D5.1 A Study of the current public perception of digital water and other related innovations

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Abstract

For the FIWARE4WATER project in general and Work Package 5 in particular, it is important from the outset to understand the perception of hitherto uninformed and uninvolved citizens in relation to water as a global issue, the use of open source enabling technology in water management and their feelings concerning the services which provide them with their water supply.

Deliverable 5.1 offers an introductory explanation whereby it defines Digital Water, the Quadruple Helix and establishes why the citizen is an important stakeholder with whom the water sector must interact. The document presents the results of a survey undertaken in three locations in the United Kingdom, Eastern Europe and the Near East where end-users were asked their opinion with regards to the aforementioned aspects. The conclusions drawn in this report show why these and other householders in the identified locations and Follower Cities, who will be recruited during the implementation of Work Package 5, must be encouraged to participate in the development, dissemination and replication of local actions aimed at promoting the use of water-based open smart technology and in the creation of a social awareness and inter-sectoral dialogue which will lead to a more proactive attitude which, in turn, must form the basis of local policy and water management continuity in order to successfully address pressing global challenges.

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Contents

List of figures

I. Introduction

FIWARE4WATER is concerned with the application of open technology in smart cities. Its investigation is based on the example of water, but the work to be undertaken and the results and conclusions that will be obtained will serve many other sectors which, together, compose the essential elements required (such as transport, waste and energy), in order to be in a position to create a truly sustainable community. Within the often misquoted and misunderstood concept of *smart cities* a broad range of enabling technologies such as FIWARE provides socio-political, economic and technical stakeholders with an enormous quantity of data and many approaches to the subsequent use of said data. This, in turn, obliges one to address a number of important issues such as the interpretation, supervision and regulation of the gathered information as well as the often difficult balance between public and private ownership.

The principal objective of Work Package (WP) 5 is to explore the socio-political and economic impact of enabling technologies (FIWARE) and the information generated (in this case regarding water). It will seek to create in-depth engagement with all members of the *Quadruple Helix*; the public sector, the private sector, the research sector and the citizen in order to achieve broader social understanding and acceptance and, subsequently, the long-term political and economic continuity of open technology application.

Such actions will be undertaken at a municipal level. The importance of local government has, in recent years, been acknowledged by supranational entities such as the European Commission (EC), the United Nations (UN) the Organisation for Economic Cooperation and Development (OECD), the World Bank (WB) and the World Economic Forum (WEF) who have identified that stakeholders within cities, towns and villages can prove to be more effective implementers of global policies than their national counterparts. This opinion, is partly the result of the fact that nation states often prove to be obstacles to the long-term implementation of important strategies, (Elelman and Feldman 2018) and yet it is long-term continuity that is the essential ingredient for the effective addressing of environmental issues. National governments are commonly restricted by partisan interest, sweeping political ideologies and the perceived need to gratify their respective electorates before committing themselves to the addressing of global issues. Local councils, in contrast, can, in the opinion of the aforementioned entities, afford to take a more objective view of such circumstances and have proved capable of interacting more freely with both the representatives of supranational organisations and their municipal counterparts in other countries.

It can be strongly argued that one of the obstacles to successful innovation has been an inability on the part of researchers to enter into a sustained dialogue with relevant political actors at any level be it supranational, national, regional or local. The same may be said of those politicians who pay little attention to the technological advances that the R+D+I sector achieve. Such a dialogue is vital if the work of research centres and universities is to prove valid for the real needs of society. Where a closer relationship can be established is at the regional and local level. The municipal dimension is key. Local governments have a unique capacity to translate supranational strategies into practical implementation. All citizens, all institutions, all business ventures be they multinationals or family businesses form part of one municipality or another. Local councils, therefore, have the ability to establish direct interaction and therefore effective engagement with the people, their constituents. It is for this reason that the Sustainable Development Goals (SDGs) of the United Nations concentrate on municipal implementation of their strategies or why the most successful of all European programmes with regards to sustainable development has been the Covenant of Mayors for Climate Change and Energy.

In the example of water, which is to be the issue on which the work of FIWARE4WATER will be based, it is true that local governments are not always the owners of the utilities which supply water. The situation varies greatly depending on the country, the region or the city in question, but more often than not, municipal councilors will have little or no say in said supply. Nevertheless, these elected representatives do have a vital role to play in the co-creation of a long-term vision for a sustainable future by employing enabling technologies. Thanks to the aforementioned proximity to all stakeholders, they are in a position to engender broad social awareness, interest, concern and as a result, participation in the formulation of policies and water-based management approaches established on a solid foundation of public consensus. Public consensus means the support of the citizen or as politicians would say, the voter. It is the citizen, the householder, the end-user, the customer and the voter who will be the principal target of the work of WP5. This approach has been validated by The Organisation for Economic Co-operation and Development (OECD) who in reference to the subject of water described the need for "*. . . growing recognition that services work better when designed and delivered in partnership with citizens, and that listening to stakeholders' insights can foster innovation in service delivery practices and better risk management. In doing so, inclusive city administrations legitimise government actions and set a foundation for successful policymaking and implementation, thus allowing a focus on medium and long term planning, an essential feature of effective water policymaking*." (Akmouch and Romano, 2016) and the World Bank who argued that "*Growing evidence confirms that under the right conditions, citizen engagement can help governments and utilities achieve improved development results*" (World Bank, 2014). In 2019, The International Water Association stated that "*No stakeholder will be left untouched by the digital transformation of the water and wastewater sector, and all will share the responsibility to step up to the challenges of the sector and secure our water resources for future generations*"(Sarni *et al.* 2019).

Thus, if FIWARE4WATER and Work Package 5 in particular, is to prove successful, it is essential, from the very outset to understand the perception of the citizen in relation to the subject being investigated and the realities of the society for which such work is undertaken. This deliverable, after defining certain basic concepts such as *Digital Water* and the *Quadruple Helix* as well as the concept of *The Citizen*, will present and interpret the results of a survey which questioned householders in the United Kingdom, Eastern Europe and the Near East (the target areas of FIWARE4WATER) regarding their opinion and understanding of water as a global issue, the use of computer technology in water management and their level of satisfaction as customers.

The results of the work presented in this document will be employed as a basis for the future tasks of Work Package 5 whereby all stakeholders at specific project demonstration sites in those places where the aforementioned survey has been undertaken, will be invited to participate in the co-creation and inter-city dissemination and replication of local actions aimed at enhancing the employment of open smart technology. The combination of an advanced technical capacity for the accumulation and interpretation of data with the comprehension and support of the hitherto uninformed layperson will signify an important step towards the implementation and continuity of local, environmentally-sustainable policies and management practices designed to overcome global challenges.

II. Digital Water

A) Definition

The water sector faces a number of serious challenges ranging from global factors such as climate change, extreme weather events, industrial development, population growth to aging infrastructures and the lack of economic investment in the sector. Water and wastewater utilities require a sustainable

approach to resource maintenance, management and financing. In order to ensure this, the water sector itself has identified the digitalization of water management as a priority. As the IWA concluded in 2019, "*Water and wastewater utilities must embrace digital solutions. There is really no alternative.*" (Sarni *et al*. 2019). In 2013, Mukhopadhyay and Mason had already affirmed that "…*there is a growing need for the water industry to tighten its control and develop its understanding of what is happening to water resources in both fine detail and in real-time.*"

Therefore, one must define digital water. The energy sector defines digitalisation as a process of optimisation, improving efficiency through monitoring and the strengthening of customer loyalty through smart meters and big data analysis (BDEW 2016). The IWA defines the digitalization of water as the employment of data, automation and artificial intelligence in order to extend natural water resources, reduce Non-Revenue Water (NRW), increase the life of infrastructures and provide financial security. (Sarni *et al*. 2019). Digital water techniques can be applied at any point of the water life-cycle. Within a specific geographical area of any particular natural water system, the relationships between the natural resource and the utility, the utility and the customer and the customer and the environment are all open to improvement thanks to the employment of digital water.

The temperature, flow, nitrate value and PH of watersheds, groundwater and surface water can be monitored remotely. The work of utilities, capturing the supply of water, treating the resource and then distributing it to the end-users, be they householders, farmers, industry, commerce or the eco-system, can be optimised with the use of sensors that control quality, detect leakage and other damaging occurrences thus improving efficiency and reducing costs. The sensors can monitor the health and operation status of the assets, the pattern of customer usage so that the utilities can (1) better manage the facilities to improve the performance; (2) detect anomalies and failures within the system; (3) predict the demand to optimise the operation of the system and prioritise long-term investment strategies and management plans. Process monitoring and optimisation are based on the continuous recording of real-time observation data from multiple sources within water utilities. Extensive amounts of data can be processed in real time, so that depending on the current framework conditions, optimum operational management can always be achieved. The current state of infrastructures such as pipes can be controlled permitting the prompt and pre-emptive taking of measures to ensure that failures of equipment do not occur.

Augmented Reality (AR) and Virtual Reality (VR) permit three-dimensional modelling in order to assist infrastructure decision-making and the training of personnel. Natural water systems can be more clearly understood thanks to the conversion of satellite input with the data generated by sensors and the internet of things (IoT) into easily understandable messages which enhance the prediction of real-world events and the subsequent solutions required.

By the use of websites, mobile phones and smart meter technologies, end users can be engaged in the creation and implementation of actions whose objective is sustainability whilst bringing utilities closer to their customers through channels of communication and more efficient digital services. A specific example of this would be invoicing. While in the past the residents of an apartment building were informed in writing about the date of reading the water meters, the reading itself was completed by employees on site and the subsequent invoice was also received in writing. Such processes can be run completely digitally. By using smart meters, analogue reading is no longer necessary and the invoice is delivered online. Artificial intelligence can identify behavioural patterns and permits a far more perceptive approach to strategic planning.

All of that described above can be used by the water utilities and all the other stakeholders whose participation in the issue of water is necessary (See Section III: The Quadruple Helix). Positive results are claimed to be numerous. Apart from the operational aspects already mentioned, clear

environmental, social and financial benefits have been identified. For example, an enhanced corporate transparency and increased awareness for the conservation of natural resources is being created thanks to digitalization. As Burritt and Christ (2016) stated "*Not only are members of the public demanding that organisations treat natural resources such as water, air, and soil with respect, government and non-government organisations are encouraging corporations to undertake activities in a manner that is economically, environmentally and socially sustainable…this is being brought about by the internet of things*". From a social perspective, digital water can mean a greater understanding of water use patterns by the customer, a reduction of unpaid bills due to more personal monitoring of the amount of water one is using at home, a subsequent reduction of costs for the householder, which can also result from the prompt detection of leakage and a far more rapid response on the part of utilities to customer incidents, whilst in the opinion of the IWA, digital water signifies reduced expenditure, increased economic efficiency and a growth in revenue (Sarni *et al.* 2019).

B) Digital Water and Smart Water Applications – The past and present

Water has always been the most essential natural element in the history of mankind. The relationships between water supply, arable land, food production and social organization have been the principal causes of the most significant transformations in the configuration and structural dynamics of human societies. In the words of Fekri Hassan, "*The history of water management is nothing less than the history of humankind in its attempts to eke out a living and, whenever possible, satisfy its desires. For human beings water was not merely a substance that sustained life. It was, above all, an elemental ingredient in the way people conceived of the world and a principal component in the expression of their thoughts and emotions.*" (Hassan, 2011). Approximately 10,000 years ago, hitherto hunting and collecting communities, dependent on wild plants and animals sustained by rainfall, which varied significantly from one place to another, but was on the whole, insufficient to provide food for large, dense, settled populations began to establish themselves along the banks of great rivers such as the Nile, the Tigrus, the Euphrates, The Po, The Rhone, the Ebro and the Tiber. The earliest agrarian sedentary communities became small elementary states which evolved into militaristic empires that rose and fell in succession in many parts of the world. These new socio-political orders capitalised on the accumulated knowledge in water management, especially the technology of irrigation in arid lands, the abstraction of groundwater, and the use of water-lifting devices. The development of the Saduf, the Saqiya, the Archimedean screw and windmills were innovations which both dictated and reflected the stature of a society (Juuti et al. 2007).

The Industrial Revolution (Now unromantically termed Industry 1.0) was based on water power and the conversion of water into steam leading to mechanisation. The use of electricity led to the invention of the assembly line and mass production (Industry 2.0) and the development of the computer brought automation to society (industry 3.0). The technological components of what FIWARE4WATER defines as *Digital Water*; Artificial intelligence, virtual reality, cloud computing, cognitive computing, the Internet of Things (IoT) and the Internet of Nano Things (IoNT), or the Internet of Everything (IoE), and big data analytics represent what the Germans named the fourth industrial revolution (Burritt and Christ 2016), or *Industry 4.0* (Tsekeris 2018). Over the last few years, much debate, many conferences and even more academic papers have been dedicated to the application of Industry 4.0 to the water life-cycle. To date, there exists a certain irony when contemplating that what was arguably the principal driving force behind human development; water, has still not, as a modern-day sector, fully embraced what the WEF referred to as "*a fundamental change in the way we live, work and relate to one another*" (Prisecaru, 2016).

In the 1990s, *Data Science* was already being employed in the banking, consumer credit and telecommunications industries (data-driven decision making). The original objectives were solutions to issues such as fraud detection and customer retention (preventing a customer from choosing another bank or telecommunications company) (Provost and Fawcett 2017).

Digital Water and related Smart Applications is water-specific *Data Science*. In relation to water, development commenced later in comparison to other sectors. This was the result, in part, of the heterogeneous structure of the water sector or eco-system, within which Industry 4.0 has been consistently interpreted in different ways by distinct stakeholders. While a certain number of large companies already heavily rely on the employment of smart applications, there are other, often much smaller, water utilities who have barely begun to contemplate the benefits of such techniques. The reasons for this are numerous. Water supply is a critical infrastructure. There is only a limited free market and consequently the need to innovate has been perceived as being less urgent in comparison to other industries. Whereas customers of the energy sector can purchase their electricity from different suppliers, this choice does not exist in the water sector. A customer can only purchase from the regional supplier. Due to the lack of market pressure, the willingness to innovate is less pronounced. Furthermore, the size of the utility and therefore, the innovation potential varies considerably in Europe. While there are global players (such as, for example, Veolia, Suez and Aqualia) who have acquired control of many smaller companies, there are also regions which have numerous micro-suppliers. For example, in Germany alone, there are approximately 6,000 water supply companies.

Nevertheless, the situation is changing and a number of factors are appearing which are leading to an increased understanding for the need of digital water and smart water applications. Since the middle of the last decade, the issue of water scarcity has become far more acute, especially in Southern Europe. A number of utilities have been privatised whilst technical developments such as the appearance of sensor-to-sensor communication and data transmission technologies such as LoRa have been accompanied by an ostensible reduction in costs. Data storage is now relatively inexpensive, there exist low-cost sensors (water meters, water quality sensors, LabOnChip, Smart Meters) and powerful open source libraries for Machine Learning and Artificial Intelligence (Tensorflow, Scikit-learn). The situation has been further influenced by the emergence of a number of start-ups and ICT companies from other sectors penetrating the world of water, together with a perceived shortage of manpower and specific skills which can be addressed by the increased presence of automation and the use of decision support tools.

The basis of smart applications is data. In the past there have been, and still today there exist, isolated data silos. This is a result of the historical development of ICT. Merging data from different data sources enables truly smart applications whereby in the words of Lee et al (2014) *"…machines are connected as a collaborative community*" within which a hitherto unimagined amount of information is shared in real time, untainted by human influence or guesswork, and which can thus provide the necessary *open* information for coherent and integrated long-term strategies for sustainability.

From a socio-political viewpoint, the merging of forces, not only of different silos or distinct academic fields of research that combined could lead to more sustainable urban societies, but also of totally different social stakeholders affected by challenges from the same sector into a *'collaborative community'* could create the necessary consensus with regards to policy-making which would answer one of the major challenges to have been identified in recent years; that the problem of water is a problem of governance, not only from the managerial aspects of water supply and treatment but perhaps even more importantly, from the broader perspective of policy-making creation, implementation and post-implementation analysis. This leads one, therefore, to contemplate the role

of those stakeholders who have not previously been directly involved in the issue of water and the necessity for FIWARE4WATER to engage representatives of what is known as the Quadruple Helix, thus further strengthening the necessity and demand for open technology application.

III. The Quadruple Helix

The creation of any technology will count for very little if a broad awareness of its availability and the understanding of the necessity to apply such a methodology does not exist. Technical development and its use depends on funding and social support.

Industry 4.0 has enjoyed to date the sponsorship of national governments and supranational entities. For example, during the Horizon 2020 research programme between 2014 and 2020, the European Union has dedicated almost €8 billion for research and innovation regarding the development of key enabling technologies. Furthermore, the EU has provided a further €10 billion for investment in innovation from European Structural and Investment Funds (Burritt and Christ 2016, Davies, 2015). However, funding and social support depend and will continue to depend on socio-political priorities which the water industry in general has been notoriously efficient at ignoring. As Rohner (2018) pointed out, "*Historical approaches (*regarding water*) have largely tended to ignore concepts developed from within the economic and social sciences*".

Socio-political priorities respond to broad social perception which means that the creation of a united global approach to future environmental sustainability must emerge and be nourished. The United Nations clearly stated, "*One of the major challenges facing the world community as it seeks to replace unsustainable development patterns with environmentally sound and sustainable development is the need to activate a sense of common purpose on behalf of* ***all*** *sectors of society. The chances of forging such a sense of purpose will depend on the willingness of all sectors to participate in genuine social partnership and dialogue, while recognising the independent roles, responsibilities and special capacities of each*." (United Nations Environment Programme Decision: 27.2). Thus, the opinion of the private sector, the public sector, academia and, perhaps most importantly, the opinion of the electorate or citizen must be sought, taken into account and engaged. These four elements constitute the Quadruple Helix.

In 1995, Henry Etzkowitz and Loet Leydesdorff published "*The Triple Helix - University-Industry-Government Relations: A Laboratory for Knowledge Based Economic Development*" in which they described how a closer bilateral relationship between either the academic sector, private sector or the public sector would evolve into hybrid institutions which would mutually strengthen the aims of each sector; research, the production of commercial goods and the regulation of the market. Much would depend on which sector was the driving force behind the initiative. If the public administration is the dominant catalyst, the result is a top-down approach which would result in the strengthening of intersectoral ties. If market forces are the predominant factor, the ties would be weaker and far less defined whereas if knowledge is the lead sector which, in the opinion of Etzkowitz, is precisely what had tended to occur in recent years, not only does knowledge itself gain more prominence but also the three elements tend to enjoy a more equally-balanced relationship. (Etzkowitz, 2003). It must of course be remembered that Etzkotwitz and Leydesdorff were writing as researchers. Further criticism of the model was forthcoming from the very start. A number of the most important drawbacks were identified by writers such as Williams and Woodson who in 2012 wrote that *"…patterns of innovation in less economically developed countries…have been historically overlooked by the…literature on innovation systems and the triple helix*" and that the triple helix framework depends on there existing a democratic state in which intellectual property rights are protected and in which economic growth and research activities are intrinsically linked.

Building on the concept of the Triple Helix, in 2009, Carayannis and Campbell introduced the notion of the Quadruple Helix and, three years later the Quintuple Helix. The Quadruple Helix approach argues that the world of research must relate to the real demands of society in general and that as a result there must exist a relationship between the original sectors of the Triple Helix with the end-users of innovation and civil society in general; in other words the citizen. The Quintuple Helix is the additional input of the natural environment and its effect on the four other *helix sectors*. However, how the influence of the environment itself is represented is a source of ongoing, heated academic debate and it is the Quadruple Helix which the European Union defends itself when describing Open Innovation 2.0 within the European Innovation System, in which '*all stakeholders need to be involved and create seamless interaction… where government, industry, academia and civil participants work together to co-create the future and drive structural changes far beyond the scope of what any one organisation or person could do alone."* (https://ec.europa.eu/digital-single-market/en/open-innovation-20).

Thus, FIWARE4WATER, as stated in the Introduction to this deliverable, has identified citizens as a vital target audience for the progress of the project. Citizens are the element which differentiates the work of Etzkowitz and Leydesdorff from current supranational policy and it is the citizen who holds the key to the continuity of long-term visions. It is therefore necessary to define what a citizen is and explain clearly why citizens should be engaged in a project which deals with the employment of open technology in smart cities.

IV. The Citizen

The word in English, 'citizen' has its roots in the Anglo-French word, 'citezein', which in turn is derived from cité. The word first appeared in the 14th Century, and was defined as an inhabitant of a city or town (as opposed to a nation state) who was entitled to the rights and privileges of a freeman. (https://www.wikipedia.org)

Citizen participation, the involvement of a person who lives in a specific place and who pays taxes to, and obeys the laws of the government of that designated area is considered to be the basis for democracy, whether one is discussing politics at a supranational, national, regional or local level. It is a basic political premise which if mismanaged or distorted can signify, in the words of Jean Jacques Rousseau in The Social Contract (1762) that *'…the state is already close to its ruin'*. And yet, the history of what one could broadly describe as '*democracy*' demonstrates that formal social structures have always been and, depending on the authority in question, still remain to this day, sceptical and wary of direct citizen participation at any political level. (Roberts 2015). There are many who would defend the virtues of an unblemished form of *Representative Democracy* whereby the electorate delegates their civic responsibilities during a limited mandate to chosen people in order to undertake predefined, specific tasks. This, such people would argue, defends society from the influence of uninformed public hearsay and the possibility of a populist tyranny. However, as current events in both the United States and Europe would appear to suggest, this theory is to say the least, of doubtful value.

Nevertheless, and despite the attitude of numerous detractors, there has been, since the beginning of this century, an increasing belief in the need for and the importance of the engagement of the private citizen in an open, more transparent form of direct, *participatory democracy*. This is especially true in the area of environmental issues such as climate change, energy, transport, water, waste, and the application of smart technologies in order to address such challenges. As early as the 1980s, Cernea et al. (1985) were talking of a *'…rising public concern for environmental protection, sustainable development, and participation and institution building.*' With the acceptance by supranational institutions of the importance of the Quadruple Helix, as described above, the interest for citizens interacting with researchers, entrepreneurs and their elected representatives has intensified leading

to the political economist, Gigler to state in 2016 that, "*Empowering citizens to make their voices heard is not enough. We have to go beyond just listening to citizens; rather, we need to support governments to build institutional systems that incorporate citizen voices in decision-making processes, and thereby increase the responsiveness of government programmes to people's real needs*". Commissioner Moadas of the European Union, speaking at the WssTP Conference entitled 'The Value of Water' on the 21st of June, 2016 in Brussels, asserted, "*The Citizen must be at the centre of open innovation and subsequent public policy*." (Elelman and Feldman, 2018).

Citizen engagement is in itself a broad subject which has inspired numerous research activities in its own right. FIWARE4WATER will during the course of its implementation, employ an approach named *ConCensus* created by Elelman and Feldman in 2018. (This will be described together with the results of its implementation in Deliverable 5.3: *Report on the application of ConCensus*). As opposed to *Citizen participation* (a bottom-up process initiated exclusively by citizens), *Citizen engagement* is an intentional, proactive dialogue between citizens and the other sectors of the Quadruple Helix.

Citizen engagement is top-down in that the initiative to involve citizens comes, in the case of FIWARE4WATER, from a consortium of research institutions who seek to improve the value of their investigations and the application of their results within local policy initiatives after having carefully identified, among other factors, citizen opinion regarding the subject being studied. This is a formal approach which seeks to provide the citizens with the necessary mechanisms and information so that they can subsequently contribute to the issue at hand and be involved in the resulting initiative of local policy-co-creation and implementation. Such engagement has commenced in FIWARE4WATER by investigating the aforementioned citizens' understanding and views regarding water as a global issue, the use of computer technology in water management and their level of satisfaction as customers.

V. The Questionnaire

A) The Methodology

Between the 21st of August, 2019 and the 29th of September, 2019, a questionnaire was employed in order to ascertain the opinion of groups of citizens in three specific geographical areas related to the activities of FIWARE4WATER, in relation to: a) The Global Issue of Water b) ICT and Water and c) Citizen Satisfaction and their willingness to participate in further engagement activities.

No single method of obtaining public opinion and the subsequent drawing of conclusions can be deemed perfect. Any form of social/research interaction immediately leads to complex debates regarding the differences between the natural sciences and the social sciences and the comparison between the reliability of their results. In the words of Clive Seale (2012), "*The relationship between natural science and social research is uneasy, with the suspicion that the application of the label 'science' to the study of social and cultural matters is unjustifiable always lurking behind debates*". Some social scientists therefore strive to make their methods as similar as possible to those employed by their *natural* counterparts whilst others simply the reject the label 'scientific' completely. Despite the latter opinion, it is undeniable and simply logical that social research must be as rigorous and objective as possible but at the same time must be aware of who will be the audience for its results. Social science, as well as natural science must be accessible not only to peer-group academics but also to policy-makers, the private sector and the layman. Different audiences understand different languages, whilst the questionnaire itself must be comprehensible to the target interviewees employing what is described as 'recipient design' (Rühlemann, 2014). When preparing the questionnaire for this report, many of the basic elements described by Owens (2002) were taken into account. The purpose of the questionnaire was to obtain information not available from secondary

sources; the opinion of target groups concerning the issues suggested by FIWARE4WATER situated in specific places where further socio-political action during the course of the project will take place. It is a *Cross-Sectional Survey* in that information is collected at a specific moment in time from a sample group of people. The questionnaire was distributed and answered employing a combination of manners; face-to-face, telephone and e-mail.

Variable	*Mail*	*Phone*	*F/F*
Cost	Cheapest	Moderate	Costly
Speed	Moderate	Fast	Slow
Response rate	Low to moderate	Moderate	High
Sampling need	Address	Telephone number	Address
Burden on respondent	High	Moderate	Low
Control participation Of others	Unknown	High	Variable
Length of Questionnaire	Short	Moderate	Long
Sensitive questions	Best	Moderate	Poor
Lengthy answer choices	Poor	Good	Best
Open-ended responses	Poor	Good	Best
Complexity of Questionnaire	Poor	Good	Best
Possibility of interviewer bias	None	Moderate	High

Figure 1 Comparison of data collection methods. Source: Owens (2002)

The manners chosen were dictated by local circumstances. The questions themselves were deliberately created in a way, so as to be understandable to the recipients, simple to answer and consequently relatively easy to interpret. Each question attempted to be concise and without bias. The language level (interpreted into Romanian for one target group) took into account the lowest educational level within the groups approached. This would avoid the problem that is observed in many cases, whereby irrelevant or incoherent questions reduce the response rate and as a result the validity of the conclusions. Strict ethical practices were applied, observing the established EU data protection legislation so that there existed no infringements on privacy. **The Questionnaire created and distributed can be seen in ANNEX A.**

B) The Target Groups

FIWARE4WATER identified three places where the questionnaire was to be employed. Two are the locations of the planned direct citizen engagement activities which will constitute an important part of the later work of Work Package 5 of FIWARE4WATER. The third is one of the non-European cities, Jerusalem, which has already agreed to form part of a FIWARE4WATER *Follower Network*.

(i) **Great Torrington (GT)** a small market town in the north of Devon, England. It has one of the most active volunteering communities in the United Kingdom. In July 2019, Great Torrington was reported to be the healthiest place to live in Britain. Researchers from the University of Liverpool found that the area had low levels of pollution, good access to green space and health services, along with few retail outlets. Nevertheless, the area has high unemployment and serious economic problems. The specific citizens contacted are customers of the project partner, South-West Water (SWW) and **20 responses** were

obtained as the result of face-to-face distribution of the questionnaire at a meeting about smart meters organized by SWW on the 27th of September, 2019.

(ii) The second area of interest were a number of sample householders identified by the project partner, BDG covering **Eastern Europe (EE)**. This is a region that is considered priority by the European Commission. The uptake of open technology in smart cities is slow and to date, extremely unusual in the case of water utilities. **60 responses** were obtained employing e-mails and telephone calls from citizens of Romania (75%), Moldova (7%). Hungary (5%), Bulgaria, (5%), Croatia (5%) and Slovenia (3%).

(iii) The third city where the questionnaire was answered was **Jerusalem (JER)**. The two reasons for contacting citizens in a city that boasts a high level of awareness concerning water issues and is a World leader in the application of smart city applications are that a) Jerusalem has agreed to form part of the future FIWARE4WATER *Follower Network* and b) it was considered interesting to compare results from the United Kingdom and Eastern Europe to the answers of a city in the Near East, providing the later opportunity to explore potential post-project exploitation actions. **7 responses** were received from people who had been contacted by e-mail, meaning there were, in total **87 responses** to be analysed.

C) The Results

As has already been stated, interviewees were asked 12 questions. A concerted attempt was made when contacting people to ensure gender equality and that a broad range of age groups were represented.

The questions were divided into three categories: a) The Global Issue of Water b) ICT and Water and c) Citizen Satisfaction and their willingness to participate in further engagement activities. (**See: ANNEX A**). There were two types of answers expected, depending on the question:

- **1-5 Score questions** (Questions 1, 2, 8, 9, 10 and 11b)
- Questions where the interviewee could answer Y: Yes | N: No | S: Sometimes | DK: Does not know | MI: Needs more info. (Questions 3, 4, 5, 6, 7, 11 and 12)

Results are presented in this report in two ways. First as a global result reflecting the answers of all 87 people consulted (**See: ANNEX B**) and then with results broken down according to geographical location, i.e.: Great Torrington (GT) Eastern Europe (EE) and Jerusalem (JER) (**See: ANNEX C**).

A: The Global Issue of Water

Q1: On a scale of 1 to 5 where 1 is totally unaware and 5 is fully informed to what extent are you aware of the global issue of water?

Average Global Score: 3.77

GT: 3.45

EE: 3.85

JER: 4

The results are not surprising. There does exist a growing realisation on the part of the general public in Europe that the issue of Climate Change and thus, water as the most essential of all natural

resources, is important. In the Middle East, awareness has existed for longer and the citizens of Jerusalem are accustomed to such issues. What is reflected here, is to what extent people consider themselves to be informed, not whether the issue is important for them.

Q2: On a scale of 1 to 5 where 1 is totally unconcerned and 5 is extremely concerned, to what extent is water an issue of concern to you?

Average Global Score: 4.33

GT: 3.70

EE: 4.30

JER: 5.00

An average global score of 4,33 is an extremely encouraging result. The results in Jerusalem and GT are not surprising. One is a green land, on the wetter, western side of England, so there does not exist a perceived threat, whilst the other is a major city which has been obliged to invest heavily in order to face the challenge of a rapidly-increasing population combined with limited freshwater supplies. (The technical solution to this crisis is that, at present, 100% of water supplied to Jerusalem by the utility, HAGIHON, is desalinated. However, this is an extremely costly process and results in an elevated carbon footprint). The concern in Eastern Europe is a welcome sign in a region which has, at present, much work to do in order to face future water challenges. Concern leads to a desire for representative action and/or personal involvement in the issue at hand. It means that FIWARE4WATER can concentrate less on the creation of awareness in the region and more on providing solutions which are visible to citizens whilst employing mechanisms which involve the citizens themselves. As will be observed later, not as many people declared an interest in becoming actively engaged and the reasons for this this must be examined during the course of the project in order to ensure that concern is converted into proactive action on the part of all sectors of the Quadruple Helix.

B: ICT and Water

Q3: Do you receive information concerning water quality in your area?

GEOGRAPHICAL LOCATION	YES	NO	SOMETIMES
Average Global Score	28	42	17
GT	16	4	0
EE	7	36	17
JER	5	2	0

The most notable conclusion that can be drawn from the answers to this question is that in the case of Eastern Europe, there is much work to be undertaken regarding water-quality information. Water

services do not take into account the citizen dimension. 60% receive, to their knowledge, no such data whilst only 12% consider themselves fully informed. The Global Results (heavily influenced by Eastern Europe, it is true) are also worrying, with only 32.1% fully informed and 48,2% stating that they do not receive such data. An increased social demand for such information must be encouraged and answers supplied. In the case of the English and Israeli locations the few NO answers may be explained by the fact that whilst information is supplied, the interviewees simply have not noticed or are unaware as regards to where such data can be found.

Q4: Are you aware of water-related technological software (ex.SCADA, IoT, Mobile apps, etc.) being used in your area?

GEOGRAPHICAL LOCATION	YES	NO	NO ANSWER
Average Global Score	30	56	1
GT	4	15	1
EE	24	36	0
JER	2	5	0

There are two conclusions to be drawn from this question. First, a majority of householders (65.5%) do not know about the use of water-related technological software which suggests an identified challenge for the FIWARE4WATER project. Secondly, and more surprisingly, 40% of the people interviewed from Eastern Europe are aware of the use of such software whilst in Great Torrington, the figure fell to 20% (one person did not answer the question) and in Jerusalem the figure was 29%. This result called for a closer inspection of the results. The people who answered YES from Eastern Europe were 21 Romanians, 2 Moldavans and 1 Hungarian. However, more revealing is the fact that those who answered YES could generally be described as middle-class professionals who are, in general, more likely to be better informed about environmental and climate change issues. Some of those within this group also appear to have some form of professional link to water, either directly or indirectly. This would explain what initially appeared to be an anomaly. The interviewees from both Great Torrington and Jerusalem had no professional ties to the world of water whatsoever.

Q5: Does your water supplier enable you to have an online account?

GEOGRAPHICAL LOCATION	YES	NO	DON'T KNOW
Average Global Score	37	15	35
GT	8	1	11
EE	26	14	20
JER	3	0	4

The first conclusion to be drawn here is that far too many people (40.2%) in all three locations are simply unaware whether or not their water account is available on-line. Due to the professional background identified in Q4 regarding a number of interviewees in Eastern Europe, awareness of this aspect was higher in said region with only 33% answering that they didn't know. However, in Great Torrington and Jerusalem this figure rises to 55% and 57.1% respectively and must be addressed accordingly.

Q6: Would you like to have better access to on-line water based goods and services?

GEOGRAPHICAL LOCATION	YES	NO	DON'T KNOW
Average Global Score	73	8	6
GT	14	6	0
EE	52	2	6
JER	7	0	0

The conclusion is simple. An overwhelming majority of people asked, (83.9%) stated that they would like to have better access to on-line water based goods and services. In Jerusalem and Eastern Europe, the figure rose to 100% and 86.6% respectively whilst satisfaction with the current situation was highest in Great Torrington where 30% do not feel the need for an improved on-line service.

Q7: Would you be prepared to become involved in a Digital Water Discussion Forum? (Digital Water Discussion Forum = A network in which citizens can discuss their opinions regarding water issues at a local and international level).

GEOGRAPHICAL LOCATION	YES	NO	DON'T KNOW
Average Global Score	52	22	13
GT	5	12	3
EE	40	10	10
JER	7	0	0

There are important considerations for the FIWARE4WATER consortium here. Whilst in Eastern Europe (66%) and Jerusalem (100%) there is a strong willingness to participate in discussions about digital water, in the location of Great Torrington, an important majority of the interviewees (60%) stated they would not be interested in such an activity whilst only 25% gave an affirmative answer. This correlates with answers to other questions. Great Torrington as will be seen below, is generally content with the service provided by South West Water giving it a score of 4.33/5.00. (See: Q8) and 80% of the population believe that they are well-informed about water quality (See: Q3). This satisfaction could be an important factor contributing to the relative unwillingness to discuss digital water. Unwillingness is perhaps too harsh a term. It could very well be argued that the people of Great Torrington simply do not feel the need for such an activity. On the other hand, it could be a reflection of the fact that concern for the global issue of water is not as high as in the other two locations. (See: Q1 and Q2). The perceived lack of a desire to talk about water is further reflected in the fact that only 15% of the population of the English town would be prepared to become actively engaged in the co-creation and implementation of a water-based policy. (See: Q12). This is not necessarily a negative scenario for the FIWARE4WATER consortium but must be studied and subsequently explained. For example, it would be interesting to investigate whether or not similar figures are produced if the issue at hand were different, such as employment, tourism, housing, health, public transport or other subjects which local governments deal with. Similar figures would indicate a general reluctance to become engaged in local policy debate in general. Distinct results would signify that it depends on the issue. Each municipality has its own priorities, its own idiosyncrasies, its own local problems. If water at a local level is being provided satisfactorily, the issue of water tends to become less important to the local citizen. Only if there is an extreme weather event such as flooding or drought does water tend to become an item for debate. This is an important factor which supranational entities seeking to engage citizens in issues of global concern through municipal channels, must understand and be prepared to react to accordingly.

C. Citizen Satisfaction

Q8: On a scale of 1 to 5 where 1 is totally dissatisfied and 5 is extremely satisfied, how happy are you with the water services provided in your area?

Average Global Score: 3.84

GT: 4.3

EE: 3.35

JER: 3.86

The results of Q8 would seem to support to a certain extent, what has been described above in Q7. The opinion expressed regarding the water services provided cannot be described as negative in any of the three locations. However, the level of satisfaction is lower in those places where citizens would be more prepared to discuss water and participate in future policy-creation initiatives.

Q9: On a scale of 1 to 5 where 1 is totally unaware and 5 is extremely well informed how much do you know about smart applications related with water in your area?

Average Global Score: 2.35

GT: 2.55

EE: 2.22

JER: 2.29

Awareness regarding the use of smart applications related with water is evidently low, no matter the location in question. The results suggest that there is, to date, no correlation between customer satisfaction with water services and the level of householder understanding regarding the employment of computer technology in water management. Therefore, further questions to be investigated by FIWARE4WATER are a) how can one increase end-user knowledge of the benefits of open source smart technology and b) to what extent do the general public need to know about such practices. After all, one can drive a car and be pleased with its performance without having the remotest idea of automobile mechanics or the technology which lies behind the information displayed on the dashboard.

Q10: On a scale of 1 to 5 where 1 is totally dissatisfied and 5 is extremely satisfied, how happy are you regarding the fee you pay for water services?

Average Global Score: 3.03

GT: 3.15

EE: 2.93

JER: 3.00

Satisfaction regarding the price of water would seem to be surprisingly homogenous. Given the number of interviewees asked to answer the questionnaire, the results should not be treated as being conclusive but it is noticeable that the location which is less predisposed to become actively engaged in water-based discussions is the population which at this, admittedly limited glance, demonstrates itself to be most content with the amount of money they pay for water consumption. However, it is important to repeat that the differences between one location and another are minimal and that the number of interviewees approached prohibit one from making sweeping statements.

Q11: Have you ever had the opportunity to participate in a local decision making process related to water and/or any other environmental subject, at local or regional level?

GEOGRAPHICAL LOCATION	YES	NO	DON'T KNOW
Average Global Score	26	60	1
GT	2	17	1
EE	19	41	0
JER	5	2	0

Q11b: If Yes, on a scale of 1 to 5 where 1 is totally dissatisfied and 5 is extremely satisfied how would you describe the experience?

Average Global Score: 4.22

GT: 4.5

EE: 3.35

JER: 4.8

Q11 and Q11b illustrate a further challenge. How to encourage more people to become engaged in policy co-creation? The combined answers clearly show that 69% of those questioned have no experience in participating in a local decision-making process related to the environment. The figure is more accentuated in Great Torrington where only 10% have been engaged in such an initiative previously. Jerusalem is the exception. It is a city where for socio-political and historical reasons there exists a strong sense of community and a long tradition of civil participation in environmental issues so the figure of 71.4% is not surprising. What is encouraging for the future development of Work Package 5 of FIWARE4WATER is that those who have been socio-politically active show a high level of satisfaction with the experience. These interesting figures must be compared to the results of a second questionnaire which should be distributed at the end of the work of Work Package 5 in order to determine the progress achieved by the project consortium.

Q12: Would you be prepared under the guidance of the FIWARE4WATER project to be involved in a citizen-based water policy creation process?

GEOGRAPHICAL LOCATION	YES	NO	I WOULD LIKE MORE INFORMATION
Average Global Score	33	22	32
GT	3	15	2
EE	24	6	30
JER	6	1	0

FIWARE4WATER will be seeking to engage laypeople in a citizen-based water policy creation process. As was discussed in Q7, there is little interest for such an action in Great Torrington, but it is hoped that further information concerning the intentions of FIWARE4WATER will lead to the recruitment of more volunteers. The figures in Eastern Europe are far more encouraging where only 10% replied that they would not be interested. 40% have shown their willingness to become involved and 50% stated that they would like more information. This highlights the fact that in this area of Europe, such approaches are to date, almost unheard of. In general terms, the figures are unsurprising. When first applying the ConCensus methodology, Elelman and Feldman (2018) discovered that before becoming engaged, citizens must be aware, interested, concerned and then fully informed with regards to both the issue at hand and the proposed solution-creation process in which they are invited to participate. One must remember that in such initiatives private householders are being asked to dedicate their own time to an activity. If they are not directly affected by the results of implementing or not implementing a specific process, it is only natural that there is a tendency to desist. Thus, as has been stated before, the more critical the issue at hand is perceived to be, the more active the citizen will be.

VI. Relevant Past European Projects

It is unfortunate that many European projects are quickly confined to the dusty archives of a research institute once they have been completed and are seldom referred to again. In many cases, there is no concerted attempt by the funding authorities to perpetrate the effect of successful initiatives. For example, when preparing a project proposal, consortia are not obliged to build on the experience and conclusions of previous, similar activities. They are not instructed to read previous funded work. This often results in the production of data which already exists and a reduction in the rate of advancement within the chosen area of investigation.

In order to further strengthen the basis for the future tasks of Work Package 5, it was deemed important to establish a close working relationship with other projects that have been funded as a result of the Horizon 2020 call: SC05-11-2018 and furthermore, note the results obtained by the work of relevant previous projects and indeed, seek to employ such work as a point of departure when conducting the proposed investigations of FIWARE4WATER. Therefore, this section presents a brief description of four examples of projects, all of which have now concluded, but the findings of which, it is hoped will prove useful to the progress of this Work Package. FIWARE4WATER does not intend to repeat past experiences but rather identify and build upon relevant results identified by these

examples, in order to complement the original work it proposes and to advance the socio-political and economic impact of open source enabling technologies in collaboration with the aforementioned SC05-11-2018 cluster of project consortia.

WatERP Project (EU-FP7 project, 2012-2015)

WatERP (Water Enhanced Resource Planning 'Where water supply meets demand') proposed to develop an intelligent open platform that integrates real-time knowledge regarding available water supply and demand, from water sources to users and across geographic and organizational scales. The information from each step of the process can be exchanged and accessed so that the entire water distribution network can be viewed, understood and improved in an integrated and collaborative manner. The major objective of the project was, to develop an *Open Management-Platform* for supporting drinking water companies in their daily operation and decision making.

The area of application was divided into two different drinking water scenarios that can be found throughout the nation states of the European community. On the one hand, to ensure water quality and quantity in water-scarce areas through an intelligent computer-assisted matching of the available water sources to different stakeholders in need. On the other hand, to achieve an energy-efficient water supply using computer-based pump scheduling in areas where water is on hand (Water Abundance). The pilot water-scarcity area was the Municipal Area of Barcelona (AMB). In Germany, a country of water abundance, the intelligent pump and tank management procedures were tested in the city of Karlsruhe to increase energy efficiency. To accomplish the ambitious aims, a lot of effort has been dedicated to adapting a water-demand forecasting procedure (*Similar Day Model*) which serves as the basis for computer-assisted decision support for water distribution problems.

As an outcome of the project a fully functionally testing environment has been developed. The software has been implemented in the corresponding pilot areas. At the moment, the developed procedures to support the daily operation in the drinking water companies are tested in parallel to the normal operation. The highest success for the developed project software has been forecasted for the energy efficiency aims of the city of Karlsruhe. The calculated savings for the network pumps is predicted to be 7%. As a result of the project, the company WatEner constituted a spin off, which today commercializes the platform developed in the project and the accompanying services.

iWIDGET (EU FP7 project, 2012-2015)

Within the project, the behaviour of consumers has been investigated (Creaco et al. 2016; Sonderland et al, 2016) using also an e-learning platform (Kossieris, 2014). The objective of iWIDGET was to advance knowledge and understanding about smart metering technologies in order to develop novel, robust, practical and cost-effective methodologies and tools to manage urban water demand in households across Europe.

The main scientific challenges for iWIDGET were the management and extraction of useful information from vast amounts of high-resolution consumption data, the development of customised intervention and awareness campaigns to influence behavioural change, and the integration of iWIDGET concepts into a set of decision-support tools (widgets) for water utilities and consumers, applicable in differing local conditions, in three case studies in the UK, Portugal and Greece. Also, within the project, 20 combined water and electricity smart meters were installed in volunteers' houses in Greece, collecting online data for two years, which have subsequently been used for further research on domestic water use.

WIDEST (H2020 Coordination and Support Action 2015-2017)

WIDEST aimed at establishing and supporting a Community devoted to applying Information and Communication Technologies (ICT) to the Water sector. Its main objective was to promote the dissemination and exploitation of the outcomes of European Union (EU) funded activities in this area, and other relevant sources of information and technologies.

WIDEST defined 5 general objectives, which were directly related with the main outcomes of the project: O1) Run an ICT for Water Observatory (IWO) to increase consortium knowledge about ICT for Water including best practices, technologies, issues, stakeholders, and thereby contribute to WIDEST main roadmap (available at http://iwo.widest.eu); O2) Establish Common Dissemination Frameworks and O3) Organise events to promote ICT technologies for the Water sector; O4) Produce 4 roadmaps (Semantic Interoperability and Ontologies topical roadmap, Smart City Connection topical roadmap, Smart Water Grids topical roadmap, and the Overall roadmap, to analyse key issues and assimilate information across topical roadmaps), and O5) Produce a Portfolio of effective ICT for Water technologies.

Resulting reports and especially, the valuable roadmaps can be downloaded from the main website of WIDEST (http://www.widest.eu), (https://www.widest.eu/downloads/downloads-roadmaps). These reports and roadmaps contain the main challenges, previous and current (till 2017) related actions being performed, and opportunities to overcome them. Finally, it is important to remark the great impulse the project provided to the ICT4Water cluster (https://www.ict4water.eu), which aggregates EU funded projects which involve ICT technologies for the Water sector to foster synergies among them and provide more effective ways of collaboration and dissemination.

POWER ((H2020 Coordination and Support Action 2015-2019)

Perhaps the most relevant of the projects described here with regards to Work Package 5 of FIWARE4WATER, POWER (https://www.power-h2020.eu) investigated and sought to reinforce political and social awareness regarding water environmental challenges. The project created a Digital Social Platform (DSP) named the Local Water Community in the Key Demonstration Cities (KDCs) of Jerusalem (IL), Sabadell (ES), Milton Keynes (UK) and Leicester (UK).

The project investigated to what extent DSPs can be effective tools when driving sustainable behaviour by raising collective awareness of the environment and the consequences of socio-political actions. The open-source technology developed, sought to encourage a strategic network whereby citizens within cities and in communication with their counterparts from other regions and countries could best employ the sharing of knowledge, public opinion and best practices through open consultation on the POWER Water Community platform. New gamification approaches and the initial proof of concept of the ConCensus methodology which will be employed and developed by FIWARE4WATER were further features of this project.

The technical development of the Digital Social Platform and the socio-political consequences of ConCensus were further reinforced by the development of a Water Governance Capacity Framework (WGCF) which permitted local authorities to identify in a simple, yet effective manner the gaps which exist in their municipalities regarding both the supply and treatment of water as well as the administrative, social and political aspects of the subject. The WGCF also provided an initial, easily-understood illustration upon which, local citizen participation could be based.

VII. Conclusions and recommendations for the future development of Fiware4Water

Work Package 5 of FIWARE4WATER seeks to enhance the socio-political and economic impact of open source enabling technologies and the data which such technology is capable of providing to all the stakeholders of what was defined by Carayannis and Campbell (2009) as the *Quadruple Helix*. A vital aspect of the work of the members of the consortium involved in the implementation of this Work Package is therefore, to engage with the public sector, the private sector, researchers and above all private citizens within those municipalities where the technical work of the project is being undertaken and further afield in what will be deemed as Follower Cities which will be recruited during the course of Task 5.2.

Engagement at the local level is vital as it is, (in the opinion of the supranational entities) when one is in direct contact with the citizens of cities, towns and villages, that one can construct a social awareness which in turn leads to interest, concern and in the case of the most motivated of people, a public, proactive contribution to the co-creation and implementation of local policies based on the broad foundations of inter-sectoral consensus. It is only with such consensus that one can guarantee a coherent policy continuity, which is, in turn, the key to successful decision-making and policy implementation. FIWARE4WATER will, as a result, advocate a *participatory* as opposed to a *representative* approach to the issue of water and the improvement of its governance and management. It will seek to learn from the mistakes made at the beginning of the 21st Century when the *Agenda 21* was promoted across the globe, by attempting to demonstrate to hitherto, uninformed members of the community that they have an important role to play *throughout the entire process* from creation to implementation and beyond to post-implementation analysis.

The approach known as the Council of Citizen Engagement in Sustainable Urban Strategies (ConCensus), created by Elelman and Feldman in 2018 will be disseminated to the Follower Cities in an exercise of inter-city knowledge exchange with the objective that replication of the FIWARE4WATER approach is undertaken in a number of the aforementioned municipalities. What FIWARE4WATER will disseminate to a broad social audience who (as the questionnaire presented in this report has demonstrated clearly) have little previous knowledge of the *whys and wherefores* of digital water, automation and artificial intelligence, is the capacity of enabling technologies to extend water resources and to improve the circular relationship between the natural resource, the utility, the end-user and the environment.
This report was created to understand the perception of the public regarding digital water. Now, the task of the Work Package is to promote, nourish and maintain society's understanding not only of the results of Industry 4.0 but also of the role that water has always played in the history of technical development and even more obviously, in the very existence of mankind. FIWARE4WATER must lead to an improved social consciousness regarding the three aspects which the questionnaire, presented in Section V, addressed; the global issue of water, the relationship between water and ICT and citizen satisfaction and engagement.

The questionnaire has revealed a series of issues which FIWARE4WATER must address if it is to achieve its aims. These factors lead one to offer three principal recommendations:

i) The Questionnaire itself cannot be considered to be infallible. It describes the opinion of a small sample group of interviewees in three distinct locations, one of which represents an extremely large and diverse area of Eastern Europe. Further information must be obtained while Task 5.2 and Task 5.3 are being implemented. For example, the answers from Great Torrington would indicate a high degree of satisfaction regarding the services provided by

South West Water. They awarded the utility with a score of 4.3/5.0 in Q8. Does this level of acceptation explain why only 15% of those asked would be prepared to participate in a form of citizen-based water policy co-creation? (Q12) Is this why only 20% of the customers in the beautiful Devon town would be prepared to form part of a discussion forum on water? (Q8) Would the same people be motivated to become active participants in a similar process if the issue instead of water were, for example, employment, local rates, education, health services or public transport? This is information that must be obtained.
Another example, is that in Eastern Europe, there appeared a certain anomaly with regards to awareness of water-related technological software (Q4) where 40% of the people were, according to their answers, well informed about such matters. This suggests that a number of interviewees were selected, informed citizens. This is not in itself a bad thing. The opinion of everyone is valid. Nevertheless, one must conclude that a second questionnaire should be distributed in Month 28 of the project.
This would provide an excellent opportunity to establish how FIWARE4WATER has affected the opinion of the 87 original interviewees in the intervening 22 months. It will also permit the consortium to assess a broader audience from Follower Cities recruited in that period. The second questionnaire should repeat the original questions presented in this document but also add supplementary features in order to answer more detailed aspects as described above.

ii) Water as a global issue is deemed to be important. In Q2 of the questionnaire, when asked if water was an issue of concern for them personally, the average global score was 4.33/5.00. The perception of water and other broader environmental issues, most notably Climate Change as being a priority is growing. The challenge for initiatives such as FIWARE4WATER is to convert that increasing awareness into more proactive as opposed to passive, reactive activity. Most cities and their citizens only respond when faced by extreme events such as long periods of drought which lead to hosepipe bans and perhaps in the long-term, water shortages, or flooding when one's personal property is at jeopardy. Such circumstances make the work of environmentalists much easier. The challenge is to create an equal amount of enthusiasm when extreme weather events have not occurred. The importance of city-to-city collaboration and the opportunity for a local government to play a role on the global stage are aspects which must be promoted during the course of the project.

iii) In the case of Eastern Europe, there is an urgent need to satisfy a public demand. 88,3% stated that they did not receive or were unaware of receiving information concerning the quality of water supplied to them, only 3% categorically stated that they did not require better access to online water services (which can partly be explained by the relatively low rate of internet users in Romania) and 60% showed themselves willing to participate in public discussion forums about water. 40% are prepared to participate in the co-creation of a water policy with another 50% asking for more information before taking a decision. This is a staggering result and demonstrates that there is a real public desire to participate in the improvement of Eastern European water services. Such enthusiasm must not go to waste and therefore, the recruitment of Follower Cities in Romania, Moldova, Hungary, Bulgaria, Croatia and Slovenia should be begun immediately. Similarly, the logical interest of a city such as Jerusalem where water has historically always been a critical issue and where there exists a total reliance on desalinated water with the economic and environmental consequences which that can entail, means that Jerusalem should be converted into an important disseminator of the FIWARE4WATER experience both in Israel and neighbouring countries.

Indeed, this possibility has already been discussed with the Deputy Mayor of Jerusalem, Ms Fleur Hassan who has stated that she and her government will cooperate fully with the project together with the Jerusalem Water Forum which was established during the Horizon 2020 project: POWER described in Section VI.

One final aspect is worthy of reiteration. Observing the global results of the questionnaire, it is obvious that, in general, there exists very little knowledge about water-based smart technology. Even including a number of professional opinions from Eastern Europe, over 64% of those asked did not know about water-related technological software in their area. (Q4). On a scale of 1 to 5, the lowest score of the entire questionnaire (2,35) was obtained when people were asked about their awareness of water-related smart applications. (Q9). The conclusion is simple and yet is often ignored by both researchers and utilities alike. The smart water sector, indeed the entire water sector must begin to learn to communicate with their customers, with researchers, with industry and SMEs and with the decision-makers**. It must establish a permanent inter-sectoral dialogue**. This is an aspect in which the water sector has been notoriously inefficient. As has been stated in Section III of this report, large amounts of public money are dedicated to the research of enabling technologies. Public money is made available because there exists a socio-political interest to invest in one priority or another. If Industry 4.0 in general and those who work on water-oriented solutions in particular are to be effective, they require time. Time is the result of funding and funding is the consequence of effective communication to the layman who, at predetermined moments, is called upon to select their representative, the decision-maker. FIWARE4WATER must contribute to the establishment of that dialogue.

List of Acronyms/Glossary

EC European Commission

F4W Fiware4Water project

IWA International Water Association

NRW Non-Revenue Water

OECD The Organisation for Economic Cooperation and Development

SDG Sustainable Development Goal

UN United Nations

WB World Bank

WEF World Economic Forum

WP Work Package

WPL Work Packages Leaders

References

1) Elelman, R, Feldman, D.L. (2018) The future of citizen engagement in cities—The council of citizen engagement in sustainable urban strategies (ConCensus). Futures Volume 101, August 2018, Pages 80-91. https://doi.org/10.1016/j.futures.2018.06.012

2) Akhmouch, A and Romano, O. (2016) Water Governance in Cities. OECD. Studies on Water, OECD Publishing, Paris DOI: https://dx.doi.org/10.1787/9789264251090-en

3) World Bank (2014) "Strategic framework for mainstreaming citizen engagement in World Bank Group Operations: Engaging with citizens for improved results". World Bank Report 92957

4) Sarni, W., White, C., Webb, R., Cross, K. and Glotzbach, R. (2019) "*Digital Water: Industry leaders chart the transformation journey*" International Water Association

5) Mukhopadhyay, C.S. and Mason, A. (Ed.) (2013) "Smart Sensors for Real-Time Water Quality Monitoring" Springer-Verlag Berlin Heidelberg https://doi.org/10.1007/978-3-642-37006-9

6) BDEW (2016) "Digitale Geschäftmodelle. Digitalisierung in der Energiewirtschaft". BDEW, Bundesverband der Energie- und Wasserwirtschaft e. V.

7) Burritt, R., Christ, K. (2016) "Industry 4.0 and environmental accounting: a new revolution?". AJSSR 1, 23–38 doi:10.1186/s41180-016-0007-y

8) Sancho, D., Rodríguez, A., Sánchez-Diezma, R., Llort, X., Anzaldi, G., Rubión, E., Corchero, A. and Rodríguez, A. (2014) "UrbanWater and WatERP: Decision Support Systems for Efficient and Integrated Water Resources Management". CUNY Academic Works.

9) Hassan, F (2011) "Water history for our times" UNESCO Digital Library https://unesdoc.unesco.org/ark:/48223/pf0000210879

10) Juuti, P., Katko, T. and Vuorinen, H. (2007) "Environmental History of Water - Global views on community water supply and sanitation" IWA Publishing Volume 6 DOI: https://doi.org/10.2166/9781780402277

11) Tsekeris, C. (2018). "Industry 4.0 and the digitalisation of society: Curse or cure?" Homo Virtualis, 1(1), 4-12. doi:http://dx.doi.org/10.12681/homvir.18622

12) Prisecaru, P. (2016). "Challenges of the fourth industrial revolution". Knowledge Horizons. Economics, 8 (1), 57-62.

13) Provost, F. and Fawcett, T. (2013) "Data Science for Business". O'Reilly Media, 414 pages.

14) Lee J., Kao H-A, and Yang, S. (2014) "Service Innovation and Smart Analytics for Industry 4.0 and Big Data Environment. Procedia" CIRP 16:3–8

15) Davies, R. (2015) “Industry 4.0. Digitalisation for productivity and growth, Briefing for the European Parliament” (PE 568.337) September 2015. European Parliamentary Research Service

16) Rohner, P. (2018) “Water: A Megatrends Perspective”. In: Biswas, A., Tortajada, C., Rohner, P. (eds) “Assessing Global Water Megatrends”. Water Resources Development and Management. Springer, Singapore

17) United Nations. Decisions adopted by the Governing Council/Global Ministerial Environment Forum at its first universal session UN Environment Programme UNEP/GC.27/17

18) Etzkowitz, H. (2003) "Innovation in Innovation: The Triple Helix of University-Industry-Government Relations". Social Science Information. Issue 42 Vol.3 pg. 293–337. doi:10.1177/05390184030423002. ISSN 0539-0184.

19) Williams, L.D.A., Woodson, T. (2012) "The Future of Innovation Studies in Less Economically Developed Countries". Minerva, vol. 50, no. 2, 2012, pp. 221–237. JSTOR www.jstor.org/stable/43548641.Minerva. 50 (2): 221–237. JSTOR 43548641

20) Carayannis, E.G. and Campbell, D.F.J. (2009) "'Mode 3' and 'Quadruple Helix': toward a 21st century fractal innovation ecosystem" International Journal of Technology Management (IJTM), Vol. 46, No. 3/4, 2009 doi:10.1504/IJTM.2009.023374

21) European Commission (Last Update: 2019) Digital Single Market Policy – Open Innovation 2.0 https://ec.europa.eu/digital-single-market/en/open-innovation-20

22) Roberts, N.C (Ed) (2015) “The age of direct citizen participation” Routledge ISBN 978-0-7656-1513-8

23) Cernea, M.M. (ed.) (1985) Putting people first. Oxford University Press for the World Bank ISBN 0-19-520465-4

24) Gigler, S. (2016) “10 Lessons on Citizen Engagement”. World Economic Forum. https://www.weforum.org/agenda/2016/01/10-lessons-on-citizen-engagement/

25) Seale, C. (Ed.) (2012) “Researching Society and Culture” Sage Publications Ltd. ISBN 978-1-84920-798-0

26) Rühlemann, C. (2014). Towards a working definition of conversational narrative. In Narrative in English Conversation: A Corpus Analysis of Storytelling (Studies in English Language, pp. 4-39). Cambridge: Cambridge University Press. doi:10.1017/CBO9781139026987.003

27) Owens, L.K., 2002. “Introduction to survey research design.” In SRL fall 2002 seminar series (pp. 78-105). Harvard. researchgate.net PDF.

28) Savić, D., Vamvakeridou-Lyroudia, L. and Kapelan, L. (2014) “Smart Meters, Smart Water, Smart Societies: The iWIDGET Project” Procedia Engineering, Volume 89, 2014, Pages 1105-1112, ISSN 1877-7058, http://dx.doi.org/10.1016/j.proeng.2014.11.231

29) Sønderlund, A.L., Smith, J.R., Hutton, C.J., Kapelan, Z. and Savic, D. (2016). "Effectiveness of smart meter-based consumption feedback in curbing household water use: Knowns and unknowns." Journal of Water Resources Planning and Management, 142(12). https://d1uo4w7k31k5mn.cloudfront.net/v4/14.png

30) Creaco, E., Kossieris, P., Vamvakeridou-Lyroudia, L., Makropoulos, C., Kapelan, Z. and Savic, D. (2016) Parameterizing residential water demand pulse models through smart meter readings, Environmental Modelling & Software, volume 80, pages 33-40.

31) Kossieris, P., Kozanis, S., Hashmi, A., Katsiri, E., Vamvakeridou-Lyroudia L.S., Farmani, R., Makropoulos, C. and Savic, D. (2014). A web-based platform for water efficient households, Procedia Engineering, Volume 89, 2014, Pages 1128-1135, ISSN 1877-7058, http://dx.doi.org/10.1016/j.proeng.2014.11.234.

Annex A: The Questionnaire

QUESTIONNAIRE
AND
AGREEMENT TO PARTICIPATE

Dear Sir/Madam,

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 XXI Century, water. Within this project, physical and digital solutions for water are brought together in order to produce a more effective means of water management.

We are hoping that you will be willing to help us to gather information concerning your opinion and understanding of water as a global issue, the use of computer technolgy in water management and your level of satisfaction as a customer.

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 with the completed questionnaire.

What is the purpose of your involvement? The purpose of this questionnaire is to learn about your opinion and understanding of water as a global issue, the use of computer technolgy in water management and your level of satisfaction as a customer.

What will your participation involve? We invite you, as a citizen, to participate by completing a questionnaire with 12 questions. Completing the survey should take no longer than 5 minutes. Your name and personal details will not appear on any material arising from this research.

You may decide to withdraw from this study at any time. If you would like that your answers are removed from this study after you have completed the questionnaire, please contact FIWARE4WATER using the details below.

How will the results be used? The data from this study will be analysed and used for project reports and presentations and in academic publications. Neither your name nor any other personal identifying information will appear in any reports, papers or presentations resulting from this study. Data may be made available to the project partners to assist them in assessing and improving the project – this data will not contain any identifying information.

What will happen to information you provide? 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.

Participation in this research activity is entirely 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 (See Q12 below).

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

Agreement to Participate

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:
• 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.

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.

Participant name (please print):

Date:

Signature:

THE QUESTIONNAIRE

A. The Global Issue of Water

Q1: On a scale of 1 to 5 where 1 is totally unaware and 5 is fully informed to what extent are you aware on global issue of water?

1 2 3 4 5

Q2: On a scale of 1 to 5 where 1 is totally unconcerned and 5 is extremely concerned, to what extent is water an issue of concern to you?

1 2 3 4 5

B. ICT and Water

Q3: Do you receive information concerning water quality in your area?

Y N Sometimes

Q4: Are you aware of water-related technological software (ex.SCADA, IoT, Mobile apps, etc.)being used in your area?

Y N

Q5: Does your water supplier enable you to have an online acount?

Y N Don't know

Q6: Would you like to have better access to on-line water based goods and services?

Y N Don't know

Q7: Would you be prepared to become involved in a Digital Water Discussion Forum (as defined below)?

Y N Don't Know

(Definition: Digital Water Discussion Forum= A network in which citizens can disscuss their opinions regarding water issues at a local and international level).

C. Citizen Satisfaction

Q8: On a scale of 1 to 5 where 1 is totally dissatisfied and 5 is exteremely satisfied, how happy are with the water services provided in your area?

1 2 3 4 5

Q9: On a scale of 1 to 5 where 1 is totally unaware and 5 is exteremely well informed how much do you know about smart applications related with water in your area?

1 2 3 4 5

Q10: On a scale of 1 to 5 where 1 is totally dissatisfied and 5 is exteremely satisfied, how happy are you regarding the fee you pay for water services.

1 2 3 4 5

Q11: Have you ever had the opportunity to participate in a local decision making proccess related to water and/or any other environmental subject, at local or regional level?

Y / N

If Yes, on a scale of 1 to 5 where 1 is totally dissatisfied and 5 is exteremely satisfied how would you describe the experience?

1 2 3 4 5

Q12: Would you be prepared under the guidance of the FIWARE4WATER project to be involved in a citizen-based water policy creation process?

Yes

No

I would need to receive more information before taking a decision

THANK YOU FOR PARTICIPATING IN THIS QUESTIONNAIRE

Please return the completed questionaire to (email of most appropriate person) before September the 21st, 2019.

For other questions related to the FIWARE4WATER project or questionnaire, please contact (email of most appropriate person).

Annex B: The Global Results of the Questionnaire

THE GLOBAL ISSUE OF WATER

Q01	On a scale of 1 to 5, where 1 is totally unaware and 5 is fully informed, to what extent are you aware on the global issue of water?	3.77 / 5
Q02	On a scale of 1 to 5, where 1 is totally unconcerned and 5 is extremely concerned, to what extent is water an issue of concern to you?	4.33 / 5

ICT AND WATER

Q03	Do you receive information concerning water quality in your area?	Y	28	N	42	S	17
Q04	Are you aware of water-related technological software (ex. SCADA, IoT, Mobile Apps, etc.) being used in your area?	Y	30	N	56	DK	1
Q05	Does your water supplier enable you to have an online account?	Y	37	N	15	DK	35
Q06	Would you like to have better access to on-line water based goods and services?	Y	73	N	8	DK	6
Q07	Would you be prepared to become involved in a Digital Water Discussion Forum?	Y	52	N	22	DK	13

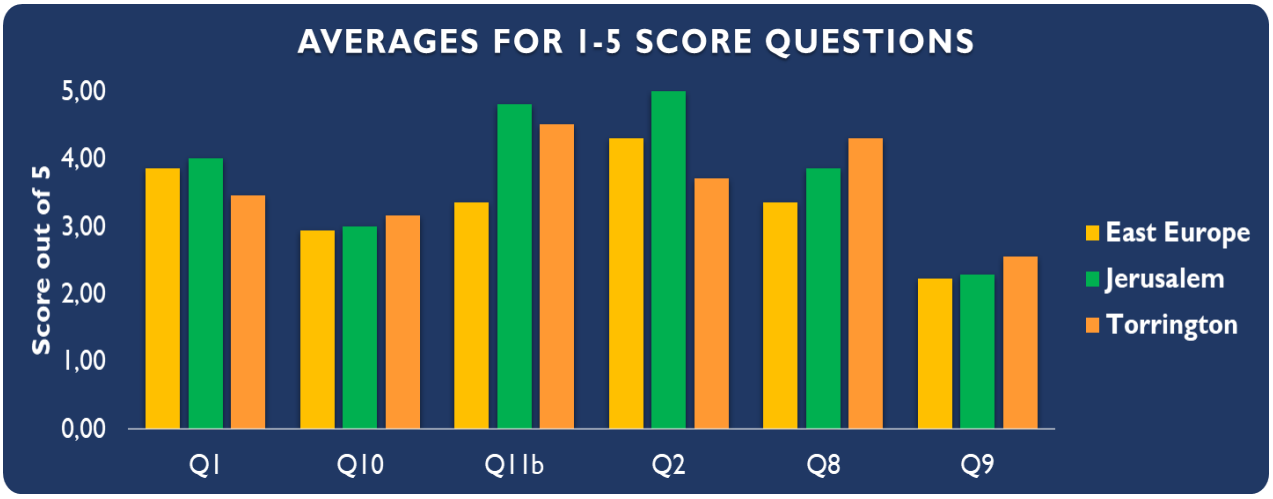
CITIZEN SATISFACTION

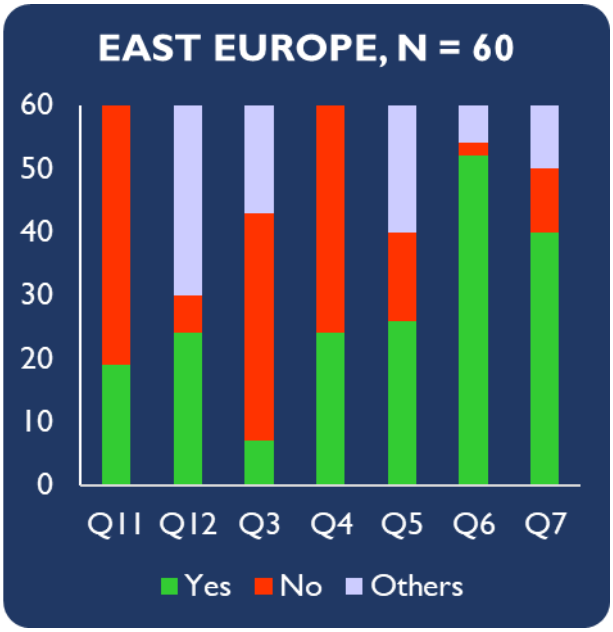
Q08	On a scale of 1 to 5, where 1 is totally dissatisfied and 5 is extremely satisfied, how happy are you with the water services provided in your area?						3.84 / 5
Q09	On a scale of 1 to 5, where 1 is totally unaware and 5 is extremely well informed, how much do you know about smart applications related with water in your area?						2.35 / 5
Q10	On a scale of 1 to 5, where 1 is totally dissatisfied and 5 is extremely satisfied, how happy are you regarding the fee you pay for water services?						3.03 / 5
Q11	Have you ever had the opportunity to participate in a local decision making process related to water and/or any other environmental subject, at local or regional level?	Y	26	N	60	DK	1
Q11b	If Yes, on a scale of 1 to 5, where 1 is totally dissatisfied and 5 is extremely satisfied, how would you describe the experience?						4.22 / 5
Q12	Would you be prepared under the guidance of the FIWARE4WATER project to be involved in a citized-based water policy creation process?	Y	33	N	22	MI	32

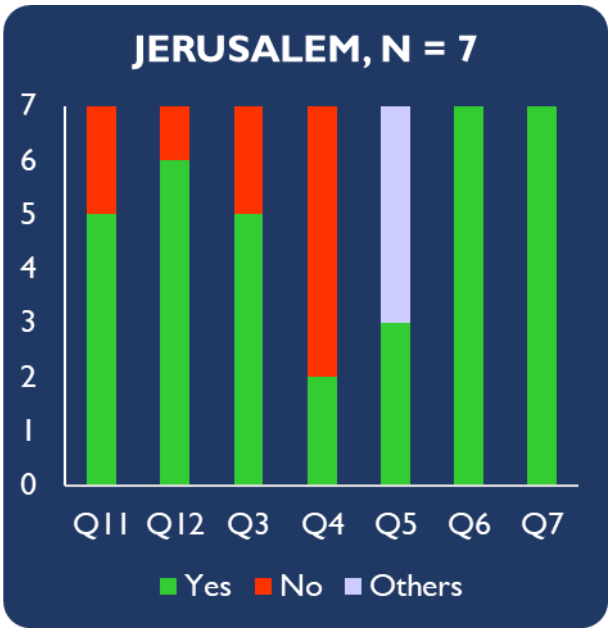
Y: Yes | N: No | S: Sometimes | DK: Does not know | MI: Needs more info

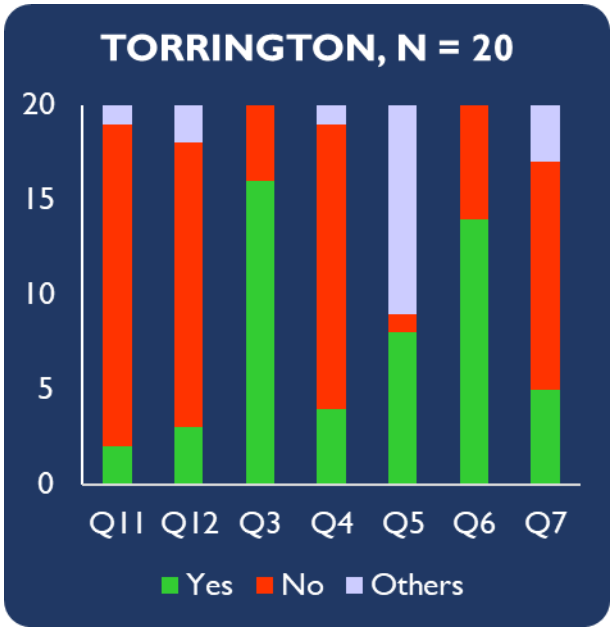
Number of respondents: 87

Annex C: Results of the Questionnaire according to Geographical Location






JERUSALEM, N = 7
7
6
5
4
3
2
1
0
Q11 Q12 Q3 Q4 Q5 Q6 Q7
Yes No Others


TORRINGTON, N = 20
20
15
10
5
0
Q11 Q12 Q3 Q4 Q5 Q6 Q7
Yes No Others