affirmative response of **54.55%**. This is a relative high interest from the interviewees to provide us requirements about the data models that we want to adopt. Together with the information of Q4.2 we will extract the contact emails in order to request detailed requirements of the implementation of the corresponding Fiware4Water Data Models in the corresponding T1.4.



*Figure 25: Interested to provide requirements for the Fiware4Water Standard Data Models*

If we analyse only the results obtained in the European countries, we could see a very similar approach with affirmative answers in the **53.85%** of all answers.

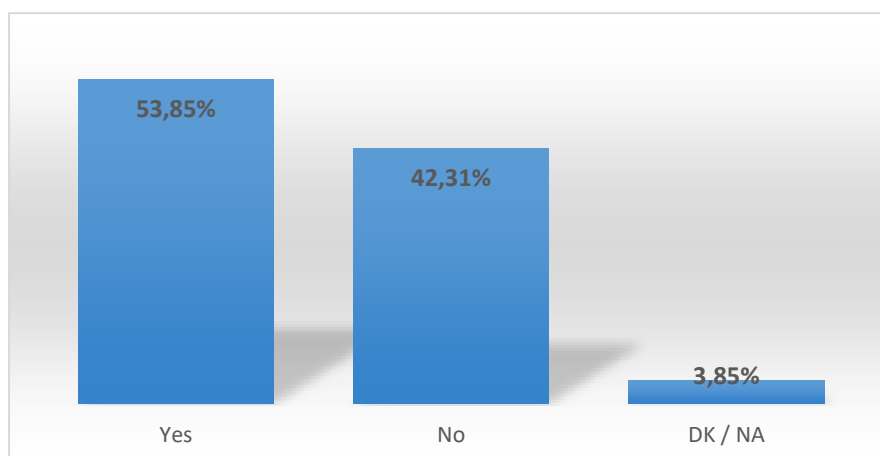


Figure 26: Interested to provide requirements for the Fiware4Water Standard Data Models (in Europe)

### III.13. Contact details

**Q4.1: In which country are you and your utility located? If your utility works on a multinational level, please only provide the country you are actual working in.**

This question helps us to identify the corresponding country from which we obtain the responses. The 60.61% of the responses were obtained in **Greece, Germany, Netherlands, and Spain**. Afterwards, we could see with the same number of responses **Brazil, France, and EEUU**, which together with the previous countries represent **78.79%** of all responses. It will help us to define proper communication campaign focused on the specific countries from which we observe an interest in our project

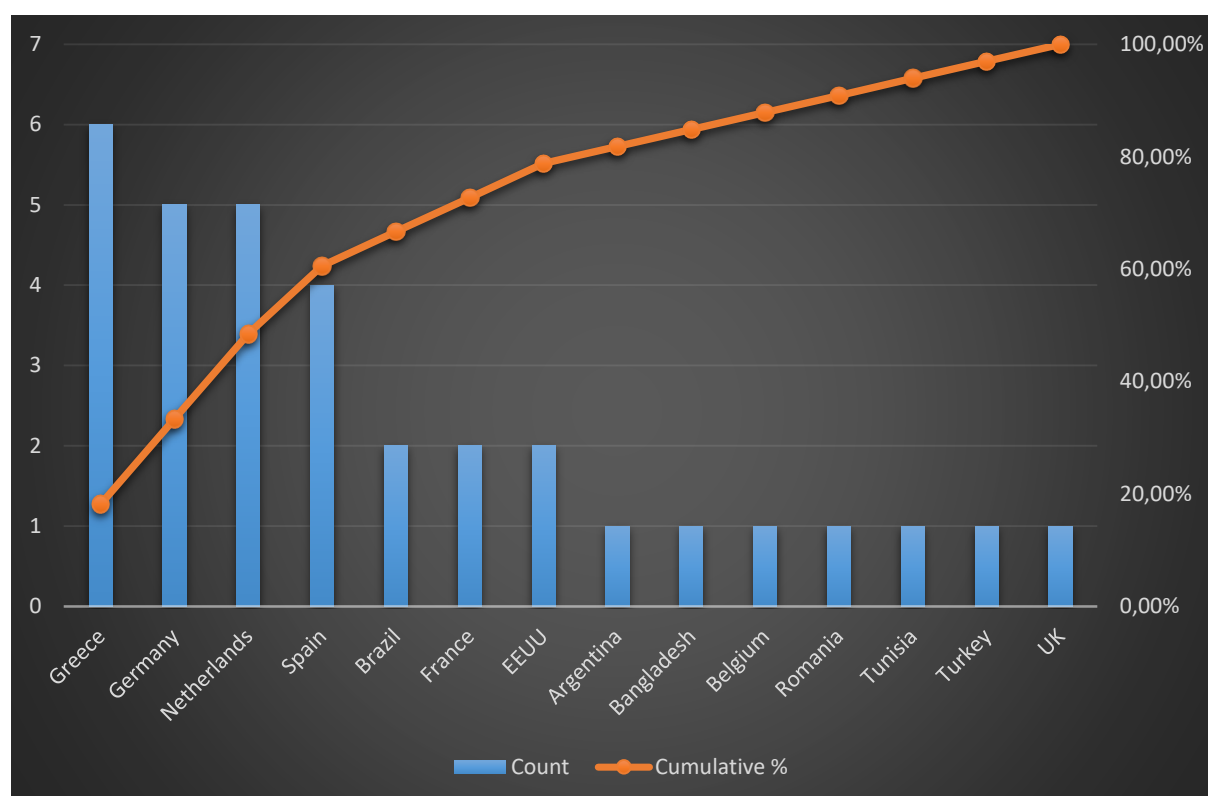


Figure 27: Geographical distribution of questionnaire answers

The reason why we provide a Pareto Analysis on this question because we want to design specific Communication Campaign in the Fiware4Water project for the more relevant countries. Therefore, this diagram is very important for the Communication and Dissemination activities in the WP6.

Although the question seems a bias because probably interviewees are mostly in the close network of the members of our consortium and therefore, they probably also use same tools and solution than us. But that is not totally right. A Deep analysis of the interviewees shows us that, for example, 42% came from the FIWARE Community related to water sector. This sample subset, only 28,57% (12% of the total cases) is currently using FIWARE Components and/or NGSI-LD protocol.

## Q4.2: Of Which type is your company?

This question helps us to identify the corresponding water sector and define communication strategies focused on the different market. It helps us to proper define campaigns for those more relevant countries from which we have received this concrete feedback. It was a multiple choice with 12 closed options with an open one just in case to add any type of company not registered in the previous cases. We obtain a number of responses of 32 from 39.

From the data that we obtained, we see that 11 responses (16.18%) correspond to **Water Utility: Drinking Water**, followed by **SME: Software Developer (services, data analysis)** with 10 responses (14.71%). This reflect the fact that there is an interest in the ICT sector to cover the Smart Water activities. The next

company type corresponds to **Water Utility: Wastewater** with 9 responses (13.24%). Again, the next company type interested in the Fiware4Water project is not a water company but a technology provider, **SME: Hardware Developer / Technology provider**, with 7 responses (10.29%). Afterwards, we found **SME: Consultant (data analysis, business models, services)** and **Water Utility: Water Supply (urban, agriculture, industry)**, with 5 responses (7.35%) each one. Finally, **Water Utility: Infrastructure Management** and **Other: Telecommunications**, with 4 responses (5.88%) each one. All of these represents 80.88% of all the answers.

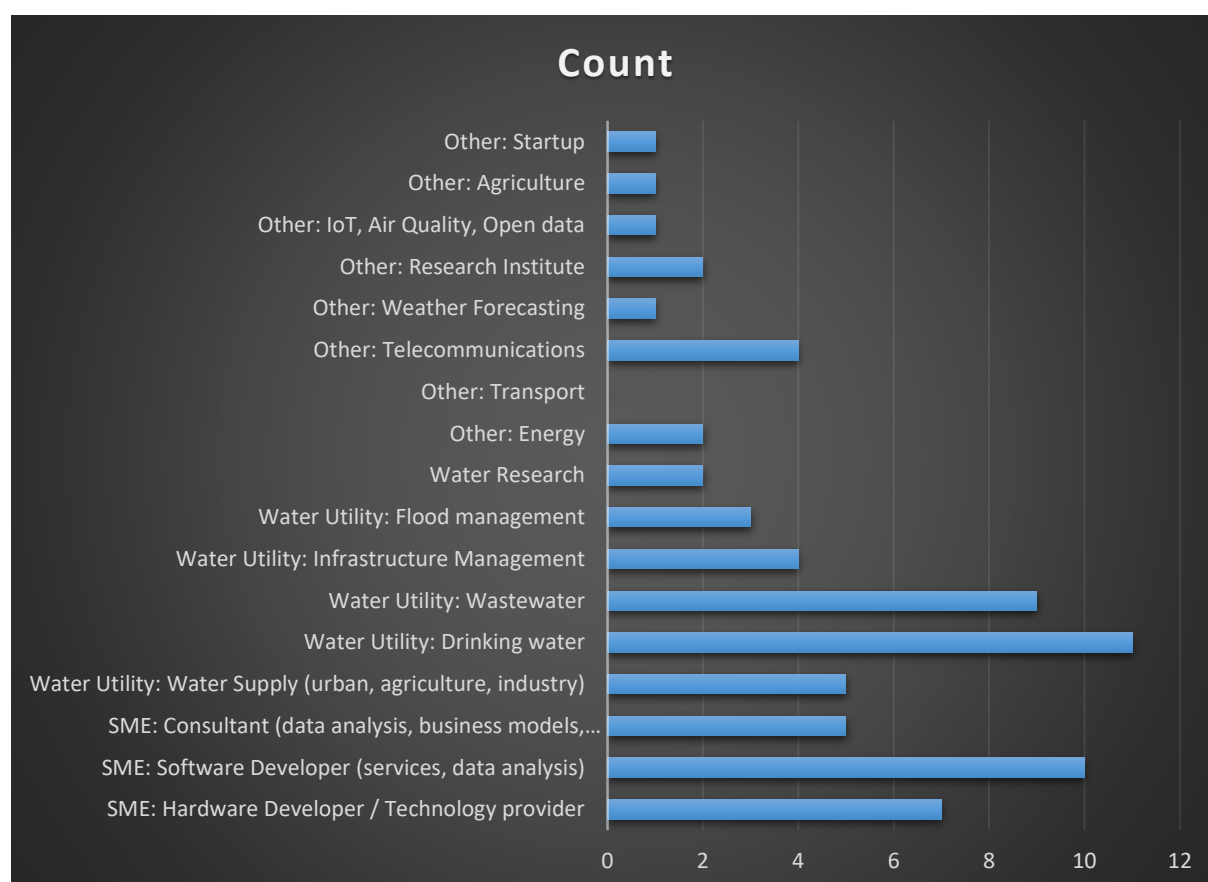


Figure 28: Type of company participating in the questionnaire

Table 8: Types of company in the survey

TYPE OF COMPANY	NUMBER OF RESPONDERS INDICATING THIS SOLUTION	PERCENTAGE OF RESPONDERS INDICATING THIS SOLUTION
SME: Hardware Developer / Technology provider	7	21.88%
SME: Software Developer (services, data analysis)	10	31.25%
SME: Consultant (data analysis, business models, services)	5	15.63%
Water Utility: Water Supply (urban, agriculture, industry)	5	15.63%
Water Utility: Drinking water	11	34.38%



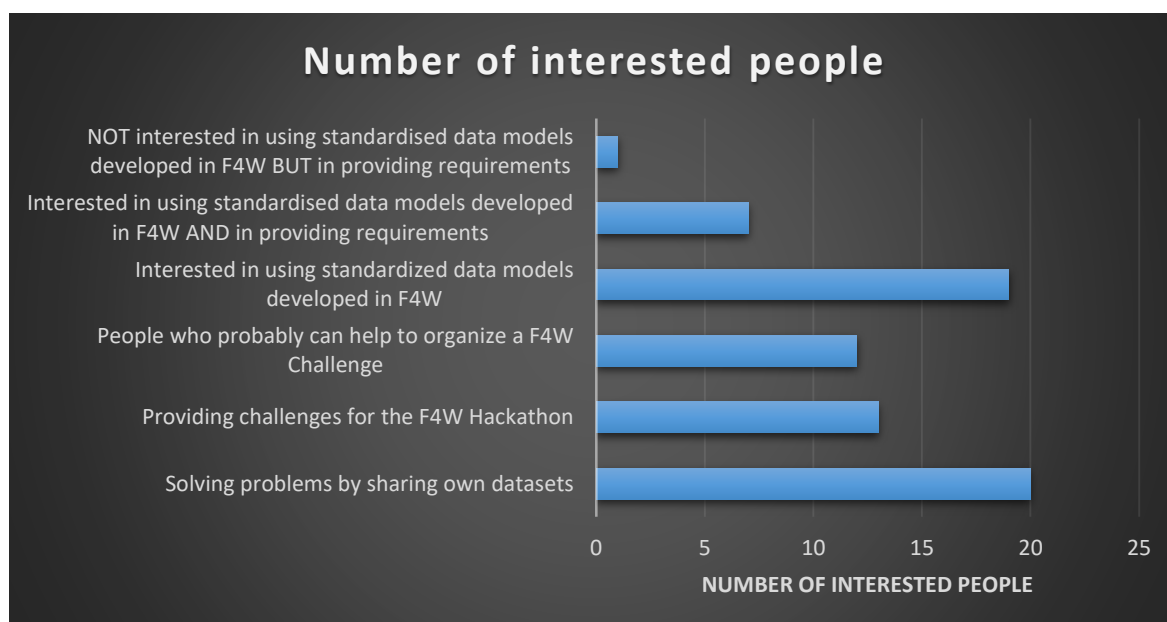
Water Utility: Wastewater	9	28.13%
Water Utility: Infrastructure Management	4	12.50%
Water Utility: Flood management	3	9.38%
Water Research	2	6.25%
Other: Energy	2	6.25%
Other: Transport	0	0.00%
Other: Telecommunications	4	12.50%
Other: Weather Forecasting	1	3.13%
Other: Research Institute	2	6.25%
Other: IoT, Air Quality, Open data	1	3.13%
Other: Agriculture	1	3.13%
Other: Startup	1	3.13%

**Q4.3: If you want, you can leave your e-mail address or the e-mail address of your company here, in case you would like to be further informed about the results of this survey and the FIWARE4Water project.**

This was a question to get details (email) of the person that response affirmative to the questions Q2.1, Q2.4, Q3.3, Q3.5 and Q3.6. The importance of this analysis is to get a set of stakeholders that can support us in the development of specific technical requirements of the Fiware4Water Standard Data Model as well as collaborate with us in the organization and definition of Fiware4Water Challenge objectives.

From the analysis of the previous question, we can obtain several sets of users categorized in the type of support that we can obtain from them:

- Solving problems by sharing own datasets, obtained from question Q2.1
- Providing challenges for the F4W Hackathon, obtained from question Q2.4
- People who probably can help to organize a F4W Challenge, obtained by merging Q2.1 and Q2.4
- Interested in using standardized data models developed in F4W, obtained from question Q3.5
- Interested in using standardised data models developed in F4W AND in providing requirements, obtained by merging Q3.5 and Q3.6
- NOT interested in using standardised data models developed in F4W BUT in providing requirements, obtained by merging Q3.5 and Q3.6



*Figure 29: Categorization of the users in function to questions Q2.1, Q2.4, Q3.5 and Q3.6*

The first three options, related to questions Q2.1 and Q2.4, will help us in the selection of datasets to be used in the Fiware4Water Challenge as well as definition of the objectives of this Challenge. Special relevant in the last one, because they can be also interested in collaborating with us in the organization of the Challenge as well. The last three options, related to questions Q3.5 and Q3.6, will help us in Task 1.4 to identify possible requirements to the definition of Fiware4Water Standard Data Models.

## IV. Conclusions and recommendations for the future development of Fiware4Water

Fiware4Water Deliverable 1.3 describes the results of the survey sent to different water domain stakeholders which aimed at collecting the innovation requirements for new solutions and services from an ICT point of view. These results are of utmost importance to be considered in follow up Work Packages, especially in WP2, WP3 and WP4.

Before going to conclusions, we should take into account the skew distribution of participants, which over 60% are from four countries (Greece, Germany, Netherlands, and Spain). Therefore, the results are representative for west European countries (northern and southern). On the other side, results might be not representative for these whole countries because the sample was very small. While going to east, we are only getting good representativeness with southeast ones. However, the survey counts with answers from not only water utilities but also different SME's, including consultants, software and hardware developers, as well as companies and/or institutes from other environmental fields such as agriculture, energy, or flood management. Therefore, we consider this as a good quality indicator in terms of representativeness, as it includes a wide and varied audience along all water value chain. On the other side, the sample is just small and scattered, therefore the conclusions might be weak, and it will be probably needed to complete it with few expert interviews.

When focusing on digitalisation, we observe that drinking water sector is the more advanced one, when considering the whole water value chain (abstraction, storage, supply, service, treatment, wastewater recycling, etc.) with special focus on quality, losses and energy, and treatment, forecast and customer relationship in second term. It's a question of public health, legal information to the public and more commercial relationship between actors. Wastewater sector on its side is more focused on treatment, energy optimisation, and starts to consider communication specially thinking in the climate change scenario we are dealing with.

In this context, front runner companies in drinking water sector are applying smart services along their value chain, providing guidelines and inspiration to more traditional ones. However, the rate of self-developed solutions is still relatively high. Several solutions are solving the same problem, without replicability analysis nor knowledge sharing among them, and what is worse, on some occasions we can detect vendor lock-in situations, in which it is very difficult to move to other scenarios from a digital point of view. A first step is to introduce more interoperability in the chain and force editor to provide reversibility plan. As water is a key resource for humanity, we consider that policies may foster water value chain companies to use standardised, interoperable and open source software, so that we ensure better resources management, while benefitting from continuous innovation in the sector.

Traditional companies have a good opportunity to start with this approach, as they have fewer legacy dependencies. However, they should start as soon as possible collecting data from their infrastructures, which is of priceless value and is being lost at the moment. The more data we lose, the less capacity to apply analytics and provide effective decision support in the short time.

From a functional services point of view, we observe that wastewater companies are specially focused on treatment, efficiency of operations, asset management, and environmental impact, while drinking water companies also devote efforts in customers services and citizen communication. It's question of contract because local authorities and users' services pay for that. At this point, where climate change is a concern along Europe, we consider that wastewater companies should also improve communication with society, so that they transmit their good practices and foster behavioural change in population letting them assess the impact of their daily routines and decisions.

It is important to remark that probably, the main concerns of companies to move to an open source solution is the lack (or less availability) of maintenance, technical, and IT security support. They feel more comfortable by subcontracting these necessities to private companies, although in big organisations this is managed internally, but usually these scenarios derive in vendor lock-in situations.

Companies currently using open source solutions are taking benefit from visualisation, information searching and processing, and GIS solutions. In this context, why are companies not moving to open source platforms? The most important triggers to use open source platforms are the ability of the platform to be self-hosted, existence of interfaces for integrating sensors and other data sources. In short, the users expect a flexible but also self-hosted platform, for their convenience. Especially the self-hosted constraint is comprehensible because water supply system is regarded as a critical infrastructure. Additionally, there is also a question of financial balance, mainly because the use of open source solutions helps to reduce costs and balance the accounts. Moreover, the minimized dependency on third-parties for daily operation is expected. Therefore, we need companies and organisations able to provide this kind of support and services (inside or by collaborating with third parties), but using standardised and interoperable open source solutions. It is often a mandatory condition in contracts. In fact, this will have a positive impact in water domain involved companies, as while they may have similar costs for infrastructures and support services, they will save resources on having access to licenses, new functionalities, etc.

Another important issue to be discussed is the sharing and storage of data. On one hand, we have several companies storing the information in their own on-premises infrastructure. On the other hand, companies are starting to use external cloud services due to better ICT infrastructure management, security, scalability, resiliency, and even costs, as well as a clear reduction in human resources because the management of the infrastructure is translated to the cloud provider. Then the question is why some companies are reluctant to do that step. We may find the answer in two main issues: are the cloud service providers, in which we store the data, secure enough? Where is that data geographically stored (it is really relevant when sovereign hosting is required)? What's happen at the end the contract or if we decide to switch to another solution? Again, we fall in the same conclusion: there should be a collection of policies defined at European level, which provide clear instructions on what has to be accomplished to ensure effective use of resources, while ensuring security and high quality service level.

Moving to data sharing, some utilities are willing to share their data, but this scenario arises several challenges. Which is/are the commonly approved/agreed standard(s) format to be used? Which are the security requirements? Which are the anonymity requirements? In the survey we detect several data formats being used, most important are XML, JSON and CSV. By far the most important protocol is HTTP/HTTPS, followed by LoRaWAN. Nevertheless, other format and protocol are used. But these are not water domain specific standards, but generic information exchange ones. Interestingly most participants do not use any data model. Some of them use data model but the diversity of the information required a large diversity of it. Some model like WaterML, GroundWaterML (OGC), NGSI, ETSI NGSI-LD or Sandre's models at French level try to cover some part of the needs. But there is not currently a wild spread standard for sensor use for (near)real time in water monitoring. Therefore, how do we exchange information? Once more, we need policies to clearly state what has to be ensured in this terms, not only thinking in what GDPR is already defining and which ICT standard to use, but tailoring and extending specific data models to the water sector so that independently of the ICT standard/protocol used, the data which is being transported/represented inside can be easily interpreted without errors. Therefore, this is a good opportunity and a big challenge that Fiware4Water will deal with also, under WP2. Moreover, we expect Fiware4water platform to be the front runner on this, increasing the attractiveness of the open source solutions we are providing under the FIWARE architecture umbrella, and with the main aim of maximising impact and market uptake.

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## Annex A: The Questionnaire



### QUESTIONNAIRE AND AGREEMENT TO PARTICIPATE

Dear Sir/Madam,

The **Fiware4Water** project needs your support to collect feedback in terms of creating the corresponding requirements for a FIWARE Reference Architecture related to Water Management. **Fiware4Water** is a project funded by the European Commission aimed at enhancing the development of solutions to one of the most important issues of the 21st Century: WATER. **Fiware4Water** will link the water sector to the smart solution platform “FIWARE”, the objective of which is to support SMEs and developers in creating the next generation of internet services. All users in the water supply chain will benefit from this action, be they cities, water utilities, water authorities, solution providers and citizens. Several interfaces and tools will be developed for the benefit of all water-based end-users and will be demonstrated in four demo cases in Athens (GR), Cannes (FR), Amsterdam (NL) and Great Torrington (UK).

In a second phase, potential European actors and stakeholders will be informed and engaged by the creation of three stakeholder networks: one for municipalities, one for water authorities and companies and one for technology providers.

**Fiware4Water** would like to collect information regarding the interaction and functionalities with different systems related to the water sector. The main aim is to ensure the future compatibility of and support to the developing FIWARE platform systems.

Thus, concentrating on current systems and applications currently being used or which have been used in the past, whilst also considering other necessities which are not catered for at present, we would ask you to answer the following questions.

If you are happy to be involved, please give your consent by signing the form below (**Agreement to Participate**). Please keep one electronic copy for your records, and send the signed form to **Fiware4Water** (contact details below) with the completed questionnaire.

### **What is FIWARE Foundation?**

FIWARE Foundation is a non-profit organization that encourages the adoption of a common, collaborative and interoperable data sharing framework based Open Source technology. We believe that eliminating existing technical and commercial obstacles hindering effective meaningful data, smart digital solutions will be able to optimize processes that will be beneficial for improving the competitiveness of the cities, services to citizens, and bringing further growth for many sectors in the digital economy based on FIWARE Technology.

### **What is FIWARE Technology?**

FIWARE Technology is a curated framework of open source platform components which can be assembled together in a standard way and with other third-party platform components to accelerate the development of Smart Solutions. FIWARE Technology was funded by the EC (2011-16) as a major flagship Public Private Partnership, to support SMEs and developers in creating the next generation of internet services, as the main ecosystem for Smart City initiatives for cross-domain data exchange/cooperation and for the NGI (New Generation Internet services) initiative.

### **What are the advantages of being open source?**

Open source avoids vendor lock-in , promotes cost effectiveness, and contributes to the building of economies of scale and data economy. FIWARE Technology is open source which resolves this vendor lock-in problem as well as allows cost effectiveness of the services developed with this technology.

### **Why we contact you?**

We contact you as an important game changer in the Water sector to join forces in developing specific water-related innovations. So far little progress has been made on developing specific water-related applications using FIWARE Technology, due to fragmentation of the water sector, restrained by licensed platforms and lagging behind other sectors (e.g. telecommunications) regarding interoperability, standardisation, cross-domain cooperation and data exchange. And we think that together we could solve pressing issues on the Water Sector with the use of this technology.

### **What is the Goal of Fiware4Water?**

Fiware4Water intends to link the water sector to the FIWARE Ecosystem using the FIWARE Technology by demonstrating its capabilities and the potential of its interoperable and standardised interfaces for both water sector end-users (cities, water utilities, water authorities, citizens and consumers), and solution providers (private utilities, SMEs, developers).

Although Fiware4Water primary target are Water Utilities (from drinking water utilities that collect, treat water to wastewater) our target is not limited to it, and can include diverse Institutions (holders of data) which are interested in solving issues related to Water by Innovating on the sector.

### **What is the FIWARE Ecosystem?**

The FIWARE Ecosystem consists of more than 100 cities, 13 iHubs, and institutions with whom we hold strategic partnerships that contribute to the sustainability of FIWARE. Among those are GSMA, TM Forum, CEF, and ETSI.

### **What is the value added for my institution when I share data with Fiware4Water?**

You got an expert technical team based on FIWARE Technology for free to provide you with concrete ideas and solutions on how to tackle the challenges you are experiencing on the Water Sector. Your institution is free to choose would want to implement/take the solution to the next level. Additionally, you have the possibility to tailor the outcome by requesting us what is the expected usage or functionality that you want to get from that data. This will help us to define the corresponding Challenges for the Fiware4Water Challenges that the project expects to organize during the execution of the project.

### **What is the purpose of the Fiware4Water Challenges?**

The FIWARE Ecosystem and FIWARE's target audience will be encouraged to support the development of specific water-related applications using FIWARE Technology. These Fiware4Water Challenges process will allow participants to manage the data provided to resolve the challenge that you communicate about these data (e.g. I have a historical data from water sensors and I want to know if it is possible to predict the water leaks in the future).

### **What happens with the data that you share with us?**

Your data will be anonymized. The management of data will result into applications and algorithms to process them (e.g. alert "algorithms", or services that will be part of the open source FIWARE platform). You could get direct access to them together with the developers' team to evaluate the next steps with them. Neither your name nor any other personal identifying information will appear in any reports, papers or presentations resulting from this study.

The results of these algorithms, applications, and services generated would be shared with you so that you would have an idea of how you can use the data and how you can use the FIWARE Technology in order to optimize your services and processes. Fiware4Water will provide direct access to the different team to evaluate the next steps with them. All data collected and processed will be handled in compliance with UK and EU data protection legislation. All information will be anonymised and stored in a secure location.

### **If I already have sensors or other technology in place? How would this fit, including FIWARE Technologies?**

FIWARE Technology is such a flexible technology that can be assembled to operate with your technology. Each Water Utility has its own sensors, treatments and already collects data. This is its legacy system where the data is already connected. There are specific components inside the FIWARE Technology to translate the legacy data representation model and APIs to the FIWARE Standards Data Models and ETSI GS CIM Application Programming Interface. In case that your legacy system uses a different representation model and/or API that it is not covered in the FIWARE Technology at the moment, it will



be resolved during the execution of the Fiware4Water project, in fact this is one of the reasons of one of the questions.

Participation in this research activity is voluntary. You may decide not to answer any of the questions if you wish. You may also decide to withdraw at any time. You will not be contacted after the activity is complete unless you seek to be involved further.

The Project Coordinator has reviewed and approved the methodology for the data collection for the Fiware4Water project. If you have any questions regarding this study or would like any additional information, please do not hesitate to contact us.

If you have any queries specifically about Data Protection Issues, you may contact [s.siauve@oieau.fr](mailto:s.siauve@oieau.fr)

I understand that:

- My participation is entirely voluntary.
- I am completely free to refuse to answer questions.
- I may be asked for clarification of some points, but I am not obliged to clarify or participate further.
- I can decide not to participate at this point and that I can withdraw my participation at any time. If I decide to do so, any material regarding my participation will be deleted or destroyed.
- If I have any questions regarding this study or would like any additional information, I can contact the researcher:

Fernando López

Tel: (+49) 1522 2600767

Email: [fernando.lopez@fiware.org](mailto:fernando.lopez@fiware.org)

- All individual results will be treated confidentially. Results will only be reported for the group as a whole and in an anonymised manner.
- The anonymised research data will be kept safely in a secure location only accessible by the researchers.
- The objectives and procedures of this study have been reviewed and approved by the Project Coordinator.
- My name, email address and availability provided via the sign-up form will only be accessible to the researchers.

**Q1. I declare that I have read and understood this form, that I have been able to ask questions, and that I consent to participate in this study.**

- ☐ I accept.
- ☐ I refuse.

## THE QUESTIONNAIRE

### 1. Usage of Open Source Platforms

**Q1.1: For what purpose would you use an open source platform? (Multiple answers possible)**

- ☐ Standardized integration of sensors
- ☐ Analysis of sensor and process data
- ☐ Development and/or use of decision support tools (e.g. tools that recommend a specific pump timetable) and models
- ☐ Collecting data (with tools provided by the platform)
- ☐ Storing data (with databases provided by the platform)
- ☐ Analysing data (with analysis tools provided by the platform)
- ☐ Exchange data (e.g. with other/external users)
- ☐ New business models (e.g. integrate utility bills and services)
- ☐ Visualization of data (with visualization tools provided by the platform)
- ☐ To process/solve specific water management issues (improving services, serious gaming, consumer interaction)
- ☐ Other (please specify)

**Q1.2: What are your concerns in using open source platforms? (Multiple answers possible)**

- ☐ None
- ☐ Legislation restrictions
- ☐ I haven't worked with open source platforms yet and have general concerns about them.
- ☐ Lack of IT security
- ☐ Maintenance (fear that the platform will not be further developed in the future)
- ☐ Technical Support
- ☐ Other (please specify)

**Q1.3: If you already use open source platforms, which one do you use and what do you use it for? (Please specify three different platforms maximum)**

Platform Example 1	<input type="text"/>
Usage Example 1	<input type="text"/>
Platform Example 2	<input type="text"/>
Usage Example 2	<input type="text"/>
Platform Example 3	<input type="text"/>
Usage Example 3	<input type="text"/>

**Q1.4: What are the factors that would you trigger to use an Open Platform? (Multiple answers possible)**

- ☐ Platform can be self-hosted on own servers
- ☐ Numerous interfaces are available in order to be able to integrate a wide variety of sensors
- ☐ Existence of interfaces in order to be able to integrate already existing analysis and visualization tools (like a Geographic Information System, GIS)
- ☐ Existence of different data models
- ☐ The platform allows me to easily and uncomplicatedly integrate with different data sources (company sensors, weather forecasts, gauging/flow rates, groundwater measuring points, rain radar, ...).
- ☐ Connection to your own process control system is possible
- ☐ Customer service provided by the platform
- ☐ Financial benefits (e.g. basic functionality is free to use)
- ☐ Flexibility to extend new functionality
- ☐ Other (please specify)

## 2. Sharing water-related data

Regardless of the capabilities and services that FIWARE includes, in the future we want to provide standardized and anonymous data sets that allow anyone to analyse and work with it. Why? The datasets are interesting for different users:

- Training purposes at universities that want to improve the education of their students.
- Consulting and software companies that can develop new tools on the basis of real-world data
- Use the data sets as reference data sets for benchmarks, e.g. to compare the performance of different leakage detection algorithms.

For example, a data set can be a multi-year time series of the water consumption of a city, e.g. at a resolution of one hour. A university can use such data to show students how the water demand of a city fluctuates seasonally and can use it to calculate various water management parameters for training purposes. Consulting and software companies can use such data to develop models for predicting water demand. Especially for the development of analysis tools, the data basis is of crucial importance. Real-world data is always preferable to synthetically generated data. Start-ups in particular usually have good ideas, but fail due to the availability of real-world data in order to test their prototypes sufficiently.

The aim of FIWARE is to create an added value for everyone with such data sets.

**Q2.1: Are you interested in solving a problem by sharing one or more datasets related to the Water Sector?**

- ☐ Yes
- ☐ No

**Q2.2: If the answer is yes, in which Value Chain of the Water sector would you want to innovate? (Multiple answers are possible)**

- ☐ Water Resources Management
- ☐ Water Supply
- ☐ Water Distribution
- ☐ Water Treatment
- ☐ Wastewater Management
- ☐ Wastewater Treatment
- ☐ Water/Energy/Nutrients Reuse (circular economy)
- ☐ Environmental Management / Ecosystem Services
- ☐ Flood Management (e.g. catchment management)
- ☐ Other (please specify):

**Q2.3: If the answer is no, can you refer us to an institution that would be interested in being part of cooperating with Fiware4Water by forwarding this email to them and copying us on it.**

- ☐ Yes
- ☐ No

All data is made available in a standardized and anonymous form so that no conclusions can be drawn about your company. **If you are willing to share data, we would approach you and discuss the specific course of action.**

The idea of making data sets available to the public is not new and is already being practiced in many other areas. Examples can be found:

- IT industry, where there are public image, video and audio databases. On the basis of these data, many companies are developing image recognition processes or, for example, speech recognition processes.
- Energy. The American Energy Data Challenge, provided by U. S. Department of Energy, provides open data to the public to create new visualization designs that will make the open energy data resources more valuable and easily understood.

#### **Q2.4: Are you willing to provide one or more Challenges to Fiware4Water?**

- ☐ Yes
- ☐ No

A Challenge does not only mean a data set, but also a concrete question or problem to be solved. The idea is that this Challenge is published on the **FIWARE Platform** just like a simple data set. Anyone, be it an interested citizen, a start-up or a company, can work on this challenge and try to develop a solution. An example:

Given is a data set containing time series of different water quality sensors. The sensors monitor the quality of drinking water at the exit of a waterworks. The employees visually check the time series on a daily basis in order to detect deviations or deteriorations in water quality. The question is whether an algorithm can be developed that automates this check and issues an alarm in the event of changes. In order to test the performance of the algorithm, additional information is provided for each point in time as to whether or not there was a real change in water quality at that time.

In addition to a good challenge, a so-called metric should also be provided, i.e. a calculation rule with which the performance of the algorithm is determined on the basis of its calculations/outputs. In this example, this could be the accuracy, which describes how often the algorithm has correctly detected a change in water quality.

If you are willing to provide a challenge, it will of course be published in a standardized and anonymous way. Fiware4Water plans to publish challenges from time to time and create incentives for others to

participate. So, if you are willing to provide a challenge, the advantage for you is that your problem will be solved and helped by someone else.

Such kind of competitions are widely used in other industries. A prominent example is the data science platform Kaggle (<https://www.kaggle.com/>), where numerous companies published challenges to solve their problems (automotive, trading sector, financial sector; companies like Santander, Google, Mercedes etc.).

### 3. Technical information about your data

The main purpose of this set of question is to allow us collecting requirements that will help us to extend our Fiware4Water platform in order that you can use it. For this purpose, we request you question to know the type of data format that your sensor uses to send you the data or the data format in which you publish that data.

#### **Q3.1: Which data format are you using to represent your data? (Multiple Answers possible)**

- ☐ XML
- ☐ JSON
- ☐ Plain text (CSV)
- ☐ Other (please specify):

#### **Q3.2: Which transport protocol are you using to send data? (Multiple Answers possible)**

- ☐ HTTP/HTTPS
- ☐ LWM2M
- ☐ LoRaWAN
- ☐ OPC-UA
- ☐ Sigfox
- ☐ Other (please specify):

**Q3.3: Are you using any standard data model for your data?**

- ☐ Yes
- ☐ No

**Q3.4: In case affirmative, may you provide us name and link to that standard data model?**

Name

Link

**Q3.5: Are you interested to use the standardized models developed in Fiware4Water?**

- ☐ Yes
- ☐ No


**Q3.6: If you want to use the new standardized developed models from Fiware4Water, are you interested to provide us requirements form those models?**

- ☐ Yes
- ☐ No

## 4. Contact details

Please provide some information about you and your company.

**Q4.1: In which country are you and your utility located? If your utility works on a multinational level, please only provide the country you are actual working in.**





**Q4.2: Of which type is your company?**

- ☐ SME: Hardware Developer / Technology provider (e.g. manufacturer of sensors)
- ☐ SME: Software Developer (services, data analysis)
- ☐ SME: Consultant (e.g. data analysis, business models, services)
- ☐ Water Utility: Water Supply (e.g. urban, agriculture, industry)
- ☐ Water Utility: Drinking water
- ☐ Water Utility: Wastewater
- ☐ Water Utility: Infrastructure Management
- ☐ Water Utility: Flood management
- ☐ Other: Energy
- ☐ Other: Transport
- ☐ Other: Telecommunications
- ☐ Other: Weather Forecasting
- ☐ Other (please specify)

**Q4.3: If you want, you can leave your e-mail address or the e-mail address of your company here, in case you would like to be further informed about the results of this survey and the Fiware4Water project.**

**THANK YOU FOR PARTICIPATING.**

**PLEASE RETURN THE COMPLETED AGREEMENT TO PARTICIPATE AND QUESTIONNAIRE BEFORE  
30.09.2019 TO:**

**[fernando.lopez@fiware.org](mailto:fernando.lopez@fiware.org)**