E-proceedings of the 36th IAHR World Congress
28 June – 3 July, 2015, The Hague, the Netherlands

BUSINESS DRIVERS FOR ADOPTING SMART WATER TECHNOLOGY

SANDER SMIT[(1)], MIREIA TUTUSAUS[(2)] , EDWARD CURRY[(3)] , THOMAS MESSERVEY[(4)] & ZENO D'ANDREA[(4)]

[(1)] *BM-Change, Hilvarenbeek, Netherlands, sander@bm-change.nu*

[(2)] *UNESCO-IHE, Delft, Netherlands, m.tutusaus@unesco-ihe.org*

[(3)] *Insight Centre for Data Analytics, National University of Ireland Galway, Galway, Ireland, ed.curry@deri.org*

[(4)] *R2M Solution, Pavia, Italy, thomas.messervey@r2msolution.com, zeno.dandrea@gmail.com*

ABSTRACT

The Waternomics project aims to reduce the water consumption of municipalities, corporations and domestic users by providing water managers and consumers alike with timely and actionable information about water usage and water availability. Understanding the social, economic and environmental drivers for introducing the necessary smart water technologies helps shaping the architecture of a water information system. To get a better understanding of these drivers, Waternomics conducted workshops and interviews with various stakeholders from industry and municipalities in Greece, Italy, Ireland and the Netherlands. The results showed a wide range of ways in which water was managed and water conservation programs where implemented. From the research, the Waternomics water information system will be designed, developed and validated

Keywords: water management, business, ICT

1. INTRODUCTION

Waternomics is an EU funded research project to reduce water consumption of corporate and domestic users by providing water managers and consumers with timely and actionable information about water usage and water availability. Currently the limited information available from the water services ecosystem is not interoperable or not presented effectively to stakeholders. Waternomics overcomes this problem by implementing a new level of smart meter and sensor technology and knowledge/social media based techniques to the water sector. These decision support services are enabled by smart water technology, which (i) enables the detailed and real-time measurement of water flows and usage, (ii) informs analysis of water consumption patterns and (iii) provides key recommendations on how to increase water efficiency in a holistic context that includes governance, standards and local area policies and environmental conditions. Waternomics introduces Demand Response principles and takes a human centric approach that uses novel channels and interfaces including personalised water data, water availability based pricing, gamification of water usage statistics and open business models.

Project results will be validated and demonstrated in three high impact pilots:

1. Domestic: Households in the municipality of Thermi, Greece.
2. Corporate: Operator from Linate Airport in Italy.
3. Municipal: University and public school in Galway, Ireland.

Figure **1** provides an overview of the structure of the Waternomics project.

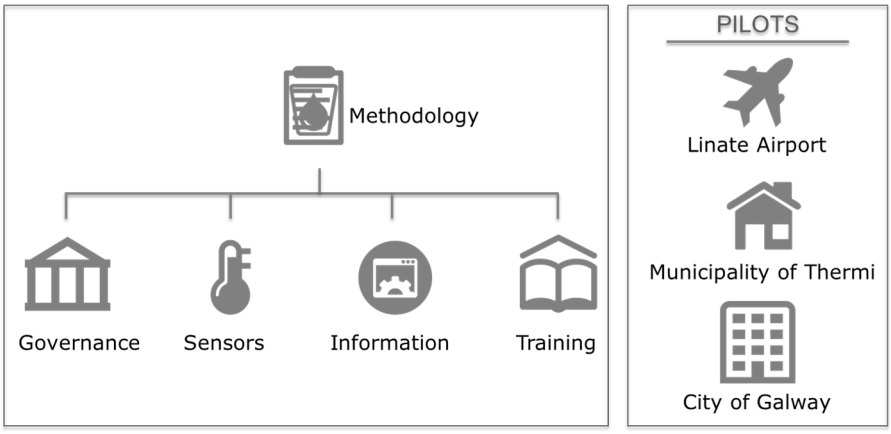

Figure 1 - Structure of Waternomics project

2. METHOD

To gain insight in the motivation and drivers of people and businesses for conserving water and to start a dialogue with future users of water information services, a series of interviews and workshops have been organised in the first phase of the project. First, the information need from the project has been mapped. This resulted in the principal research question: "How can ICT help households, companies and municipalities save water?" From this research question, sub-questions in three areas have been defined, being 'Motivation', 'Business' and 'Infrastructure', covering the areas of interest of the project. This set of questions is used by the interviewers as a checklist during their interviews so that results where easily comparable. A total of twenty representatives from various businesses and water utilities in Ireland, Italy and the Netherlands have been interviewed.

Next to the interviews, two round table sessions have been organised, one at the municipality of Thermi in Greece and a second at Linate airport in Italy. The sessions involved local majors and representatives from public and private water companies and the program involved discussions around the same three themes as defined in the interview checklist.

To identify the factors that determine the adoption of information and communication technology by water utilities, a literature review on the topic of ICT adoption was undertaken. This literature review particularly focused on the cases of California, Singapore and Australia, which were selected due to their limited availability of water resources and experience in reducing water consumption. This literature review was complemented with empirical data obtained from the pilot cases of the WATERNOMICS project. Field research was undertaken during the month of October 2014 at the pilot sites of Linate airport (Milan, Italy) and the water utility of Thermi in Greece. Data collection was done through semi-structured interviews with key informants in the organizations engaged in the project..

3. RESULTS

During the research, a distinction has been made in the drivers for adopting smart water technology and the factors that influence the adoption of smart water technology. The drivers are directly linked to the benefits an organisation expects from taken certain measures. The operational context influences the adoption of smart water technology and impact the strategy for adopting smart water technology.

3.1 Drivers for adopting smart water technology

From the interviews and the literature research, the following categories of drivers for adopting smart water technology was constructed:

1. Cost reduction
2. Competitive advantage
3. Operational efficiency
4. Reduction energy consumption
5. Risk reduction
6. Reputation
7. Sustainability
8. Regulation

Cost reduction: Expected cost reductions can be split in direct cost reductions, caused by reducing the costs for the purchase of drinking water, and indirect costs related to water consumption like water related energy usage or costs for wastewater treatment. In all cases the direct cost savings for the purchase of water was considered minimal and too low to justify investments in smart water technology. Main cause is the low price of drinking water and the monopoly water utilities have on the delivery of water in a specific region. Businesses and households cannot switch form water utility and price competition between utilities is absent. The interviewed owners of small businesses would consider investing in smart water technology when the expected payback time was less than two years. Large enterprises expected to safe on the costs for the disposal of wastewater. The amount of sewage water discharged by households or industries is often not measured but estimated based on the amount of water purchased. Reducing the intake of water or have a more precise measurement of the discharged water can reduce the costs for water purification. In one case it was estimated that the total savings on water sewage was around one hundred thousand euro when the company would switch to measurement based billing for wastewater disposal.
Competitive advantage: For water intensive industries, like the potatoes industry, water is a critical resource. These companies develop their own smart water technology and water efficient machines and equipment, enabling them to produce their end-products with less water and energy than competitors. Water optimisation measures in this specific sector doesn't stop at the organisational border, but water conservation measures are taken together with other businesses in their value chain. This exchange of information and best practises is also seen between non-competitive companies operating in the same geographical region. Especially large companies are increasingly collaborating with nearby companies, exchanging information and sharing best practices on water and energy. In some cases this results in the building of shared facilities, in other cases this is considered too complex because of regulation, real-time measurement of water quantity and quality and distribution and measurement of costs and benefits.
Operational efficiency: In companies where water is not a critical resource, benefits are not in reducing the level of water consumption but in reducing the impact of not having water. All businesses stated that receiving timely information about

leakages or weak points in their water distribution network is very valuable for them. Core business is impacted when water is not available for a longer period of time.
Reduction energy consumption: In the researched businesses, the costs of energy are a multitude of the costs of water. Therefore, energy usage is monitored more closely then water consumption. In combination with sustainability programs and targets for carbon footprint reduction, energy saving measures are being taken. Also the fact that the energy market is more liberalised and switching to another energy provider can significantly reduce costs for energy, contributes to the increased attention on energy usage. Apart from the water utilities, none of the interviewed businesses monitored how much of their energy consumption was related to the distribution and usage of water in their organisation.
Risk reduction: Research shows that awareness amongst companies is growing when it comes to water related business risks. Access to water, quality of water, pricing, drought, changes in regulation or social acceptance all impact direct operations or the supply chain. While the awareness amongst businesses is increasing, research amongst industries worldwide show that water stewardship activities are lacking.
Reputation: Behavioural economists argue that customers are not as much in control of their decisions as generally thought. Many factors subconsciously influence the choices they make. While people generally express a strong inclination and motivation to act in a manner that fosters sustainability, it's usually not a predictor of sustainable behaviour. People tend to conform to social norms. When sustainability is the social norm, people expect organisations to conform to this new norm as well. Organisations need to act according to the social norms of their customer base. In our research creating a sustainable reputation was not mentioned as a driver for adopting smart water technology. Maintaining or creating an innovative reputation was for some public water utilities a reason to start smart meter programs or deploy other smart water technologies.
Sustainability: Most large businesses have a sustainability program covering a wide range of topics often on the "People-Planet-Profit" three pillar principle. Water is part of the pillar "Planet", in some programs also referred to as "Environment", covering environmental performance of organisations. Like the "Sustainable in a Generation"-program from MARS, the sustainability programs aim at minimising impact of on the environment and resources. The interviewed small business owners lack a formal sustainability program but take water conservation measures in an ad-hoc way, often based on available technologies at the time reconstruction work is scheduled.
Regulation: When national or international regulation required specific measures like measuring of water intake and outflow, organisations deployed technology to remain compliant. In only very few cases, smart water technologies like remote sensors or smart meters, where selected for this purpose.

From the research, achieving cost reduction, sustainable operations and energy reduction where the drivers most mentioned by businesses and water utilities for starting technology driven water conservation programs.

3.2 Factors influencing the adoption of smart water technology

Three interrelated clusters of factors that influence the adoption of smart water technology by water utilities and industries have been identified: environmental factors, organisational structure and characteristics, and individual factors. The environmental factors cluster contains all factors that are of an influence to what (ICT) technology is adopted but that remain external to the management and functioning of the (water) organization. Typical factors in this cluster are the market or industry, regulation, user demand or social trends and bio-physical conditions (ie. water availability). In the organizational structure clusters factors are included that manifest themselves at the scale of the organization and that characterize the operations of any given (water) corporation. For the water sector elements like corporate culture, budgetary dependency, shareholders ownership or maturity play an important role. Finally, individual factors play an important role in the adoption of information and communication technology. These individual factors are strongly related to the factors described in the organizational structure cluster.

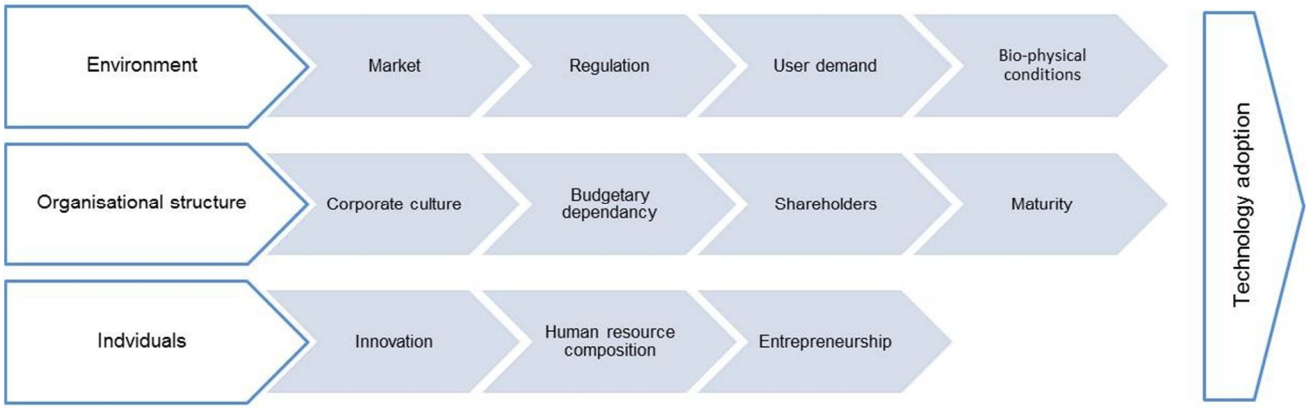

Figure 2 – Contextual framework for the adoption of smart water technology

Environment: Regional differences in availability of water has a significant effect on the attitude of organisations towards water conservation programs and smart water technology. For example, in the Netherlands motivation for starting water conservation program is driven by reducing energy usage or lowering carbon footprint or for sustainability reasons. Water usage and management has a low priority compared to energy because water is available in sufficient quantities, with

good quality and at a low price. Next to that, the fact that one cannot switch from water utility does result in a lower interest in investigating water reduction programs. Only in industries that heavily rely on water and use water in large volumes, water is managed as a critical resource. The increasing block tariff is not an incentive for small businesses to reduce water consumption. In order to get to a lower tariff, small businesses have to make unrealistic savings on water consumption.
A totally different situation occurs in Ireland where new regulation requires the installation of a smart meter network. In Greece, where water utilities have faced droughts and water shortages for decades, the willingness to adopt smart water technology is high. Greece water utilities have a sense of urgency that is lacking in the Netherlands or Ireland. Just like in Italy, lack of access to capital is what prevents them from investing in new technology. Price regulation in Italy result in decreasing room for capital investments. One Italian public water utility stated that in the last ten years the price of energy has doubled, increasing operational costs, where the tariffs for water cannot increase because of legislation.

Organisational structure: Owners of organizations involved in the management of water have an important role to play in setting the strategic directions for the organization. Different types of owners are likely to have a different prioritization of organizational objectives, and thus may require different technologies. In the Netherlands, for example, the ownership of water utilities lies with municipalities and provinces. These government entities want to ensure that the water utilities not only provide water services to users but also insist that this happens in an environmentally sustainable manner. As a result many Dutch water utilities not only supply water services but also invest heavily in the conservation of the natural areas where they abstract their water resources. This has consequences for the technology used by the water utilities. In Italy, the major shareholder of SEA is the municipality of Milan, which also influences the prioritization of objectives of Linate airport. A purely privately-owned company, on the other hand, may prioritize more business-oriented objectives and will develop business processes which reflect this.

Individuals: Apart from factors relating to the external environment and the organization, also the decisions of individuals within the organization play an important role in determining the adoption of ICT. Although organizational factors provide boundary conditions for an individual's room for manoeuvring, intrapreneurship can influence decisions regarding what technologically is used. Individual managers may be more adventurous or inclined to take considerable risk, or more conservative and risk-aversive. Another factor mentioned in interviews was the skill set of the staff in an organisation. In non-technical organisations, the ICT knowledge level was low, creating a barrier for adopting smart water technology.

4. DISCUSSION

The ambition level of Waternomics is very high considering the projects plans to develop a single technology platform for smart water services. As the research shows, there is a large variation in drivers and motives for adopting this technology and also the operational context in which such a platform should perform ,varies widely. However, from a conceptual point of view the implementation of a smart water system is very similar in the different environments. At the lowest level a sensor network is required, measuring flows and pressure. The data from this sensor network is linked with data from external sources and transformed in information that can be feed back to the users via various applications. This results in a four- layer conceptual model, sensor-data-information-application. The to what extend this layered concept is generic and which part is implementation specific. And second, what is the impact of the different drivers and motives for adopting smart water technology on a water information system and the organisation implementing such a system.

4.1 Information and channels

The different drivers for adopting smart water technology result in different information needs from the various customer segments. In a cost-driven organisation, there will be a need for information about actual costs and achieved cost reductions with respect to water usage. This implies linkage of water consumption information with actual water and energy prices. In the case of a sustainability driven water conservation program, management will be more interested in information about their carbon footprint and absolute water consumption or water consumption per production unit. This requires linkage of information about carbon dioxide emissions with water consumption information, conceivably from different businesses in a single value chain. Also within organisations different types of users of water information have different needs for the kind of information, the granularity of the information and the ways water related information can be accessed. Where operations needs real-time alerts upon disturbances in their water network, e.g. leakages or overflows, management might require only weekly or monthly status updates about average water consumption and related energy consumption. And where maintenance staff requires access to water information on remote locations, possibly with low internet connectivity, households might want their water usage information presented on in-home displays. Differences in user's expert level impact the requirements on design and usability of the water information system. Many differences in information need, user characteristics and operational context can be resolved at the application level of a water information system. To ensure interoperability between various applications and water information systems, data and information should follow broad accepted communication standards.

4.2 Platform or products

Waternomics targets at a wide range of users, from households to small businesses and large enterprises to water utilities. It is unlikely that a single technology platform can serve all customer needs and be deployed in all operational environments. Instead, the focus should be in developing a modular, scalable and interoperable platform that can be split up or supports products and services where each product should in itself be an attractive enough proposition for the

customer. The expected benefits of deploying a smart water platform might be high for a large organisation, the accompanying costs can also be significant. Especially smaller business and households do not have the resources to purchase a complete water information system. To be able to address the needs of these smaller users, a smart water platform should be split up in several independent products or services, each being part of a strong enough value proposition to justify its purchase. The value added is in the combination of multiple products and services, gradually building a distributed smart water platform. For example a small business might initially purchase a real-time water monitoring system, consisting of only one smart meter, which alerts on abnormalities in the water consumption pattern. In a later stage a water re-use system might be installed, reducing the costs for water in-take from a water utility. Connected with an energy management system and weather information, this combined system might decide when it is best to fill a water reservoir with drinking water or with harvested rainwater. On a larger scale, the water information system of a single company could in combination with the water information from supply side partners provide information to support decisions on the optimal measures for water conservation in a given value chain.

4.3 Business Model

Understanding the drivers and implications of adopting smart water technologies on an organisations business model, guides the definition of technology selection criteria, implementation strategy and build or buy decisions for a Water Information Platform. Following the definition of the nine building blocks of a business model as defined by Osterwalder, the possible impact of implementing a Water Information Platform on the individual components of a business model is considered.

New value propositions. Smart water technology enables new value propositions, not possible today because of lack of (near) real time water consumption and water network status information. Examples of new value propositions are personalised water recommendation services for households and corporate users, outsourced water management services for industries or integrated water and energy management services for industries and households.
Increased customer intimacy. Availability of water usage information and increase the number of customer touch points and create an opportunity for water utilities to increase their customer relationships. Instead of estimated billing, customers can be charged based on real usage and with higher frequencies. Customer support can advise customers on their water consumption and alert customers when deviations in usage pattern is detected. By having a stronger customer relationship, it will be easier for utilities to get support for water conservation programs or to involve customers in the development of new water conservation initiatives
Service bundling. Water management or information services can be bundled with energy management or information services to benefit from sharing infrastructure and resources. Water services can even be bundled with other commodity services like telecom or internet services. All these industries have usage based revenue systems, and similar billing and customer support systems which could be managed more efficiently when combined for multiple utilities or service providers.
New revenue streams. With the collecting of more detailed and near real-time information about water availability, water usage and water related energy usage, new, more flexible pricing options become available. Water prices can be based on actual consumption in specific timeframes. Another area where new revenue streams for water utilities, technology providers or consultants are enabled is in the delivery of value added services based on the information technology required and data and information becoming available. Many water utilities and companies don't have the expertise to set-up and operate a water information system. Companies who do have that experience can offer training, consultancy, project management, strategic management or data analysis services.
Delivery channels. Implementing a water information system in an existing organisation can be a complex and challenging operation. One way to deliver such systems or services is by making use of experts or specialist services. This can be a water utility, delivering a water management system to a corporate customer, a technology provider installing a specific piece of technology in the water distribution network of the water utility or an expert consultant, delivering a water information system to a water utility or corporate user. In case of delivering Waternomics enabled product or service through an expert channel, the Waternomics proposition should also be attractive for the expert or consultant.
Key resources: The water distribution network will be expanded with the Water Information Platform, connecting the various data sources and creating information services. Investments need to made in smart meters, smart pipes, embedded sensors and valves enabling a more fine-grained monitoring of the water distribution network. The water distribution network can be managed more efficiently through the detailed status information. Leakages and other abnormalities are detected in an earlier stage while lowering the energy usage of the water distribution network. Staff with IT skills is required to operate and maintain the Water Information Platform. Depending on the size and the scope of the organisation, these activities will be performed in-house or outsourced to an external information provider.

4.4 Corporate strategy

For business drivers an organization can control, a consideration of competitive advantage is appropriate which typically drives differentiation strategy development. In the "Manuale di economia aziendale " (Airoldi, Brunetti, Coda) the authors outline three different strategies that a company can adopt depending on what competitive advantage it wants to invest in. These theories are derived from the work done by M. E. Porter on companies' competitive advantages. A firm's relative position within its industry determines whether a firm's profitability is above or below the industry average. The fundamental basis of above average profitability in the long run is sustainable competitive advantage. There are two basic types of competitive advantage a firm can possess: low cost or differentiation. The two basic types of competitive advantage combined with the scope of activities for which a firm seeks to achieve them, lead to three generic strategies

for achieving above average performance in an industry: cost leadership, differentiation, and focus. The focus strategy has two variants, cost focus and differentiation focus.

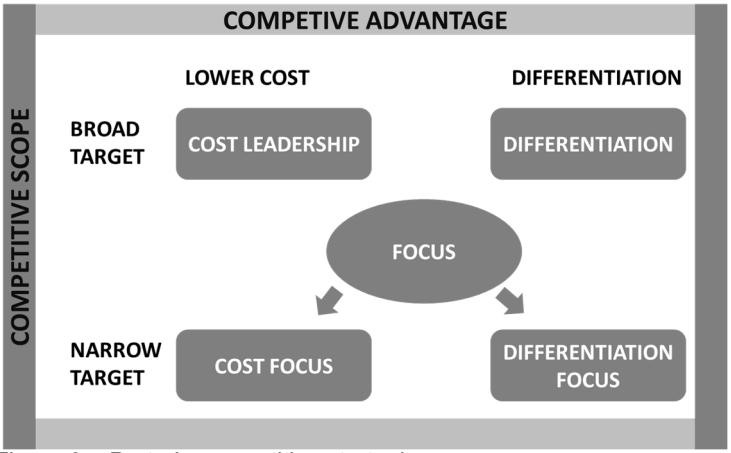

Figure 3 – Porter's competitive strategies

These four possible competitive strategies are briefly defined as:

- **Cost leadership**: the vital element of the company is the capacity to reduce its costs so as to be the overall low-cost provider of a product or service. A low cost producer must find and exploit all sources of cost advantage.
- **Differentiation strategy**: in a differentiation strategy a firm seeks to be unique in its industry along some dimensions that are widely valued by buyers. It selects one or more attributes that many buyers in an industry perceive as important, and uniquely positions itself to meet those needs. It is rewarded for its uniqueness with a premium price. Today two important drivers of differentiation are public opinion and compliance with Corporate Social Responsibility rules.
- **Cost focus**: The generic strategy of focus rests on the choice of a narrow competitive scope within an industry. The focuser selects a segment or group of segments in the industry and tailors its strategy to serving them to the exclusion of others. In cost focus a firm seeks a cost advantage in its target segment.
- **Differentiation focus**: differentiation focus exploits the special needs of buyers in certain segments

Applied to WATERNOMICS, the objectives and project foreground may contribute in the following way to the four competitive strategies.

Cost Leadership: In a recent article the Economist Intelligence Unit wrote about how reducing the consumption of resources, like water and raw materials, has become a key business driver to control costs. Many researchers agree and say that this trend is especially important in Europe, where resources have never been abundant. A water information system can help this positive trend develop, especially .

- The constant monitoring of water usage helps a company to better organize and manage its water consumption so reducing the amount wasted. This represents an important reduction of costs.
- Monitoring helps to find leakages in an early stage when costs for repair are still relatively low. The consequence of this is that there will be a reduction of the amount of wasted water and an important saving on maintenance costs. As an example we quote Caroline van den Berg of the World Bank: "In the municipal sector, water productivity is less than optimal as the difference between water put into the distribution system and the amount of water billed to consumers (i.e., "non-revenue water") tends to be large. Kingdom et al. (2008) mention that the total cost to water utilities caused by NRW worldwide can be conservatively estimated at $141 billion per year."
- The possibility to collect data about water usage can help create awareness among employees and eliminate water wasteful practices which represent a great part of the costs tied to wasted resources. The Economist article quoted above states that in certain companies a change in employee practices, like turning computers off when they are not needed anymore, can bring to a 75% reduction in energy consumption

Differentiation strategy: Climate change must also be taken into account. Many researches concur on the fact that changing climate conditions will increase the variability of water supplies with the effect that traditional water sources will become less reliably available. At the same time, climate extremes are likely to increase which may increase the likelihood of water related disasters reflected in more frequent floods and droughts (example: drought in the USA). Climate change has become an international issue. More stringent environmental regulation is starting to be adopted in many countries. Coupled with this, much attention is starting to be given to what resources a company uses and how it manages them. Sustainability has become a key issue for consumers and, also thanks to consumer-organizations (ex. Ethical Consumer),

a great influence can be exerted on a company which is deemed to have a negative behavior (ex: boycott of Nike and Nèstlè, or E10 fuel in Germany) .

Today a company must demonstrate that it is serious about tackling the issues that consumers are passionate about if it wants to stick out from the others and created a loyal clientele. Smart water systems can help reduce a company's footprint making it more environmentally sustainable.

- The more competitive the market sector is the stronger the incentive to adopt new technology if this allows the company to distinguish itself from its competitors. The fewer the firms on the market the less value is given to this technology.
- Smart water technology helps to reduce the amount of water used by companies thanks to a more rational use of this resource and the prompt identification of leaks. This makes the economic activities more sustainable and creates a better image for the company. A more sustainable firm can attract new customers and can increase the loyalty of the current ones.
- The adoption of an advanced water management system shows a strong commitment to the Corporate Social Responsibility (CSR) principle of sustainability. Another incentive to adopt CSR are the specific CSR programmes and awards, for instance the European CSR Awards, that can give the firm a greater notoriety. This can better the image of the firm in the eyes of clients, other firms and public institutions. John L. Campbell (professor at Dartmouth College) has proven, using the work done by Waddock and Graves (1997), that corporate financial performance increases with an increase in investments in CSR. Even on the website of the EU Commission one can read: "CSR refers to companies taking responsibility for their impact on society. As evidence suggests, CSR is increasingly important to the competitiveness of enterprises. It can bring benefits in terms of risk management, cost savings, access to capital, customer relationships, human resource management, and innovation capacity"

Focus: All the reasons listed above show how smart water technology can be applied in a focus competitive strategy depending on which kind of focusing a company want to do. A rational organization and management of inputs is essential if a company wants to focus on reducing its costs. A company which wants to be different from the others must identify which are the main concerns of its customers and then show that it is committed to tackling them. Sustainability has become an essential issue worldwide. A company that wants be considered completely different from the others has to make investments in sustainable processes to show customers that their product doesn't negatively impact the planet.

5. CONCLUSION AND RECOMMENDATIONS

Waternomics target a broad range of customers, from households to corporate users and water utilities. Customer needs vary widely between these customer segments. From the research it is seen that most mentioned drivers for adopting smart water technology in all segments are: cost reduction, sustainability and energy reduction. Each of these drivers result in different requirements with respect to water related information presented, granularity of the presented information and feedback channels/devices. To overcome these differences the technical architecture of the water information system should be designed in a modular way, be designed as a distributed system and support standards from the water and communication domain to ensure interoperability between various system components. Furthermore, to maximise customer adaptation of smart water technology, each component of the water information system should in itself generate enough customer value to justify purchase by the end-user. Apart from the business drivers, operational context needs to be taken into account when designing a water information system. Again, environments vary widely between the different customer segments. From low-tech low-budget organisations to organisations who already have real-time water network monitoring systems in place and collaborate with supply side businesses in their value chain. To be able to serve both kind of organisations, a water information system should be designed in such a way that it is modular, scalable, compatible with legacy systems and supports single installations at small businesses as well as multi-organisation . The use of communication standards between the various system components is also here a pre-requisite for a scalable information system. Finally, for a successful introduction of a water information system, the impact on the business model of the involved organisation(s) should be considered. Having information about one's detailed water consumption and losses gives the opportunity to share this information with stakeholders and start a dialogue, strengthen customer engagement and improving one's image.

ACKNOWLEDGMENTS

The research leading to these results has received funding under the European Commission's Seventh Framework Programme from ICT grant agreement WATERNOMICS no. 619660.

REFERENCES

Airoldi, Brunetti, Coda (2005) Manuale di Economia aziendale, Il Mulino

CDP (2013), A need for a step change in water risk management, CDP Global Water Report 2013

Curry, E., Degeler, V., Clifford, E., Coakley, D., Costa, A., Van Andel, S.-J., Van De Giesen, N., Kouroupetroglou, C., Messervey, T., Mink, J., and Smit, S. (2014). "Linked Water Data For Water Information Management," in 11th International Conference on Hydroinformatics (HIC 2014), New York, New York, USA.

Clifford, E., Coakley, D., Curry, E., Degeler, V., Costa, A., Messervey, T., Andel, S.-J. Van, Giesen, N. Van de, Kouroupetroglou, C., Mink, J., and Smit, S. (2014). "Interactive Water Services: The Waternomics Approach," in 16th International Conference Water Distribution Systems Analysis (WSDA 2014),

Defra (2008), A framework for pro-environmental behaviours, Department for Environment, Food and Rural Affairs January

The Economist (2015) Making Energy Efficiency Big Business, http://www.economistinsights.com/sites/default/files/presentations/EIU%20article%20-%20Making%20energy%20efficiency%20big%20business.pdf

European Environmental Agency (EEA) (2014). Performance of water utilities beyond compliance: Sharing knowledge bases to support environmental and resource-efficiency policies and technical improvements. EEA Technical Report No. 5/2014

Frontier Economics (2011), Review of Assessment Papers: Business Models (topic 6): A Report prepared for the National Water Commission, Frontier Economics Pty. Ltd. Australia

Hall D. Lobina E. (2012) Water companies and trends in Europe 2012, Public Services International Research Unit, the University of Greenwich

ITU (2010). ICT as an enabler for smart water management

Osterwalder A. (2010), Business Model Generation, self-published ISBN: 978-2-8399-0580-0

Porter, Michael E. (1985), "Competitive Advantage" The Free Press. New York.

Sensus (2012),Water 20/20: Brining Smart Water Networks into Focus.

University of Cambridge (2015), website: http://www.ifm.eng.cam.ac.uk/research/dstools/porters-generic-competitive-strategies/