AccelWater

Accelerating Water Circularity in Food and Beverage Industrial Areas around Europe

WP 9: Business Cases and Exploitation Strategy
Deliverable D9.5 "Replication Assessment Methodology"

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DIGNITY Private Company	DIGNITY	EL	
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CALISPA SpA	CALISPA	IT	
Associazione Nazionale Industriali Conserve Alimentari Vegetali	ANICAV	IT	
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Executive Summary

AccelWater aims at the optimization of freshwater water consumption in the F&B industry, as well as the waste and energy reclamation, under a waste-water-energy nexus, by introducing advanced technologies. The project includes the development, integration and demonstration of relevant technologies in four demonstration cases across Europe, regarding different F&B industries. The aim of this deliverable is to examine the replicability or transferability of the AccelWater solutions and to evaluate the possible adaptation of the developed solutions from other companies of the F&B industry on the same or different region.

Deliverable D9.5 “Replication Assessment Methodology” describes the guidelines that will be followed in order to assess the replicability of the AccelWater approaches. The methodology framework includes the following steps:

i. selection of final AccelWater replicable results
ii. contact and engagement of various relevant stakeholders
iii. analysis of national and regional policies and regulations, as well as the institutional framework
iv. identification of funding schemes
v. implementation of an initial feasibility study, taking into consideration technical, economic, social, legal and market criteria
vi. evaluation of the socio-economic cost-benefit analysis of the AccelWater replicable solutions

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Abbreviation	Explanation
EBRD	European Bank for Reconstruction and Development
EC	European Commission
ECC	European Economic Community
EU	European Union
F&B	Food and Beverage
ICT	Information and Communication Technology
IRR	Internal Rate of Return
IS	Industrial Symbiosis
NPV	Net Present Value

1 Introduction

The AccelWater project targets the optimization of freshwater water consumption in the F&B industry, under a waste-water-energy nexus, by introducing advanced environmentally friendly technologies for water reclamation and reuse that will allow the use of reclaimed water in the processing chains of the industries. The project also targets waste and energy reclamation, optimization and management, leading to water and energy savings, environmental sustainability, cost savings and development of final added value products. Various solutions for water reclamation and reuse, by-products and waste valorization, energy recovery and rainwater harvesting are proposed and applied in four different demonstrators throughout Europe, that operate in different F&B sectors (beer manufacturing, dairy processing, meat processing, tomato processing, as well as fish processing and aquaculture). The proposed solutions are evaluated regarding their technical, economic and environmental feasibility, as well as their social impact and the key exploitable results are identified.

In order to disseminate the main technological innovations and valorize the project’s results to other regions and industries, enhancing circular economy approach and near-zero-waste processing, replication in other sites is assessed. The aim of Deliverable D9.5 “Replication Assessment Methodology” is to describe the methodology and the national, local, or regional regulatory frameworks that have to be taken into account in order to develop the replicability assessment of the AccelWater solutions to other selected sites.

AccelWater technologies for:

i) water reclamation
ii) waste valorization
iii) energy recovery and
iv) ICT systems for monitoring the new solutions for each one of the four demonstrators

are gathered, described and evaluated and their replication to interested stakeholders of various industrial sectors, municipalities, communities or others, is studied.

The selection of the replicable results, by AccelWater consortium, for each of the components studied (water reclaiming and reusing, waste valorization, energy recovery and reuse, ICT solutions) is based on technical and sustainability assessment, as well as legislative criteria. Relevant stakeholders mainly from the F&B industry at the same or different country will be identified and contacted for studying the replicability of the selected solutions on their sites. In order to select the best replicable solution, the national, local and regional policies, regulations and barriers will be analyzed and market size and readiness will be evaluated. Feasibility studies (D9.6) and sustainability assessment (based on WP8) will be used to finally evaluate the proposed solutions and present their replicability level.

2 AccelWater Project and Demonstrators

Since the F&B industry consumes high energy and water and produces huge amounts of waste and by-products, efforts to increase the water use efficiency, minimize freshwater consumption and lead to near-zero-waste production have to be taken into account. The AccelWater project develops, integrates and demonstrates water reclaiming and reusing technologies, waste valorization technologies and energy recovery and reuse technologies, under a water-waste-energy nexus, in order to use the reclaimed products and energy inside the plant or for other purposes. The project studies different sectors of the F&B industry, by optimizing various reclamation and valorization technologies, depending on the value chains and products' characteristics. It is structured in four different demonstrators throughout Europe, focusing on sectors that have high water use and energy consumption and produce widely used products. The four demonstrators include brewery, dairy, tomato processing, meat processing and fish processing industries (Figure 1) and are explained in more detail in the following sections.

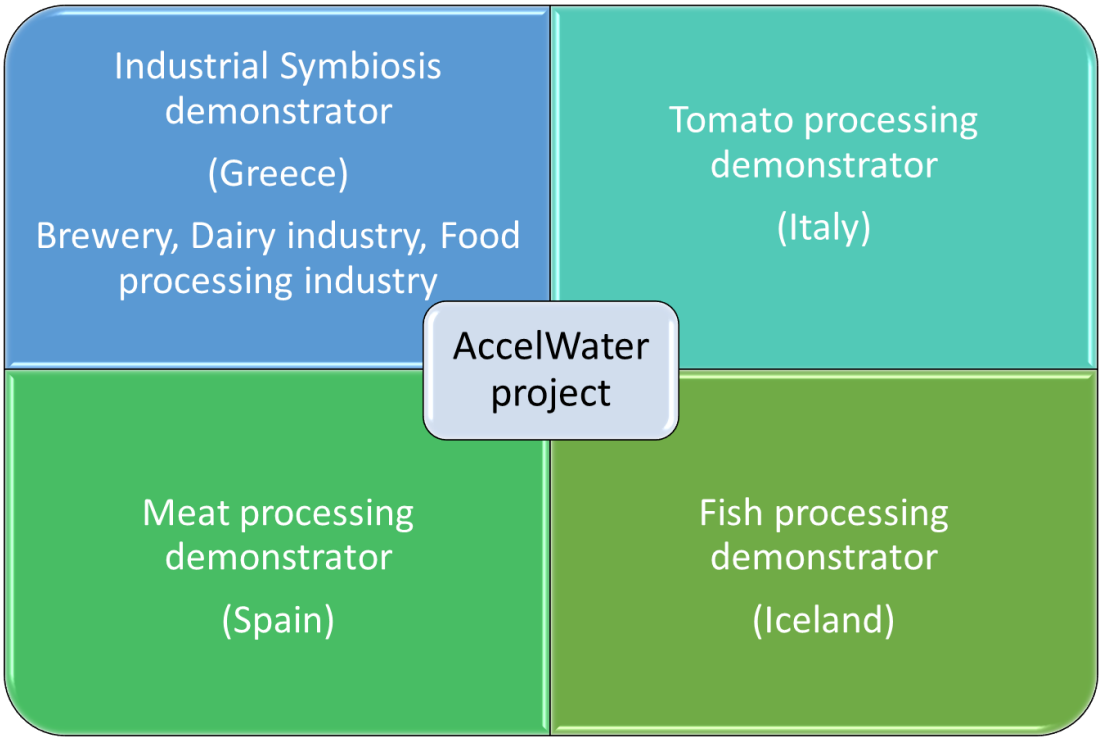

FIGURE 1: ACCELWATER DEMONSTRATORS

2.1 Industrial Symbiosis Demonstrator (Greece)

The Greek demonstrator is located in the Industrial Area of Patras and includes the symbiosis of three different food and/or beverage industries, operating in the fields of beer manufacturing, dairy processing and food processing. The industrial symbiosis demonstrator is described in the table below (Table 1).

TABLE 1: IS DEMONSTRATOR (GREECE)

Demonstrator	IS
Location	Industrial Area of Patras
IS partners	AB (beer industry) FCH (dairy industry) REZOS (food processing industry)
Other partners	NTUA DIGNITY AGENSO ICCS

The basic objectives of the IS demonstrator are to:

- ✓ Develop and optimize sustainable approaches, leading to water and energy saving
- ✓ Develop a novel rainwater harvesting system
- ✓ Valorise acid whey from dairy industry and spent grains from brewery for the recovery of valuable compounds
- ✓ Develop functional food products fortified with high added value ingredients
- ✓ Produce thermal energy and electricity from dairy and beer processing waste and by-products to be used on the symbiosis environment
- ✓ Reduce the volume of waste and by-products
- ✓ Assess the sustainability of the developed strategies and reduce the environmental footprint of the demonstrator

2.2 Tomato Processing Demonstrator (Italy)

The Italian tomato processing demonstrator is located in Castel San Giorgio and is described in the table below (Table 2).

TABLE 2: TOMATO PROCESSING DEMONSTRATOR (ITALY)

Demonstrator	Tomato Processing
Location	Castel San Giorgio
Industrial partner	CALISPA (tomato processing industry)
Other partners	PRODAL ANICAV

The basic objectives of the tomato processing demonstrator are to:

- ✓ Reduce energy costs
- ✓ Save Water

- ✓ Valorise tomato processing wastes, such as tomato pomace (peels and seeds) for the production of new food ingredients
- ✓ Reduce the volume of wastes and by-products
- ✓ Assess the sustainability of the developed strategies and reduce water and energy footprint of the processing industry

2.3 Meat Processing Demonstrator (Spain)

The Spanish meat processing demonstrator is located in Sant Joan de Vilatorrada and is described in the table below (Table 3).

TABLE 3: MEAT PROCESSING DEMONSTRATOR (SPAIN)

Demonstrator	Meat Processing
Location	Sant Joan de Vilatorrada - Manresa
Industrial partner	MAFRICA (meat processing industry)
Other partners	UVIC INNOVAC

The goals of the meat processing demonstrator are to:

- ✓ Save water and reuse it in MAFRICA's facilities
- ✓ Reduce meat processing wastes and by-products
- ✓ Produce products with a high agronomic value
- ✓ Recover Energy
- ✓ Assess the sustainability of the developed strategies and reduce water and energy footprint of the processing industry

2.4 Fish Processing Demonstrator (Iceland)

The Icelandic fish processing demonstrator is located in Akureyri and is described in the table below (Table 4).

TABLE 4: FISH PROCESSING DEMONSTRATOR (ICELAND)

Demonstrator	Fish Processing
Location	Akureyri
Industrial partner	ÚA, SAMHERJI (fish processing and aquaculture industries)
Other partners	MATIS UoI

The goals of the fish processing demonstrator in the context of the AccelWater project are to:

- ✓ Increase reuse water and energy in fish processing and land-based aquaculture
- ✓ Reduce fish processing wastes and by-products
- ✓ Valorisation of compounds from various water streams to produce products with high value
- ✓ Assess the sustainability of the developed strategies and reduce water and energy footprint of the industries

3 AccelWater Replication Assessment methodology

Replication assessment can be defined as the evaluation of the transferability to other stakeholders (industries, bodies, etc.), of solutions developed in the project. The developed technologies for i) water reclamation and reusing, ii) waste valorization and iii) energy recovery that lead to water/energy saving, reduced processing waste, economic feasibility and sustainable environmental performance, can act as examples for similar or different cases, at the same region or in other countries across Europe. The methodological approach and replication strategy is described in the following flowchart (Figure 2) and includes the following steps that are described in detail in the sections below (Baxevani et al., 2021; HYDROUSA, H2020; SmartEnCity, H2020; THERMOSS, H2020).

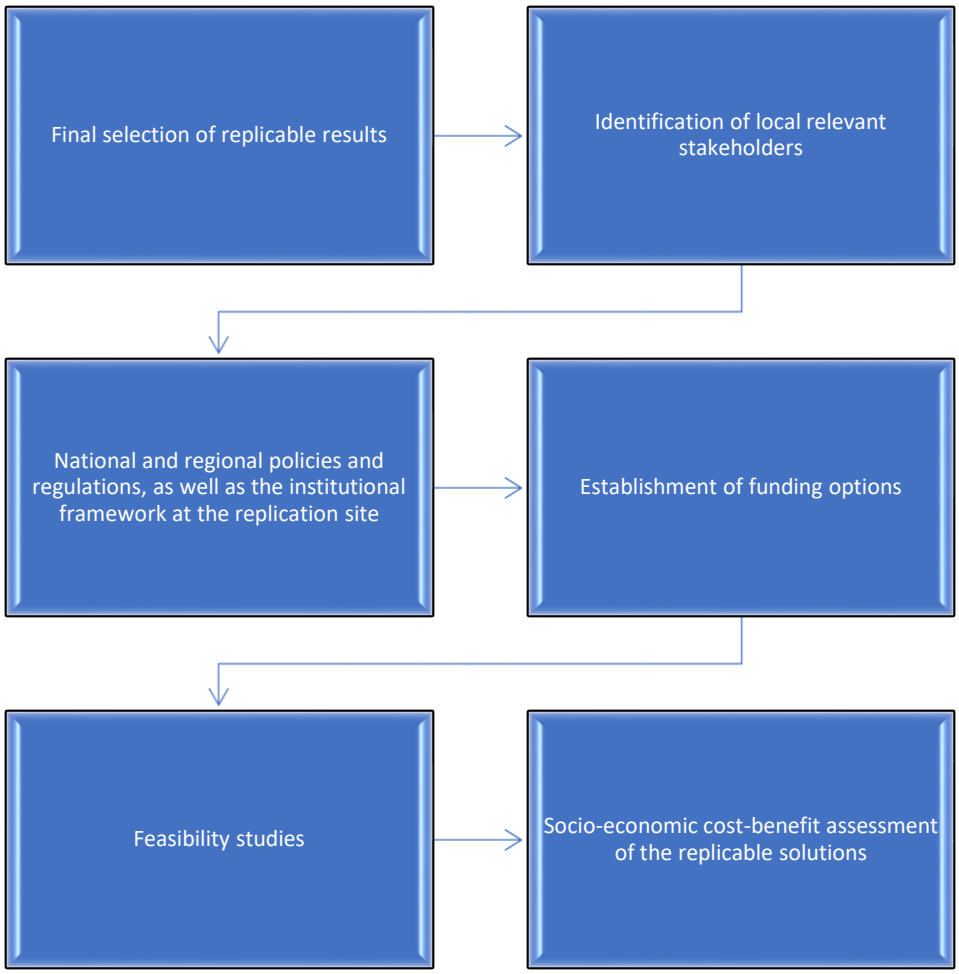

FIGURE 2. REPLICATION ASSESSMENT METHODOLOGY

3.1 Final Selection of Replicable Results

Each one of the four AccelWater demonstrators will integrate and demonstrate different water reclaiming, waste valorization, energy recovery and ICT technologies in order to achieve its specific and

distinct objectives. The table below (Table 5) presents examples of the possible solutions identified for each demonstrator case and for each specific component.

TABLE 5: ACCELWATER SOLUTIONS FOR EACH DEMONSTRATOR

Components	Demonstrator	Solution
Water reclaiming and reuse	Industrial Symbiosis demonstrator	Irrigation
	Tomato processing demonstrator	Reuse water on site
	Meat processing demonstrator	Reuse water on site
	Fish processing demonstrator	Reuse water on site
Waste valorization	Industrial Symbiosis demonstrator	Food/ingredients formulation
	Tomato processing demonstrator	Food/ingredients formulation
	Meat processing demonstrator	Agricultural bioproducts
	Fish processing demonstrator	Food/ingredients formulation
Energy recovery	Industrial Symbiosis demonstrator	Thermal energy and electricity
	Meat processing demonstrator	Biomass fuel
ICT solutions	All	ICT systems for monitoring the solutions

As soon as the technologies have been optimized, the demonstrators have been finalized and all the proposed solutions have been assessed, the final replicable results will be set for each case. The final selection of the replicable results for each component will be based on the final quality and quantity of the output (effectiveness, product, etc.), the product market, the sustainability assessment and legislative criteria. A brief description of the replicable solutions, containing information (in collaboration with WP8) on the results, the sustainability and technical issues will be presented in the deliverable describing the business plans and exploitation strategy (D9.2, due in M54). In addition, survey templates and questionnaires for national, regional and local regulations, institutional framework, technical data and requirements will be prepared.

3.2 Identification of Local Relevant Stakeholders

Two or three possible follower cases have to be defined for each demonstrator, from the networks of the AccelWater partners or from interested stakeholders outside the consortium. In order to select the stakeholders and replication sites, the following steps will be taken into account (Varvasovszky and Brugha, 2000).

3.2.1 Research for identification of potential stakeholders

Desk research will be carried out to identify the stakeholders in the first phase. Various industries with focus on the F&B sector, local communities, municipalities, etc. in the countries of the AccelWater consortium or across Europe, will be identified. Interviews with potential stakeholders will be conducted

in order to validate the data collected during the desk research and reveal their interest to examine the adoption of AccelWater replicable solutions. The more interested stakeholders will be selected.

3.2.2 Study of the Condition of the Follower Case

After the identification of the potential stakeholders, the following data will be collected, for each one of them:

- ✓ Information on the current situation of the industry/agency regarding the levels of water management, waste valorization, water, energy and/or waste reclamation
- ✓ Local needs

Depending on the data gathered and the status of the replication sites, the targeted stakeholders that can be potential beneficiaries of the replicable technologies of AccelWater will be selected. They will be informed about all the different identified replicable solutions and the most promising ones will be selected.

3.3 Policies, Regulations and Barriers at the Replication Site

In order to determine the potential of the solution to be replicated, the local regulations should be taken into account (HYDROUSA, H2020). The national, regional and local regulations, as well as the institutional framework for the replication sites will be studied in order to identify regulations for i) wastewater treatment, waste valorization, reuse of clean water, added value products or energy on site or outside the replication site, ii) costing and invoices services, iii) environmental management practices, iv) sewage or industrial waste disposal, etc. The permitting procedures and financing pathway for the integration and management of the solution on each case will be identified. The permitting pathway will decide the potential of the AccelWater solution to be replicated.

Indicatively, for the case of the AccelWater demonstrators, as well as for the EU, specific regulatory frameworks have been identified. For regional locations and other countries, a detailed study will be conducted.

In the EU specific regulations and directives have been developed regarding the water policy, water treatment and use. Indicative directives are listed below (Water Reuse Europe, 2020):

- Regulation (EU) 2020/741 regarding the requirements for water reuse
- Directive 2006/118/EC regarding the protection of groundwater against pollution and deterioration
- Directive (EU) 2018/2001 regarding the promotion of the use of energy from renewable sources
- Regulation (EC) No 2003/2003 regarding fertilisers
- Directive 2000/60/EC constructing a framework for action in the field of water policy
- Council Directive 91/271/EEC regarding urban waste-water treatment

- Regulation (EC) No 178/2002 establishing broad principles and requirements of food law, the European Food Safety Authority and procedures for food safety issues

Indicative national policies and regulations of the AccelWater countries hosting the demonstrator cases are listed below. Spain, Greece and Italy have their respective standards for water reuse.

In Greece, the following directives have been developed for the water reuse sector:

- Joint Ministerial Decision (KYA) 5673/400/1997 (B 192) on Measures and conditions for urban wastewater treatment
- Joint Ministerial Decision (KYA) 145116/2011 on Definition of measures, conditions and procedures for the reuse of treated liquid waste and other provisions
- Circular 145447 on Clarifications regarding the correct application of the KYA 45116/02-02-2011 (Government Gazette B΄354/2011) "Definition of measures, conditions and procedures for the reuse of treated liquid waste and other provisions".
- Circular 1589 on Clarifications regarding the correct application of the KYA 45116/02-02-2011 (Government Gazette B΄354/2011) "Definition of measures, conditions and procedures for the reuse of treated liquid waste and other provisions" after the issuance of Law 4014/2011 (Official Gazette 209/21-09-2011)
- Joint Ministerial Decision (KYA) 191002/2013 on Amendment of the KYA 145116/2011 "Definition of measures, conditions and procedures for the reuse of treated liquid waste (B' 354)" and other provisions

Indicative directives developed in Italy for water reuse follow:

- Legislative Decree 10 December 2010, n. 219, Implementation of Directive 2008/105/EC regarding standards of environmental quality in water policy sector, amendment and subsequent repeal of Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC, amendment of Directive 2000/60/EC and adoption of Directive 2009/90/EC establishing, in accordance with Directive 2000/60/EC, technical requirements for chemical analysis and water quality monitoring
- Decree 12 June 2003, n. 185, Regulation including technical standards for wastewater reuse in implementation of article 26, paragraph 2
- Legislative Decree 3 April 2006, n. 152, Environmental standards
- Legislative Decree 13 October 2015, n. 172, Implementation of Directive 2013/39/EU amending Directives 2000/60/EC regarding priority substances in water policy

Indicative directives developed in Spain for water reuse and treatment follow:

- Royal Decree RD 1620/2007 – Regulations for Reuse of treated wastewater
- Royal decree 1120/2012, of 20 July, modification of the Royal decree 140/2003, of 7 February, which establishes the sanitary criteria for water quality intended for human consumption
- Royal Decree 140/2003 of 7 February, on the establishment of the sanitary criteria for water quality intended for human consumption

- Royal Decree 2116/1998, of October 2, modification of the Royal Decree 509/1996, of March 15, for the development of Royal Decree-Law 11/1995, of December 28, which sets the requirements for the treatment of urban wastewater

Indicative directives for Iceland have been also identified:

- Act 36/2011 on water management
- Regulation 935/2011 on water management
- Regulation 535/20211 on the classification of water bodies, their properties, stress analysis and monitoring

3.4 Establishment of Funding Options

Possible funding options and financing models will be identified according to specific needs of the interested replication regions, resulting in different options for other interested locations/regions. Specifically, funding from European, national and international research and development programs (e.g. HORIZON-EUROPE, Interreg, etc.) will be identified as well as the use of public and private funding (e.g. funding from the EBRD, investors, Individual agreements, Public Private Partnership, Crowdfunding, etc.).

3.5 Feasibility Studies

Feasibility studies will be contacted in order to assess the capability, viability and sustainability of the proposed solutions to be replicated in other sites (Feasibility Study 2023a; Feasibility Study 2023b; Purwantono et al., 2021). The feasibility and assessment study of each replication site will be presented in the feasibility report. The report will also include the description of the replication site, regarding the status of the site, the geographical characteristics and the needs, as well as the proposed solution in detail. Regulatory data from the previous section, as well as technical, economic, market and social data will be collected. More details on the feasibility assessment methodology will be given on deliverable D9.6 “Feasibility studies for the replication of the AccelWater demonstrators” due in M54.

The feasibility study for the replication of the demonstrators to other stakeholders and regions, will be based on (HYDROUSA, H2020; Purwantono et al., 2021; THERMOSS, H2020):

- Technical analysis
- Investment analysis
- Market analysis
- Legal and Social analysis

3.5.1 Technical Analysis

The technical feasibility study will evaluate the capability of the selected stakeholders and replication cases to provide the technical assets to apply the proposed solution. The technical criteria that will be taken into account include firstly, the identification of the:

- location that the solution will be placed
- features and functionalities
- necessary equipment (sizing, type, etc.) and devices
- standardization of technology

Following, the existing equipment available in the replication site will be evaluated in order to explore the opportunity to be used for the needs of the replicable solution. Otherwise, the construction criteria will be defined. The replication site will also be assessed in terms of having the means to integrate the proposed solution, like the requested area, the required personnel, etc. Potential technical risks (i.e. scalability) will also be investigated and evaluated. The timeframe, the required financial resources and the final offered products and processes will also be defined for implementing the final proposition.

3.5.2 Investment Analysis

To implement an investment analysis, the economic feasibility of the proposed solution will be investigated. An AccelWater solution's potential performance level and suitability for a certain stakeholder will be assessed. The basic criteria that should be taken into account include:

- the costs of implementation, cost of equipment (maintenance, purchase), utilities, labor, depreciation, operating costs, etc.
- the suitable entry fee
- the anticipated payback period

The funding sources identified in the previous step will be also taken into consideration. The aim of implementing the investment analysis is to determine if the interested stakeholder is going to benefit from the proposed solution. The expenses that have been made prior to this investigation are not going to impact the final decision. Moreover, the cash flow due to the implementation of the selected solution, the timing, the possible financial schemes are crucial factors that have to be considered.

3.5.3 Market Analysis

The F&B industry will be segmented by product category (beer, dairy, meat, tomato, fish) and the different market sectors will be studied. Further segmentation will be applied depending on the market need (wastewater treatment, waste valorization, energy recovery, ICT solutions) or the type, location, revenue and size of the company. Desk research and Delphi survey will be conducted in order to analyze the market sector and the potential clients (Frewer et al., 2011; Okoli and Pawlowski, 2004; Padel and Midmore, 2005).

3.5.3.1 Desk research

Desk research involves analyzing and synthesizing information that has already been collected and published by others. Desk research is often conducted at the initial stages of a research project, as it can provide a broad overview of the market and help to identify potential customers. The advantage of desk research is that it is relatively cost-effective and can be conducted quickly, as the information is already available. However, the quality and reliability of the information collected through desk research depend

on the quality of the sources used and the validity of the information contained within them. Therefore, it is important to be accompanied by a second method for data collection.

3.5.3.2 Delphi survey

A Delphi survey usually consists of several rounds of data collection with controlled feedback. The Delphi approach first starts with the identification of experts. Subsequently, interview guidelines or questionnaires are developed. After the first round of interviews, the expert panel is reassessed and, if needed, new experts are recruited. The next step is to develop further interview guidelines or questionnaires based on the findings of the first round of interviews. The aim is to confront interviewees with pre-formulated hypotheses forged in previous interview rounds or derived from literature to verify these results.

Competitive analysis will also be performed in order to identify the performance of other competitors with similar products or services on the market. The competitors will be evaluated in terms of sales performance, general strengths and weaknesses and opportunities to learn from their techniques.

3.5.4 Legal and SocialAnalysis

The regulatory framework that will be analyzed will be taken into account for the legal feasibility study. Social analysis will be conducted to evaluate the acceptance of the replicable solution by society and the social effects it might have. It will evaluate criteria such as the following (Anabestani and Zareie 2017; Vaseghi et al, 2017):

- engagement and acceptance of the community
- creation of new jobs
- updating and informing the community on water reclamation, waste valorization and energy recovery technologies
- impact on health and safety
- impact on the local community

Questionnaires (based on WP8) will be distributed to the relevant stakeholders in order to evaluate the social feasibility of the proposed solutions.

3.5.5 Feasibility Analysis Score

Several criteria will be considered for assessing the feasibility of each replication site, as a result, a Multi-Criteria Decision Analysis (MCDA) will be performed in order to come to the conclusion for the appropriate decision (Bandaru et al., 2021).

The key criteria (technical, financial, market, social and legal) will be assessed according to their significance (score: f_i). In addition, the relevant sub-criteria ($N_{i,j}$) of each key criterion (N_i) will be scored in a scale of 1-10, based on set limits. The total score of each criterion is calculated in Equation 1.

EQUATION 1

$$N_i = \frac{\sum_{j=1}^{x} N_{i,j}}{x}$$

where x the number of sub-criteria of each key criterion.

The final score (S) is given by Equation 2.

EQUATION 2

$$S = \frac{\sum_{i=1}^{4} N_i \times f_i}{\sum_{i=1}^{4} f_i} \times 10$$

Sensitivity analysis will also be performed to evaluate the effect of the relevant criteria on the final score of the feasibility assessment.

3.5.6 Socio-economic Cost-benefit Assessment of the Replicable Solutions

Social analysis, environmental assessment and cost-benefit analysis of the selected replicable solutions, based on the results of WP8, will be conducted, revealing the impact on local and national economy and society, as well as on environment. The criteria taken into account include:

- public engagement
- job creation
- contribution to the local and national economy
- contribution to the social indicators of the region
- expected environmental impacts
- Social-NPV
- Social- IRR

The methodology that will be applied includes "Top-Down" and "Bottom-Up" approach, as well as the Benefit Transfer method. The "Top-Down" approach describes the effects (direct and indirect) of the studied solution on the local and national economy regarding macroeconomic indicators and examining aspects like employment, creation of differential income due to increased earnings, Gross Value Added, etc. The "Bottom-Up" approach is implemented based on the Social Cost-Benefit Analysis by recording, assessing and costing the social and environmental factors. The performance of the solution to the environment regarding various environmental factors, such as water resources, environment, biodiversity, etc., will be evaluated using the Benefit Transfer method, examining the impact on the air, groundwater, surface water, ecosystem, etc.

The social cost-benefit analysis will be carried out based on the Net Cash Flow, including social and environmental aspects. Indicators, such as the NPV, the IRR and the profitability to cost ratio will be used to determine the feasibility of the proposed solution.

4 Conlcusions

The methodology for evaluating the replicability potential of AccelWater solutions for the four demonstrators of the project has been described in detail in this deliverable.

Additionally, the basics steps to be followed and required data from the replication sites are presented in detail. Appropriate stakeholders either from the F&B industry or from municipalities, communities, etc. will be identified and the potential for replicability on their sites will be examined. Furthermore, details on the feasibility studies that will be implemented for each replication site are reported, including the criteria that will be taken into consideration. The feasibility and assessment studies for the replication of the demonstrators to Europe and other regions will be reported in deliverable D9.6 “Feasibility studies for the replication of the AccelWater demonstrators”.

Moreover, the methodology for assessing the socio-economic and environmental impact of the selected solutions has also been described. Finally, the replication methodology will be combined with other initiatives (i.e. other EU funded projects) for increasing the impact of the project.

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