*Article*

# Design Thinking for Urban Water Sustainability in Huelva's Households: Needfinding and Synthesis through Statistic Clustering

**Gustavo Bermejo-Martín[1], Carlos Rodríguez-Monroy[1*] and Yilsy M. Núñez-Guerrero[1]**

[1]    **Department of Industrial Organization, Business Administration and Statistics, E.T.S. Ingenieros Industriales, Universidad Politécnica de Madrid (UPM);**
gustavo.bermejo.martin@gmail.com (G.B.-M.); carlos.rodriguez@upm.es (C.R.-M.);

ym.nunez@upm.es (Y.N.-G)

*    Correspondence: carlos.rodriguez@upm.es;

**Abstract:** This article shows the numerical results and the analysis of households' degree of knowledge in an intermediary city such as Huelva (Andalusia, Spain) about the sustainable use of urban water. It analyzes the needs and values regarding water and the attitudes that households maintain regarding the acceptance of reclaimed water and the use of new technologies to achieve more efficient and sustainable consumption. These results are part of the stages of needfinding and synthesis of Design Thinking methodology, adopted as a framework to improve the efficiency and sustainability of urban water among households in this city. Different statistical analysis techniques of surveys sent to households and the use of clustering are the mathematical tools used to draw conclusions and recommendations that allow the design of a web-based prototype grounded on Product Service Systems methodology, as a tool to improve the engagement of households concerning water and align citizens with the sustainability of their city. Strategies of customization and technological facilitators will be the means to improve the hydrosocial contract among households in Huelva in future later stages of the project.

## 1. Introduction

This article describes the state of departure on the degree of household knowledge about the sustainable use of urban water, identification of their needs and values as consumers, and the attitudes regarding different aspects of water that households in an intermediary city such as Huelva (Andalusia, Spain) have. For this purpose, surveys with questions to measure the above factors have been used, and their subsequent statistical analysis has been performed. This study is necessary to cover the stages of needfinding and synthesis of Design Thinking (DT) methodology as a framework to face the challenge of improving the efficient and sustainable use of water resources in Huelva's households. It is part of the project that "focuses on understanding, within the water cycle, what are the factors, elements, and data that generate the greatest impact and understanding of the challenges faced in terms of water resource management, thus being able to generate a reflection of households towards a cultural change regarding their use and valorization" [1].

This paper considers the central role of citizens in designing solutions for sustainable development of cities relating to water, expressing itself through private behavior using water in households. Previously, we analyzed how water was taken into account for integrated sustainable urban development and citizens' needs, from the different public administrations, through the approved Integrated Sustainable Urban Development Strategy (ISUDS) plans in the Andalusian region [2]. The citizens are one of the main stakeholders in the elaboration of the ISUDS. "In a way, these plans are expressions of citizens' public behavior concerning water, their values, and their needs" [1]. The focus of these two analyses would give us a picture of the common patterns and coherences between the two spheres of the citizen, public, and private [3]. Private behavior would measure citizens' social needs [4], focusing on real habits of comfort and cleanliness [5].

To carry out such research, it would be necessary to involve Huelva's water company, which is the service utility that interacts with citizens. This is the case of Aguas de Huelva company, where 51% belongs to the Huelva city council, and 49% belongs to the Suez group [6]. "Urban water services, the direct public responsibility of each city council, in most Spanish cities are carried out through a water utility that is either entirely private through commissioning or mixed public-private ownership" [1]. For this project, we have used different Information and Communication Technologies (ICT) as a measuring tool and means of education on the efficient use of water in households. These are facilitators to begin a transition where water and ICT will have a central role in the city's sustainability.

To get citizen participation, we use DT, a human-centered methodology that allows creating a framework to support actions and relationships between the water utility and households. There are some examples using DT methodology to get engagement, i.e., the case of the Austrian gas company Redgas, a subsidiary of Linz AG [7]. They followed the recommendations of Meyer and Tucker [8] to better understand customer needs and behavior. In addition, it was a key issue to improve the trust in the water company, through the "service brand" [9]. To support the educational activities carried out in other successful projects [10], trust, together with the improvement of the sustainability challenge's understanding are critical factors. "Therefore, it seems clear that actions must be brought into play that improve the perception of the service brand by households to increase household trust in the proposed future actions" [1].

There are a myriad of DT methodologies [11]. We have used the six stages defined in the Stanford ME310 model [12]. For the goals of this paper we will focus on:

1.	Needfinding: the interviewing method has been used. This is the first in the ranking of [11]. "We conducted in-depth interviews with different specialists from the company Aguas de Huelva who gave us the vision of the utility: the director of innovation and social responsibility, the commercial director, and the general manager" [1]. With this feedback, we elaborated a 28-questions survey for households to know their needs, values, knowledge of the integral water cycle, and water use in the home. We sent surveys to households that agreed to participate in the experiments.

2.	Synthesis: the clustering method was chosen, first in the ranking of [11]. Using the statistical analysis of the survey responses, we have tried to obtain different household profiles in the way of those obtained in [3], which allows us to do a sustainable solution customized to each profile.
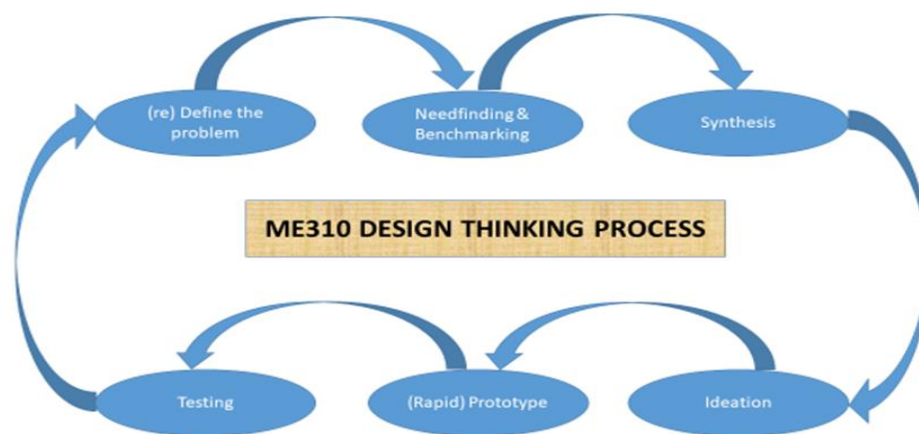
**Figure 1**. Stanford ME310 model. Adapted from [12].

Huelva is an intermediary city (between 50,000 and one million inhabitants) in Andalucía (Spain) with four main urban challenges that affect water: demographic stagnation, social diversity, climate change, and unstable and unpredictable water social needs [13]. They present a high social diversity, which will demand management strategies with very different approaches for their efficiency, according to Dean et al. [3].

On the other hand, to avoid young people leaving the city, they need to generate sustainable growth. We take the anthropocentric approach to sustainable development [14] linking it with the concept of "habitability" (or "liveability"), which, although as diffuse as the previous concept, could be defined according to Veenhoven [15] as "reflection of the quality of life, welfare, and satisfaction of the needs of the individual/citizen." Both concepts are, therefore, correlated. Habitability is closest to the needs of the present moment, and therefore, more easily identifiable by the citizen and more likely to find a response from management and public policy with more tangible and immediate benefits. Sustainable development is linked to possible future needs, more uncertain, and difficult to define and make tangible.

The satisfaction of the needs of society and the citizen improves habitability, but this does not imply that this situation is healthy for society, the city, or the ecosystems that are part of its context (de Haan et al. [13]). A city with a high degree of habitability is not necessarily sustainable. In addition to a correlation between both concepts, there is also a tension between what both represent in their practice patterns. A way to delimit the influence of these two concepts is the citizen's behavior towards more efficient use of water. A mechanism to lead the transition towards a new model of relationship with water, translated into what is called a "new hydrosocial contract" [16].

"The hydrosocial contract is understood as the values and, often, implicit agreements between communities, governments, and businesses on how water can be used. This hydrosocial contract will reflect citizens' practice and behavior in water use within the city and the needs and mechanisms used to satisfy them" [1].

The citizens' needs are embedded in a specific city context, where the citizens try to satisfy them through the water company services. Depending on the needs covered by the services already deployed and on the existing hydrosocial contract and the relationship between habitability [15] and sustainability [17], some strategies could be implemented to achieve the citizens' engagement.

The hydrosocial contract is expressed on how the environment is organized (de Haan et al. [13]). For the physical environment, technology is required, and the resulting organization is the infrastructure on which the services are provided. The social organization is made through rules, habits, and routines, and its resulting institutions. In the systems of society there is a combination of institutions and infrastructures within the city, which defines their degree of intelligence. In the case of urban water, in addition to the gray infrastructure itself (classical water engineering), natural infrastructures (rivers, lakes) and green infrastructures (wetlands) are included. In these infrastructures, water services are provided in the cities.

However, water services in most cities only meet a selection of identified urban water needs. De Haan et al. [13] classify these needs based on the ERG (Existence, Relatedness, Growth) theory of Alderfer [4]:

1. Existence: material and psychological desires. Food, shelter, working conditions, payment. Resources, products and services. Public needs for health, safety, and property protection.

2. Relational: relations with society and the physical environment.

3. Growth: productive and creative effects on the individual himself and the environment. Needs of society regarding identity, social justice and intergenerational equity.

By way of summary, taken from de Haan et al. [13], the following table shows the citizens' main urban water needs:

**Table 1:** Social needs of urban water. Adapted from de Haan *et al.* [13]

|  | SOCIETAL NEED | SOCIETAL URBAN WATER NEED |
|---|---|---|
| EXISTENCE | Sustenance & livelihood | Potable water |
|  | Shelter | Non-potable water |
|  |  | Flood protection |
|  | Safety | Flood protection |
|  | Health | Sanitation |
|  |  | Water-supported thermal protection |
| RELATEDNESS | Interaction & social cohesion | Water-supported public spaces |
|  |  | Water-supported productivity |
|  | Ecological health | Healthy ecosystems |
|  | Knowledge & beliefs | Water literacy |
|  |  | Water system knowledge |
|  | Beauty & pleasure | Enjoyment of water |
|  |  | Aesthetic urban environment |
|  | Comfort & convenience | Accessible water services |
|  |  | Water-based mobility |
|  |  | Water-supported thermal comfort |
| GROWTH | Culture & identity | Water-based culture & identity |
|  | Equity & justice | Equitable access to water services |
|  | Purpose & expression | The pursuit of purpose & expression through water |
|  | Influence & respect | Meaningful influence on and contribution to water servicing |
|  | Freedom & autonomy | Water independence |
|  |  | Water choice and liberty |
|  |  | Open water dialogue |

Based on the theory of "Educational Psychology", Dean *et al.* [3] propose a methodological framework developed in the socio-cultural context, which elaborates three pillars of the citizens' commitment to the water of their city:

1. Understand water and its context. That is, the knowledge possessed about water.
2. Value water through emotions and the development of positive attitudes, such as:
   a. Support for alternative sources of water.
   b. Pro-environmental attitude: "environmental identity of the home".
3. Support the most intelligent daily behavior regarding water in different spheres
   a. Public:
      i. Through the influence on political processes.
      ii. Support and pressure to repair damaged waterways.
   b. Private:
      i. By saving and using water efficiently.
      ii. Use of water-saving devices.
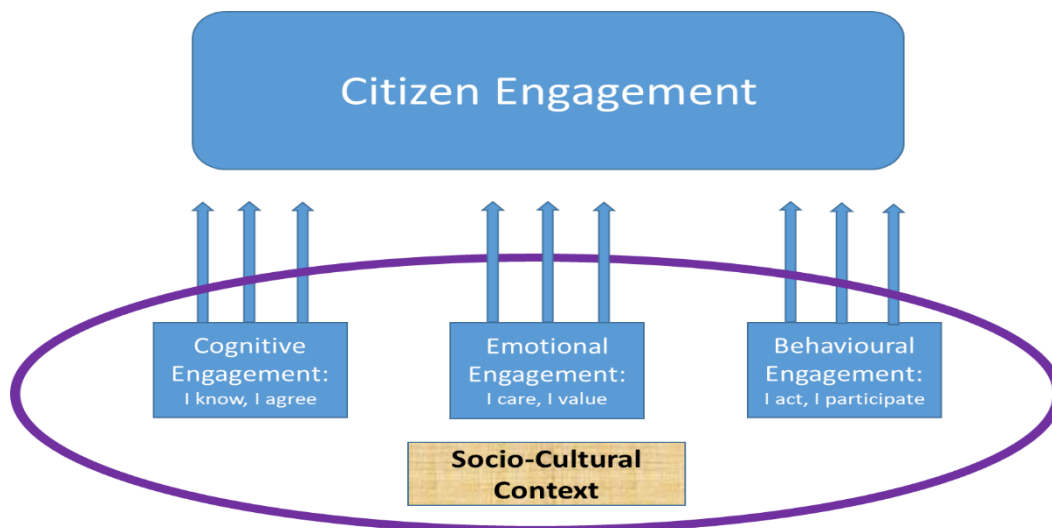      iii. Reduce water pollution.



**Figure 2.** Methodological framework to evaluate the commitment regarding water. Adapted from Dean *et al.* [3]

For this article's purposes, only the private sphere of citizens' behavior will be considered a research proposal. This daily behavior has a direct relationship with the habit created in the daily use of water in homes to meet the aforementioned needs. Habit, according to Bourdieu, P. [18], occurs in a social context and according to an accumulated capital of knowledge and material wealth of households. Bourdieu's idea connects with the methodological framework of "educational psychology," which, through the pillars of knowledge and valorization, seeks to change this habit. This is not immutable and less in current societies where changes are continually occurring, but the habit does have an internal limit in its original structure within contours of continuity that allow it to vary up to certain limits. Therefore, it is necessary to determine strategies, methods, and technological tools to change habits or bring current dominant habits to their own limits. In addition, as part of that accumulated capital of households, there are the domestic technologies and the devices with which they interact to meet their needs. These strategies and methods can be enhanced through technology, which, when used well, will act as a tool for empowerment and increase the commitment of citizens to the use of resources, in our case, water.

This habit guides the behaviors of comfort and hygiene, which are those that consume more water in homes. Depending on the study, the figures vary slightly from one to the other, but we can take the data from Knoeri [19], which indicates that in the United Kingdom, the water used inside households

goes mostly to hygiene services, where 33% of the water is for personal hygiene (bathrooms, showers, hand-cleaning), 30% for flushing the toilet, and 13% for washing clothes. That is, the habit of consumption that is part of households' domestic daily lives has a very high impact on the water resource.

Besides, according to Strengers [5], an increase in comfort and hygiene expectations is occurring in the western world. This increase stresses the balance between habitability and sustainability, between real or perceived need and resources needed to satisfy it, and will condition the citizen's real commitment. Managing the citizens' expectations and daily behavior regarding water is part of the water demand management strategies, which should be personalised to each type of household.

## 2. Materials and Methods

The article presents a statistical analysis of the knowledge of water integral cycle, most water value aspects, uses, and water needs and water technological solution attitudes of households in Huelva. It is the first step to build methods and a strategy proposal of getting household engagement about urban water efficiency use through DT framework. This could ease combining two elements: water demand management actions and facilitating technologies.

The Suez group through the UP4 Solutions program, in collaboration with the UP4 technological universities alliance (Universitat Politècnica de Catalunya, Universidad Politécnica de Madrid (UPM), Universitat Politècnica de València, Universidad Politécnica de Cartagena) [20] defined a challenge to get a more efficient and sustainable use of water in homes.

"The main objective of the challenge is to promote the efficient and sustainable use of water resources based on information, communication, and awareness of citizens. The project focuses on understanding, within the water cycle, what are the factors, elements, and data that generate the greatest impact and understanding of the challenges faced in terms of water resource management, thus being able to generate a reflection of households towards a cultural change regarding their use and valorization" [1]. Specific goals have been defined:

1. Evaluate the degree of knowledge of consumers about the challenges associated with the sustainable use of water.
2. Identification of their needs and values as consumers.
3. Evaluate attitudes towards different aspects of water:
   a. Attitude towards consumption efficiency.
   b. Attitude towards the adoption of technological devices in the home related to water.
   c. Attitude towards reclaimed water in the home.
4. Determine and prototype solutions that help raise awareness and value water use sustainability, proposing specific actions to consumers that address part of their needs at the same time.

"This should help to directly relate the day-to-day behavior of Huelva's households with the sustainability of comprehensive water management. In this way, it is intended to promote a change in consumer behavior, which, together with the efforts of the managers of the urban water cycle (Aguas de Huelva), should lead to more sustainable use and better protection of current and future resources" [1].

The Suez group designated Aguas de Huelva, as the utility to carry out the project. "The city of Huelva has approximately 140,000 inhabitants. Aguas de Huelva has around 52,000 clients, most of whom are households. These clients are distributed in six districts that show social homogeneity. Of the 52,000 clients, 9,350 of them receive a digital invoice, from which it can be deduced that they are accustomed to using ICT tools, such as email, SMS, APPs, and web browsing and have sufficient technological infrastructure (computers, tablets, smartphones, and telecommunications connectivity) to communicate with them through digital channels" [1].

In collaboration with Aguas de Huelva a plan based on DT methodology was approved in July 2018. The time scope was set up for one year to avoid the seasonal effect of the natural water cycle in

Spain. Due to many factors to be considered such as logistics reasons, costs, and time, among others, a sample goal of households in a fork between 200 and 300 households was targeted.

"The plan contemplates three phases:

1. Measurement of the starting point of households in Huelva regarding the three axes of knowledge, needs, and valuation of water using a survey via email.

2. Proposal for a web-based prototype to measure the impact of actions in the three previous axes (touch-points with households) to increase engagement regarding water.

3. Workshops with households to qualitatively measure their evaluation of the prototype and possible improvements to incorporate into a new prototype, the last one, before the final launch of the web-based solution" [1].

Regarding the mathematical analysis of the household survey data, this paper follows the methodology of Dean *et al.* [3], clustering groups of households based on needs, valorization, and similar behaviors. This statistical classification technique allows extracting common patterns for groups, which could allow customizing different demand management strategies to each group, directing more effective personalized messages to each of the groups for being more effective in citizen engagement about water.

Communication is a key issue in achieving customer engagement because it is necessary to generate new messages and meanings regarding water, acting in the semantic dimension, and the functional dimension (technology) of water [21]. Changing people's behavior is a complex challenge, and it needs a radical design-driven innovation approach [22], managing symbolic and functional factors that influence individual water use patterns. Hence, our project's semantic dimension is critical to generate our future prototype with which to interact with households (web-based prototype) [23], since the graphic part and the web customer relationship interface should be taken care of. Wicked problems are too abstract, difficult to communicate with words, so it is mandatory to have a good graphical interface to relation with households [24].

Clustering is a technique that could be more suitable for today's cities, with very dynamic societies and a broad myriad of knowledge, values, and behaviors. Thus, there is a need to use more targeted strategies, more differentiated, personalized, and better built according to each household profile. Strategies that can be facilitated, scaling the research pilot to all homes in the city, using ICT and mathematical techniques as Artificial Intelligence (AI), Big Data Analytics (BDA) [25], and Artificial Neural Networks (ANN).

In summary, the plan contemplates a first phase that corresponds to a study of the knowledge that households have of the integral water cycle and the values and relationships they have with respect to water. This is an exploratory and descriptive investigation. These parameters will be measured through a survey with 28 questions to respond by households in about 30 minutes. "The survey questions were reviewed by 15 experts from Aguas de Huelva, making various modifications and eliminating some of the original questions proposed by the UPM team. This was done during September 2018. The means to make it reach the citizen would be through email with a link to Aguas de Huelva web site where the survey is placed" [1]. The questions/answers will follow a 5-level Likert scale, associating them with three major factor blocks:

1. Demographic characteristics: collected in the first five questions such as age, gender, education, annual income, and professional occupation.

2. Home characteristics: number of people in the household, children in the home, surface area, age. These questions go from number 6 to 9 (both included).

3. Life experiences and psychosocial factors: household activities around the city water, active participation in any social organization, and if they have suffered any water restriction. They are questions 10, 11, and 12.

4. Needs, values, and identity regarding water: the importance of different aspects of water, consumption with respect to neighbors, identification of better use of water within the home, the possibility of the investment amount in water-saving devices and acceptance of water regenerated in the home (support to alternative sources of water). Questions from 13 to 18.

5.    Knowledge of the home regarding the integral water cycle: ordered the questions in the following blocks:

      a. Uptake: questions 19 and 20.

      b. Treatment: question 21.

      c. Distribution: question 22.

      d. Sewerage networks: questions 23 and 24.

      e. Purification: questions 25 and 26.

      f. Regeneration: questions 27 and 28.

"The commitment of participation of 120 households was achieved. In December 2018, the survey was launched via email with a link to questions to the 120 participating households. Finally, in mid-June 2019, after several rounds of survey submissions, the survey response collection process was closed with a total of 97 valid responses from participating households" [1].

The responses were coded. In this coding stage, the following fields provided by Aguas de Huelva were added to the response table:

1. Huelva area to which the home belongs: six possible ones that correspond to the social districts that the Huelva City Council applies to the city.

2. Average consumption per person within the home: liters/person/day. They correspond to the average of the year 2018.

3. Consumption range of each household, according to this classification agreed with Aguas de Huelva:

      a. Less than 100 liters/person/day is low consumption.

      b. Between 100 and 130 liters/person/day is an average consumption [26].

      c. More than 130 liters/person/day is high consumption.

The consumption range was set taking into account that:

1. The average consumption per inhabitant per day in households managed by Aguas de Huelva is 126.5 liters/inhabitant/ day.

2. The minimum vital water consumption set by the World Health Organization is set between 50 and 100 liters/inhabitant/day [27].

Surveys have been statistically processed using IBM SPSS v. 25

## 3. Results

The analysis of the data obtained through the survey's application that contributes to answering the research objective is presented. Results are structured according to three-factor blocks: demographic characteristics, household characteristics, life experiences, and psychosocial factors.

Concerning the household's knowledge regarding the integral water cycle, each correct answer was given a value of 1, and each incorrect answer a value of 0. The maximum score, therefore, that could be obtained was 10 points. These scores were grouped in the following ranges:

1. Low knowledge range: scores less than 4.

2. Average knowledge range: scores between 4 and 6.

3. High knowledge range: scores equal to or greater than 7.

Taking the global score over ten possible points, and the previous rank classification, the following results were obtained:

1. A low range of knowledge: 30 households.

2. An average range of knowledge: 57 households.

3. A high knowledge range: 10 households.

We observe that, on ten possible points, the average of total knowledge, gives a score of 4.2577, which indicates a degree of knowledge of the integral water cycle close to that approved, that is, a degree of average knowledge, but still deficient on some of the stages.

Besides, it can be seen that the question that presents the least number of correct answers is the one referring to the sewerage system of the network, question 24, where there are only eight correct answers. However, 71 households correctly answer question 23 about the water sanitation system.

In contrast, the question with the highest number of positive responses is question 28, with 84 correct answers. This question is about using wipes and measuring knowledge about the challenges associated with sustainable use that impact water. It reflects the good results of previous educational campaigns on this aspect, and that Aguas de Huelva carried out among its client households before the survey [6].

However, we again detect the same trend as in the block on the stage of sewerage networks. The correct answers fall to almost half (46 correct answers) in question 27, which measures the knowledge on water regeneration compared to question 28.

There is one fact that is striking, and that is that the number of correct answers in questions 19, 20, and 26 is of the same order of magnitude (14, 17, and 18 respectively). The first two measure the knowledge of the origin of the water (catchment), while number 26 measures the knowledge of the physical place where the water is poured (purification).

It is the water catchment stage that presents the least number of correct answers, and therefore, the highest level of ignorance on the part of the households. The stages of treatment and regeneration and use present a higher number of correct responses and, therefore, a greater knowledge of these stages.

Regarding the needs, values, and identity regarding water, it is question 13 of the survey that reflects the household's state of opinion. To extract useful information from the data in this question, it is necessary to reduce the number of variables to be handled to facilitate their interpretation. For this, a factor analysis by maximum likelihood with the extraction of main components is applied to each block. This analysis allows us to pass to a new set of variables, which maintains the maximum information of the original variables, which enjoy the advantage of being uncorrelated with each other and, moreover, can be ordered according to the incorporated information. In all the rotated component matrices that appear in this paper, the following methods have been applied:

1. Extraction method: principal component analysis.
2. Rotation method: Varimax with Kaiser normalization.

The results obtained are:

**Table 2**: Rotated component matrix about question 13. (Source: Authors)

| | COMPONENTS | | |
|---|---|---|---|
| | *1* | *2* | *3* |
| RECEIVE MORE INFORMATION | | | .829 |
| SOCIAL BONUSES | | | .710 |
| ORIGIN OF WATER | .885 | | |
| GOOD TASTE OF WATER | .886 | | |
| HAVE HEALTHY WATER | .815 | | |
| REDUCE NUMBER OF SERVICE CUTS | | .848 | |
| RECEIVE WATER LEAK NOTICES | .819 | | |
| WATER AVAILABILITY WITH GREATER PRESSURE | | .861 | |
| MINIMIZE FLOOD EFFECTS | | .857 | |
| INVEST IN RECLAIMING AND HARVESTING WATER | .523 | | |

The explained variance is 69%, which indicates that the original variables are grouped into three groups represented by the three main components or factors obtained; and that they do sufficiently explain the needs and values of households. We performed the Kaiser, Meyer and Olkin (KMO) test to assess whether the factor model (or the extraction of factors) as a whole is significant (high relationship between variables). The KMO obtained is 0.773, which indicates that the relationship between variables is high and, therefore, the factor model is significant.

Bartlett's sphericity test evaluates the applicability of factor analysis of the variables studied. The model is significant if Significance (P-value) <0.05, indicating that factor analysis can be applied. This is the case.

Based on the weights of each variable in the factors, it can be determined that each component obtained, in some way, explains aspects of water that households value. Thus, we can name each of the factors as follows:

1. Component 1 = "Quality of service/health". The weight is given more in aspects related to water quality and its impact on health. This is the component with the highest variance and therefore explains what households value most.

2. Component 2 = "Quality of infrastructure". It collects information on the valuation of aspects related to the quality of the infrastructure of the water network.

3. Component 3 = "Customer Relationship Management (CRM)". It expresses the value of the household's relationship with the water company. In some way, it measures the "service brand" [9] of Aguas de Huelva among households and the importance that they give to it, and therefore the trust that they could have in the face of engagement actions to propose to them in later stages of the project. It presents the smallest variance.

The results obtained allow evaluating the individuals' attitudes that make up the sample with respect to different aspects of water:

1. Attitude towards water consumption efficiency: given by the data in question 15.

2. Attitude towards the adoption of technological devices in the home related to water: extracted from the data of question 16.

3. Attitude towards reclaimed water in the home: given by data from questions 17 and 18.

Once again, to extract useful information from the data of these questions, it is necessary to reduce the number of variables to handle to facilitate interpretation. For this, a block processing is applied, applying to each one the factor analysis by maximum likelihood.

The measure of the home improvement attitude regarding its possibility of improvement with respect to water consumption is represented by the data from question 15. We proceed to apply factor analysis with the extraction of main components, obtaining:

**Table 3.** Rotated component matrix about question 15. (Source: Authors)

| | COMPONENTS | |
|---|---|---|
| | *1* | *2* |
| BATHTUB & SHOWER | | .717 |
| WASHING MACHINE | .520 | .704 |
| DISHWASHER | | .765 |
| TOILET | .830 | |
| HOUSEHOLD CLEANING | .818 | |
| COOKING | .795 | |

As in the previous point, the explanation of the results shows that the two main components obtained explain the attitude towards improving the efficiency of water use in the home, since the explained variance is 66%. The resulting KMO is 0.761, and the Bartlett sphericity test is p = 0.000 (significant model).

Although putting labels on the interpretation, in this case, is not so simple, it can be said that households show a more favorable attitude towards improving water use, grouping actions around two groups:

1. Component 1 = "General efficient use". There is an association of variables that would explain a general use, where to improve the efficiency of water in the home.

2. Component 2 = "Efficient use in cleaning". Here clearly appears a group associated with a field of improvement on the use of water in personal or household cleaning tasks.

When carrying out the KMO contrast (Kaiser, Meyer and Olkin) and the Bartlett and sphericity test, it is verified that the factorial model as a whole is significant and applicable to the analyzed variables.

The data from question 16 represent the measure of attitude regarding the adoption of technological devices in the home. We proceed to apply factor analysis with the extraction of main components, obtaining:

**Table 4.** Rotated component matrix about question 16. (Source: Authors)

| COMPONENT | |
|---|---|
| | *1* |
| SHOWER HEADS | .631 |
| ACOUSTIC WARNING DEVICES | .866 |
| SMART METERS | .853 |
| RAIN WATER REGENERATION | .884 |

In this case, only one main component was obtained with an explained variance of 65%. To the KMO test (with a value of 0.787) and the Bartlett test with results that validate the model, an additional test has been added, the so-called "Cronbach's Alpha" test, obtaining a value of 0.825; indicating that the reliability of the measurement scale that we determined a priori is high. The component obtained will be called:

1. Component 1 = "Water saving devices." It will contain all the variables except "Faucet flow limiters." That is, this variable is not significant, and therefore, we will not take it into account for our analyses.

The attitude towards reclaimed water in the home is shown by the results obtained from the analysis of the answers to questions 17 and 18.

The data in question 18 does not admit factor analysis since the question was not designed with a scale in its possible answers (Likert scale).

Therefore, we applied factor analysis to question 17, obtaining the following results:

**Table 5**: Rotated component matrix about question 17. (Source: Authors)

| | COMPONENTS | |
|---|---|---|
| | 1 | 2 |
| RECLAIMED WATER FOR TOILET | .875 | |
| RECLAIMED WATER FOR WASHING MACHINE | .631 | |
| RECLAIMED WATER FOR GARDEN IRRIGATION | .752 | |
| ALL PREVIOUS CASES AT A LOWER PRICE | | .898 |
| NO CASE | -.569 | |

The explained variance is 63%, with two groups of significant variables through two main components:

1. Component 1 = "Reclaimed water for washing machine, toilet, garden and no case"
2. Component 2 = "All previous cases at a lower price"

Although the Bartlett test is acceptable (p = 0.000), the KMO test gives a low result (0.595), although valid (close to 0.6), so another analysis is performed to seek to improve the factor analysis with the introduction of the extracted components that measure the attitude of households; in this case the KMO improved with all of them. In other words, all the factors/components that summarize the attitude described in question 15 ("General efficient use", "Efficient cleaning use"), 16 ("Water saving devices"), and question 17 itself have been introduced. ("Reclaimed water for washing machine, toilet, garden and no case", "All previous cases at a lower price"), obtaining the following results:

**Table 6.** Rotated component matrix. (Source: Authors)

| | COMPONENTS | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| GENERAL EFFICIENT USE | | .819 | |
| EFFICIENT CLEANING USE | | | .879 |
| WATER SAVING DEVICES | .861 | | |
| RECLAIMED WATER FOR WASHING MACHINE, | | -.711 | |

| | |
|---|---|
| TOILET, GARDEN AND NO CASE | |
| ALL PREVIOUS CASES AT A LOWER PRICE | .799 |

The KMO test again gives a very low result (0.363), clearly insufficient (below 0.5), indicating that the component extraction model is not valid in this case (with all components/factors) and does not record a valid relationship between the factors entered.

Therefore, for question 17, the two main components extracted are taken: "Reclaimed water for Washing Machine, Toilet, Garden and No case", "All the previous cases at a lower price.
Regarding the results obtained from question 18:

1. 26 households found it indifferent to have their own rainwater regeneration system in their home/community, with the maximum technical guarantees of quality and safety
2. Six households would not accept to use reclaimed water in their home/community.
3. 43 households would accept to use reclaimed water for washing machine, toilet and irrigation.
4. 22 households would agree to use reclaimed water for other household uses as well.

Finally, a clusterization of households has been carried out (grouping of data with similar characteristics) [3]. The objective is to be able to implement differentiated future strategies and designed "ad-hoc", personalized towards each type of household (cluster) to change, reinforce or eliminate real attitudes and behaviors of households in the efficient use of water. To design these strategies, we will use different DT techniques, such as product service systems (PSS) or design for behavior, which ensure the sustainability of the designed product or service [29]. The aim is to achieve a greater commitment from households ("engagement") regarding water. The following factors have been taken into account for the chosen clustering [3]:

1. Range of knowledge.
2. Main factors or components of needs and values.
3. Main factors or components of attitude regarding water consumption efficiency.
4. Main factors or components of attitude regarding the adoption of technological devices in the home related to water.
5. Main factors or components of attitude regarding the use of reclaimed water in the home and codification of question 18.

An analysis has been performed taking the previous clusters with the variables defined below that characterize households:

1. Block of demographic characteristics.
2. Block of household characteristics, consumption range and zone or district of Huelva.
3. Block of life experiences and psychosocial factors:

The method followed by clustering is hierarchical (Euclidean squared distance and Ward method), obtaining three clusters characterized by:

1. Cluster 1:
   a. High knowledge about the integral water cycle.
   b. They value having a good quality of the infrastructure of the water network.
   c. They do not particularly value the rest of the other two factors of the analysis.
   d. Moderate attitude towards improving water consumption efficiency concerning the use of the toilet, cleaning the home and kitchen. They do not believe that in other uses they can achieve greater efficiency (bath, washing machine, dishwasher).

e. Positive attitude towards the use of water-saving devices. Most choose to have the water company give the devices to them, although there is a household that would accept spending up to 30 euros of the total limit.

f. Positive attitude towards the use of reclaimed water in the home (washing machine, toilet, and garden) as long as it is at a lower price than the current price for the same uses.

g. They are also inclined to adopt their own rainwater regeneration system in their home/community for previous uses, or even some other use.

2. Cluster 2:

a. Low knowledge of the integral water cycle.

b. They moderately value a good perceived service, in the form of perceived water quality and absence of problems in the water service delivered to the home.

c. They value having a good quality of the infrastructure of the water network.

d. Negative attitude towards improving water consumption efficiency concerning the use of the toilet, cleaning the home, and the kitchen. Nor do they believe that in other uses they can achieve greater efficiency (bath, washing machine, and dishwasher).

e. Negative attitude towards the use of water saving devices.

f. Negative attitude towards the use of reclaimed water in the home (washing machine, toilet, garden).

g. However, they are very sensitive to the price of water and its possible drop.

h. Moderate/indifferent attitude to adopt their own rainwater regeneration system in your home/community for washing machines, toilets, or garden uses.

3. Cluster 3:

a. Average knowledge of the integral water cycle.

b. They value positively a perceived good service, in the form of perceived water quality and absence of problems in the water service delivered to the home.

c. They value positively having information from the water company and how it relates to households.

d. Positive attitude to achieve greater efficiency in the use of water in bathtubs, washing machines, dishwashers. They do not believe that they can improve the efficiency of water consumption, in relation to the use of the toilet, cleaning the home and the kitchen.

e. Negative attitude towards the use of water-saving devices in the home.

f. Positive attitude towards the use of reclaimed water in the home (washing machine, toilet, garden). Regardless of whether an improvement in the price of water is achieved.

g. Indifferent attitude to adopt their own rainwater regeneration system in your home/community for washing machine, toilet or garden uses.

**Table 7.** Case Processing Summary (Source: Authors)

|  |  | N | % MARGINAL |
|---|---|---|---|
| CLUSTERS | High knowledge | 45 | 46.4 |
|  | Low knowledge | 21 | 21.6 |
|  | Average knowledge | 31 | 32.0 |
| AGE | From 18 to 30 years | 4 | 4.1 |
|  | From 31 to 40 years | 16 | 16.5 |
|  | From 41 to 50 years | 32 | 33.0 |
|  | From 51 to 65 years | 39 | 40.2 |
|  | More than 65 years | 6 | 6.2 |
| GENDER | Male | 66 | 68.0 |
|  | Female | 31 | 32.0 |
|  | No Studies | 2 | 2.1 |

| | | | |
|---|---|---|---|
| EDUCATION | Basic Studies | 24 | 24.7 |
| | Bachelor | 35 | 36.1 |
| | University Studies | 36 | 37.1 |
| INCOME | Less than 10,302 €/year | 20 | 20.6 |
| | From 10,302 € to 25,000 €/year | 43 | 44.3 |
| | From 25,000 € a 50,000 €/year | 26 | 26.8 |
| | From 50,000 € a 100,000 €/year | 8 | 8.2 |
| OCCUPATION | Unemployed | 13 | 13.4 |
| | Employed | 55 | 56.7 |
| | Self-Employed | 15 | 15.5 |
| | Retired | 14 | 14.4 |
| CHILDREN | No children | 57 | 58.8 |
| | 1 | 24 | 24.7 |
| | 2 | 16 | 16.5 |
| WATER CONSUMPTION | Low | 30 | 30.9 |
| | Average | 57 | 58.8 |
| | High | 10 | 10.3 |
| DISTRICT | Zone 1 | 29 | 29.9 |
| | Zone 2 | 16 | 16.5 |
| | Zone 3 | 13 | 13.4 |
| | Zone 4 | 3 | 3.1 |
| | Zone 5 | 18 | 18.6 |
| | Zone 6 | 18 | 18.6 |
| VALID | | 97 | 100 |
| LOST | | 12 | |
| TOTAL | | 109 | |
| SUBPOPULATION | | 94a | |

The grouping followed by an iterative process (hierarchical) is shown graphically in the following dendrogram in Figure 3 (it is cut into three branches, at level 15):
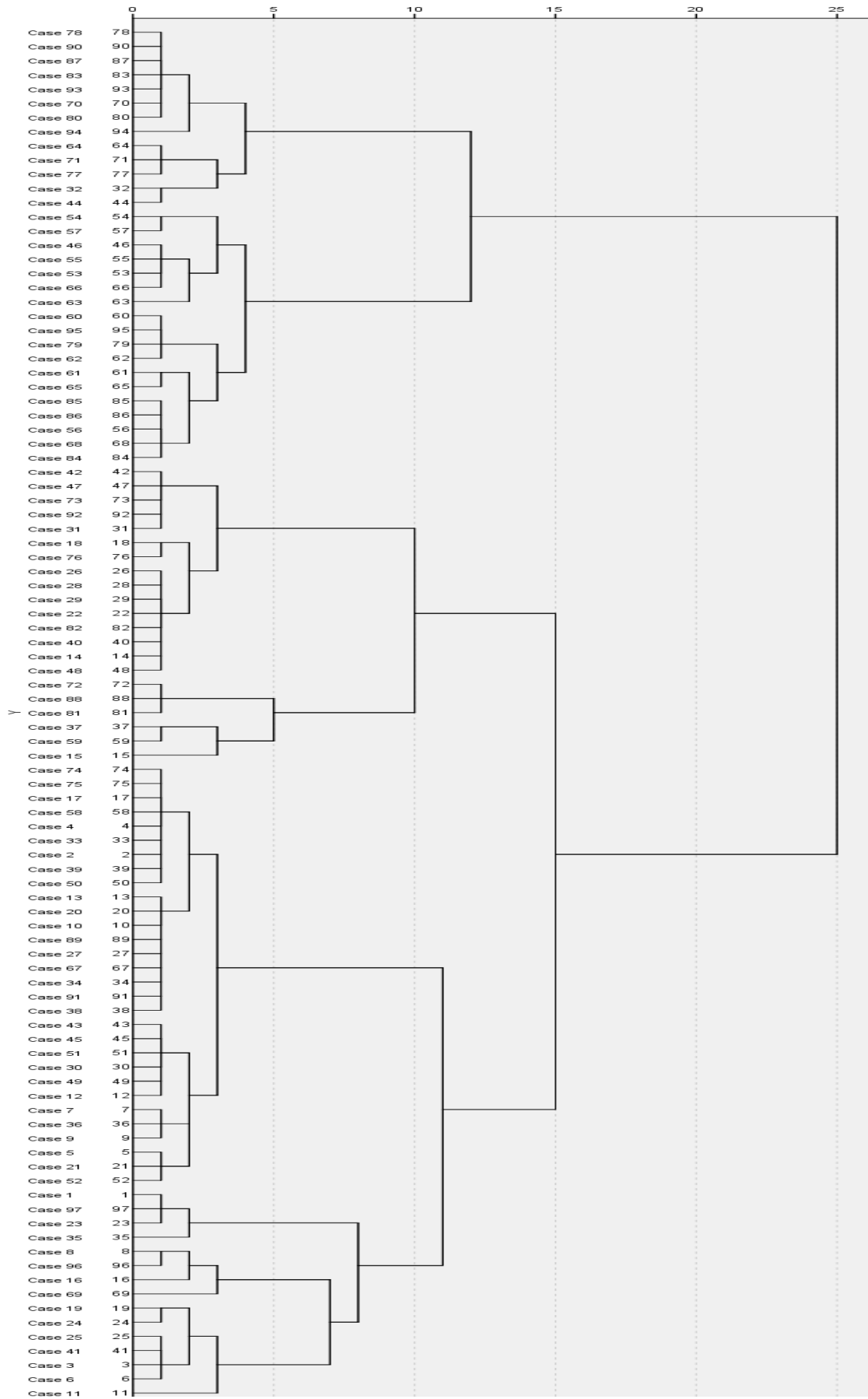
**Figure 3.** Dendrogram. (Source: Authors)

We verify the adequacy of the clustering model applied to our data sample. That is, we are going to verify if the clusters obtained discriminate well enough. For this, we carried out an analysis of variance through ANOVA, using the results of the knowledge questions about the distribution network, sanitation, and sewerage network, obtaining:

**Table 8.** ANOVA (Source: Authors)

**DISTRIBUTION**

|  | SUM OF SQUARES | ROOT MEAN SQUARE (RMS) | F | SIG. |
|---|---|---|---|---|
| AMONG GROUPS | 9.794 | 4.897 | 34.561 | .000 |
| WITHIN EACH GROUP | 13.319 | .142 | | |
| TOTAL | 23.113 | | | |

SANITATION

|  | SUM OF SQUARES | ROOT MEAN SQUARE (RMS) | F | SIG. |
|---|---|---|---|---|
| AMONG GROUPS | 5.681 | 2.841 | 20.003 | .000 |
| WITHIN EACH GROUP | 13.350 | .142 | | |
| TOTAL | 19.031 | | | |

SEWERAGE NETWORKS

|  | SUM OF SQUARES | ROOT MEAN SQUARE (RMS) | F | SIG. |
|---|---|---|---|---|
| AMONG GROUPS | .762 | .381 | 5.448 | .006 |
| WITHIN EACH GROUP | 6.578 | .070 | | |
| TOTAL | 7.340 | | | |

In all three cases, we obtain sufficiently high F and significance less than 0.05, which indicates that the cluster results obtained discriminate well and are therefore valid.

We then carry out multinomial logistic regression tests to determine if the model obtained has the explanatory capacity, that is, if it is statistically significant and can be used to predict "the classification" of future data in the defined clusters. The statistics obtained in different tests are:

1. The goodness of fit.
2. Pseudo R squared.
3. Likelihood ratio tests.
4. Parameter estimates of the three clusters (two-to-two).

The results of Chi-squared (high), Pseudo R squared (<1), significant and two-to-two parameter estimates, give as good the model obtained in terms of prediction of classification of new samples.

## 4. Discussion

A first issue to review is the difficulties we had in achieving a diverse and sufficient number of participating households, since, "Locating restless users for your cooperating user pool may not be easy; however, they are extremely helpful. Regular users are needed as well… A challenge is to find a diverse set of restless users" [28]. However, with the participation of the 97 households which answered the survey, "we believe that this last point has been achieved, by minimizing the effect of uncertainty, the personal preferences of each household, the possible errors in obtaining household data, misunderstandings in language and communication with households, and inconsistencies, among other. In any case, the experience can be scaled in the future to all households in Huelva, using different ICT solutions, such as BDA and inference of future behaviors of homes such as through AI" [1].

Regarding the analysis of the results that serve as a basis to cover the stages of needfinding and synthesis of the DT framework used [12], it can be interpreted:

1. Regarding the knowledge that households in Huelva have about the integral water cycle, there is a disproportion between the correct answers to questions 23 and 24. The combination of both questions measures the knowledge of the stage of sewerage networks. The disproportion may lie in question 24, which is a question that requires more technical and specific knowledge, while question 23 is more general.

2. The question with the highest number of positive responses is question 28. This question is about using wipes and measuring knowledge about the challenges associated with sustainable use that impact water. It was included at the request of Aguas de Huelva, and reflects the good results of previous educational campaigns on this aspect, and that Aguas de Huelva carried out among its client households on dates prior to the survey [6]. Perhaps, it can serve as a way forward in implementing subsequent educational campaigns among Huelva's households.

3. There is again a disproportion between the correct answers in question 27, which measures knowledge about water regeneration, compared to question 28. That is, when questions with a technical varnish the number of correct answers is reduced, although they are part of the same block of knowledge; in this case, the block on regeneration and sustainable use. As previously indicated, a more than acceptable general knowledge is remeasured, as well as improved technical knowledge of the same.

4. The pattern is repeated again with the questions of the debugging block (questions 25 and 26), where there is a disparity between the number of correct answers to the two questions that are part of it.

5. On the results of the questions that measure the knowledge of the origin of the water (collection) and those that measure the knowledge of the physical place where the water is poured at the end of the cycle (purification), it seems that the households do not have sufficient knowledge of where the water they consume comes from and where it goes. To these aspects of the cycle, it seems that they give a "magical" character, as if the water appeared and disappeared on a whimsical basis. Perhaps it is due to the fact that, in both cases, origin and completion, the physical place occupied by water is the furthest from the city, that of the environment of nature, something that is seen as alien from the perspective of the city.

6. It is the catchment stage, which presents the least number of correct answers, and therefore, the greatest ignorance on the part of the households. It would require a greater effort with educational campaigns on this stage, linked to the natural environment.

7. The stages of treatment and regeneration and use are those that present a greater number of correct responses and, therefore, a greater knowledge of these stages.

8. Regarding the needs and valuation that households have regarding water, from the statistical processing of the data we can interpret that in general, households will be more likely to positively value actions that improve the "quality of service with an impact on health", understanding the service as a perceived service (visualized) in the form of perceived water quality and absence of problems in the service delivered to the home. Within this group, the variable "Invest in purifying and harvesting water" is less related to the other variables in this main component.

9. Secondly, they will value having a good quality of the water network infrastructure.

10. Finally, they value the information from the water company, and how it relates to households. In other words, in some way they are qualifying the importance they attach to the company's "service brand" and that conditions their trust with respect to it.

11. Regarding the aspects of better water use that households detect to be able to improve, we can conclude that in general, households are aware of and are willing to apply strategies for better water use in a combination of actions on toilet use, cleaning home and kitchen. These three variables are highly associated being collected in the main component "General efficient use". To a lesser extent, the variable on a better efficient use of the "washing machine" is.

12. Regarding the attitude towards the use of reclaimed water in households, reflected by question 17, the conclusion that can be drawn from it is that households have a majority favorable attitude towards the use of reclaimed water for washing machines, toilets, and gardens, but provided it is at a lower price than they currently pay for said water. The economic factor is an important component in the possible acceptance of water regeneration technologies in the home for the described uses (washing machine, toilet, garden).

13. Regarding the acceptance of new technologies in the home, which help to better use water in it, we can say that it seems that households do not accept the incorporation of flow limiters in taps, perhaps due to their involvement in the invasion of their decision-making power or in restricting their freedom. In any case, it seems clear that acoustic limiters and smart meters that are devices that can provide them with information on their consumption would be highly valued.

14. Regarding the use of water reuse and regeneration systems, there is an overwhelming majority (65 households out of 97) who would agree to have its OWN rainwater regeneration system in their home/community. Besides, the most notable is that there is hardly any opposition (only six households out of 97) to having its OWN rainwater regeneration system, which opens a field for the introduction of this type of technology in the households served by Aguas de Huelva.

In addition, we would like to draw attention to several facts, which act as some important conclusions:

1. Beyond the interpretation of the results of the clusterization; if we focus only on the analysis of the factors or components of the variables presented here, we can already extract knowledge and imagine possible actions to be carried out, strategies based on DT, in future field experiments to "provoke" real changes in the results measured by said variables by means of PSS or design for behavior strategies and methods [29].

2. The data has been processed several times, obtaining different numbers of clusters in each process, all of them valid. The one we propose here has finally been chosen, following the criterion of balancing between having a high number of clusters that would allow highly targeted and customized field actions (experiments) to very particular segments of households (and therefore with greater efficacy of results). However, that would complicate in excess the fieldwork related to the households (increasing the cost and the time of execution of the experiments). Considering a lower number of clusters (two) it would be easier to carry out the subsequent fieldwork with the households, but it would be less effective in its results by allowing less customization of subsequent actions on

the households. We believe that we have chosen the best option of selecting 3 clusters, which discriminates sufficiently and facilitates subsequent interaction with households. Furthermore, this number of clusters is in line with that of other similar research in other parts of the world [3].

3. The variables that measure the psychosocial factors corresponding to "Social activities around water" and "Participation in social organizations" (questions 11 and 12) are not significant. In other words, they do not explain, they do not discriminate, they do not characterize the households participating in this survey. In conclusion, they are totally expendable.

4. A clusterization has been attempted according to the districts of Huelva, and a clear differentiation has not been achieved either. The maximum obtained were two clusters with the data very grouped between them, which provided little real knowledge and little discrimination. This has allowed us to certify what Aguas de Huelva had already told us in previous meetings: the great social homogeneity between the city's different areas/districts. In other words, the district to which the home belongs is not decisive, nor does it explain the questions that the investigation tries to answer.

5. Only results have been obtained that add valid scientific information about the objectives of this research, beyond the information obtained from the simple statistical exercise, adding and treating all the variables and components described above.

In relation to improving the knowledge of households in Huelva about the integral water cycle, we can recommend a series of actions that, in some way, the web-based prototype [23] should incorporate such as:

1. Household education on the catchment stage, sewage and purification networks, especially on the impact of water use on sources (source) and purification (discharge). We understand that the focus must be on reviewing the relationship between Huelva and the sustainability of its closest natural environment, as other experiences have reviewed [30,31].

2. Technical but informative and entertaining approach to the water path in the different blocks that make up the integral water cycle and its impact on the consumer.

3. It is recommended to follow the communication style previously used in the campaign for the use of wipes in the Huelva water home [6], emphasizing the use of more straightforward language and attractive visual support through images or videos that can improve touch-points with households, since these are a critical element within the DT where the value created between customers and the service Company occurs [32].

4. The semantic dimension in our project is critical, so in the future prototype stage in our DT framework [12], the graphic part and the web customer relationship interface are critical to generating our web-based prototype, with which to interact with households [23]. Wicked problems are too abstract [33]; therefore, there are many lexical barriers to communicate with precise words. Having a good graphical interface is essential for the success of the project. Therefore, it could be necessary to contract an agency specialized in web design [34].

To achieve greater household engagement regarding the efficient use of water, it is necessary to generate new messages and meanings about water combined with the use of technology, ICT facilitators around water [35]. The goal is to create a radical vision about water, a new strategic meaningful direction with a high impact on water valorization by households [36].

Since the economic factor is a major component in the possible acceptance of water regeneration technologies in the home, the use of models based on type of design produced by PSS should be considered. This can lead households to change their perception of water, going from models of technologies in the home that you produce to a sense of wellbeing based on product ownership, to models based on access to the service that water produces for households (access-based wellbeing) [37]. In this new paradigm, the water company owns the technology that facilitate such service. From the point of view of the water company itself, there would be an economic interest clearly aligned with sustainability [38] in increasing the efficiency, durability, and reuse of the technology and materials involved in water service. This model aligns PSS with sustainability.

It should be especially noted that "The efficacy of a potential PSS in terms of, i.e., its environmental performance and customer value, is generally determined in the conceptual design phase" [39]. Therefore, at this stage of needfinding and synthesis, this aspect must be expressly taken care of [12].

In this sense, Yan, and Roggema [40], bet that design solutions reflect action programs for the UN Sustainable Development Goals (SDGs) with the cooperation of producers, citizens, and governments, aligning their respective interests of economic benefit, better living environment and improvement of efficient public services (in this order). Pruneau *et al.* [41] showed numerous examples of how DT has been incorporated into producing sustainable solutions that lead to sustainable development.

Additionally, we want to highlight the role of ICT facilitators. These tools will be used as support:

1. Smart meters, if available, for later stages in DT, especially in the prototype and testing stages [12]. One of its benefits would lie in trying to measure, from the point of view of household management, effectiveness of this tool, balancing it with given the cost of its deployment. For more information on this technology, see Boyle *et al.* [42].

2. Web-based prototype to test true customer behavior to face meanings proposal from the water utility.

3. Email as an extra communication channel with the client.

4. APPs for mobile phones, that allow a semi real-time interaction and better quality of information with the homes, especially for consumption feedback.

As future lines of research for the continuity to the results published in this article, we are working on the statistical analysis of the data used here, to analyze the influence of the different variables and components/factors on household consumption ranges (high, medium, low). The statistical tool used are the "decision trees", using the CRT method (classification and regression trees). This will allow us to know which variables/factors / independent components are the decisive ones regarding water consumption, as a quantitative expression of households' real behavior in the efficient use of water.

This approach will be completed with subsequent workshops with households and with the design of a web-based prototype that allows actions to improve their engagement with respect to water (experiments), according to the DT-based framework described in [1], which give a clear idea of the qualitative behavior regarding water.

### Nomenclature

AI: Artificial Intelligence.
ANN: Artificial Neural Networks.
BDA: Big Data Analytics.
CRM: Customer Relationship Management.
CRT: Classification and Regression Trees
DT: Design Thinking.
ERG: Existence, Relatedness, Growth.
ETSII: Escuela Técnica Superior de Ingenieros Industriales.

ICT: Information and Communication Technologies.
ISUDS: Integrated Sustainable Urban Development Strategy.
KMO: Kaiser-Meyer-Olkin.
PSS: Product Service Systems.
SDG: Sustainable Development Goals.
UPM: Universidad Politécnica de Madrid.

## References

1.   Bermejo-Martín, G.; Rodríguez-Monroy, C. Design Thinking Methodology to Achieve Household Engagement in Urban Water Sustainability in the City of Huelva (Andalusia). *Water* **2020**, *12*, 1943.

2.   Bermejo-Martín, G.; Rodríguez-Monroy, C. Sustainability and Water Sensitive Cities: Analysis for Intermediary Cities in Andalusia. *Sustainability* **2019**, *11*, 4677.

3.   Dean, A.J.; Lindsay, J.; Fielding, K.S.; Smith, L.D.G. Fostering water sensitive citizenship—Community profiles of engagement in water-related issues. *Environ. Sci. Policy* **2016**, *55*, 238–247.

4.   Alderfer, C.P. An empirical test of a new theory of human needs. *Organ. Behav. Hum. Perform.* **1969**, *4*, 142–175.

5.   Strengers, Y. Smart Metering Demand Management Programs: Challenging the Comfort and Cleanliness Habitus of Households. In Proceedings of the 20th Australasian Conference on Computer-Human Interaction: Designing for Habitus and Habitat, Cairns, Australia, 8–12 December 2008; pp. 9–16.

6.   Aguas de Huelva. Available online: https://www.aguashuelva.com/retos-sociales-retos-compartidos/ (accessed on 15 July 2020). (In Spanish)

7.   Redgas. Available online: www.redgas.at (accessed on 15 July 2020). (In German)

8.   Meyer, M.H.; Tucker, M.J. Innovating for effectiveness: Lessons from design firms. *Res. Technol. Manag.* **2010**, *53*, 21–28.

9.   Andreassen, T.W. Innovating for Trust. Edited by Marika Lüders, University of Oslo and SINTEF, NHH Norwegian School of Economics, Simon Clatworthy. In The Oslo School of Architecture and Design and Tore; Hillestad, N.H.H., Ed.; Chapter 11: "Service Design Thinking" Simon Clatworthy; Norwegian School of Economics: Bergen, Norway, 2017; ISBN 978 1 78536 947 6.

10.  Ide, T.; Tubi, A. Education and environmental peacebuilding: Insights from three projects in Israel and Palestine. *Ann. Am. Assoc. Geogr*. **2020**, *110*, 1–17.

11.  Hehn, J.; Uebernickel, F.; Herterich, M. "Design Thinking Methods for Service Innovation—A Delphi Study–" (2018). PACIS 2018 Proceedings. 126. Available online: https://aisel.aisnet.org/pacis2018/126 (accessed on 14 May 2020).

12.  ME310. 2010. ME310 Design Innovation at Stanford University. Available online: https://web.stanford.edu/group/me310/me310_2016/ (accessed on 15 July 2020).

13.  De Haan, F.J.; Ferguson, B.C.; Adamowicz, R.C.; Johnstone, P.; Brown, R.R.; Wong, T.H.F. The needs of society: A new understanding of transitions, sustainability and liveability. *Technol. Forecast. Soc. Chang*. **2014**, *85*, 121–132.

14.  M.J. Milne, C. Byrch, Sustainability, environmental pragmatism and the triple bottom line: good question, wrong answer? 10th CSEAR Australasian Conference, Launceston, 6–8 December 2011, 2011, p. 2011.

15.  Veenhoven, R. Happy life-expectancy. Soc. Indic. Res. 1996, 39, 1–58.

16.  Fletcher, T.D.; Shuster, W.; Hunt, W.F.; Ashley, R.; Butler, D.; Arthur, S.; Trowsdale, S.; Barraud, S.; Semadeni-Davies, A.; Bertrand-Krajewski, J.L.; et al. SUDS, L.I.D., BMPs, WSUD and more—The evolution and application of terminology surrounding urban drainage. *Rev. Urban Water J*. **2014**, *12*, 7.

17.  Brundtland, G.H. World Commission on Environment and Development (WCED). Our Common Future 1987, 17, 1–91.

18.  Bourdieu, P. (2005) 'Habitus', in J Hillier & E Rooksby (eds), Habitus: a sense of place, 2nd edn Ashgate Publishing Ltd, Hants [England], pp. 43-9.

19.  Knoeri, C.; Steinberger, J.K.; Roelich, K. End-user centred infrastructure operation: Towards integrated end-use service delivery. *Journal of Cleaner Production* **2016** 132. pp. 229-239.

20.  http://i2t.webs.upv.es/documentos/Reto2SUEZ.pdf (accessed on 15 July 2020). (In Spanish)

21.  Verganti, R. Design, Meanings, and Radical Innovation: A Metamodel and a Research Agenda. *J. Prod. Innov. Manag*. **2008**, *25*, 434–456.

22. Verganti, R. Design as brokering of languages: The role of designers in the innovation strategy of Italian firms. *Des. Manag. J.* **2003**, *3*, 34–42.

23. Collaborative Service Blueprinting for Design Thinking: Evaluation of a Digital Prototype Tobias Potthoff1, Dominik Siemon2, Konstantin Wilms1, Sascha Möser2, Marco Hellmann1, Stefan Stieglitz1, Susanne Robra-Bissantz2. In Proceedings of the 51st Hawaii International Conference on System Sciences, Waikoloa Village, HI, USA, 3–6 January 2018. Available online: http://hdl.handle.net/10125/50467 (accessed on 14 May 2020).

24. Buchanan, R. Wicked problems in design thinking. *Des. Issues* **1992**, *8*, 5–21.

25. Sakao, T.; Neramballi, A. A Product/Service System Design Schema: Application to Big Data Analytics. *Sustainability* **2020**, *12*, 3484.

26. Instituto Nacional de Estadística https://www.ine.es/prensa/np934.pdf (accessed on 15 July 2020). (In Spanish).

27. United Nations Department of Economic and Social Affairs (UNDESA) https://www.un.org/waterforlifedecade/index.shtml (accessed on 15 July 2020).

28. Tannian, M.F. Embracing Quality with Design Thinking. In The Future of Software Quality Assurance; Goericke, S., Ed.; Springer: Cham, Switzerland, 2020; pp. 161–174, doi:10.1007/978-3-030-29509-7_13.

29. Grant Young, Design Thinking and Sustainability. Available online: https://zum.io/wp-content/uploads/2010/06/Design-thinking-and-sustainability.pdf (accessed on 15 July 2020).

30. Hussein, H. A critique of water scarcity discourses in educational policy and textbooks in Jordan. J. Environ. Educ. 2018, 49, 260–271, doi:10.1080/00958964.2017.1373620.

31. Ide, T.; Tubi, A. Education and environmental peacebuilding: Insights from three projects in Israel and Palestine. *Ann. Am. Assoc. Geogr*. **2020**, *110*, 1–17.

32. Clatworthy, S. Bridging the gap between brand strategy and customer experience. *Manag. Serv. Qual*. **2012**, *22*, 108–127.

33. Buchanan, R. Wicked problems in design thinking. *Des. Issues* **1992**, *8*, 5–21.

34. Enfoque Comunicación. Available online: www.enfoquecomunicacion.com/ (accessed on 15 July 2020). (In Spanish)

35. Dell' Era, C.; Marchesi, A.; Verganti, R. Mastering Technologies in Design-Driven Innovation. *Res. Technol. Manag.* **2010**, *53*, 12–23, doi:10.1080/08956308.2010.11657617.

36. Dell' Era, C.; Magistretti, S.; Cautela, C.; Verganti, R., Zurlo, F. Four kinds of design thinking: From ideating to making, engaging, and criticizing. *Creat. Innov. Manag.* **2020**, 1–21, doi:10.1111/caim.12353.

37. Manzini, E. Context-based wellbeing and the concept of regenerative solution: A conceptual framework for scenario building and sustainable solutions development. *J. Sustain. Prod. Des.* **2002**, *2*, 141–148.

38. Hila Shapira, H.; Ketchie, A.; Nehe, M. The integration of Design Thinking and Strategic Sustainable Development. *J. Clean. Prod.* **2017**, *140*, 277–287.

39. Sakao, T.; Neramballi, A. A Product/Service System Design Schema: Application to Big Data Analytics. *Sustainability* **2020**, *12*, 3484.

40. Yan, W.; Roggema, R. Developing a Design-Led Approach for the Food-Energy-Water Nexus in Cities. *Urban Plan.* **2019**, *4*, 123–138.

41. Pruneau, D.; Lang, M.; Kerry, J.; Langis, J.; Fortin, G.; Liboiron, L. Leaders of sustainable development projects: Resources used and lessons learned in a context of environmental education. *J. Educ. Sustain. Dev.* **2014**, *8*, 155–169.

42. Boyle, T.; Giurco, D.; Mukheibir, P.; Liu, A.; Moy, C.; White, S.; Stewart, R. Intelligent Metering for Urban Water: A Review. *Water* **2013**, *5*, 3, 1052-1081.