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HOW TO IMPROVE INHABITANTS' ACCEPTANCE OF RAINWATER HARVESTING SYSTEMS? APPLICATION TO AN EXISTING COLLECTIVE RESIDENCE IN NORTHERN ALGERIA

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Abstract: In Algeria, at the present time, there are no rainwater harvesting systems (RWHS) registered with the public authorities as an alternative to the public water supply. This is explained by numerous factors, the most important being inhabitants' acceptance. The aim of this article is to investigate the current level of acceptance of an RWHS as a viable method for backing up the public water supply system. Our hypothesis is that inhabitants' acceptance can be improved by the increasing awareness of the benefits of an RWHS. For the purposes of this study, an RWHS located in northern Algeria was designed, and its benefits were measured and discussed with the direct participation of residents living in the building. The first benefit was the potential potable water saving (PPWS) and the second was the benefit-cost ratio (BCR). The PPWS was estimated at 51 m^3/year. The BCR was estimated at 7% (15% with local council funding). This paper shows that, in the case of an existing building, inhabitant acceptance of an RWHS depends on three factors: (1) the amount of rainwater delivered by the RWHS; (2) the cost of building and managing it; and (3) the extent of the modifications made to the building.

Keywords: rainwater harvesting system; inhabitants' acceptance; potential potable water saving; existing collective residence; northern Algeria

1. Introduction

Rainwater harvesting system (RWHS) is currently one of the most commonly used methods to sustainably manage water supply and conserve potable water supplies in urban areas (Abdulla, 2020; Lúcio et al., 2020). Rainwater use in developed countries has increased over the last decade. In France, for example, in 2012, 15% of apartment buildings and 25% of individual houses were equipped with a rainwater harvesting system (Belmeziti et al., 2014). However, in developing countries, the use of rainwater harvesting remains limited (Belmeziti, 2019). In Algeria, despite some areas having higher average levels of rainfall than France

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(particularly the north), rainwater harvesting is almost non-existent, except for some improvised systems in rural areas (Belmeziti, 2019). In Annaba, for example, a town in the north-east of Algeria, average rainfall is approximately 712 mm/year compared to 644 mm/year in some parts of France as Ile-de-France for instance (Infoclimat, 2023). Yet Algeria has significant problems with freshwater distribution and interruptions in supply are a daily occurrence for the inhabitants of major towns (Mokssit et al., 2018). In response to this problem, most of them have installed freshwater storage tanks for use when the water supply is interrupted. RWHS could contribute solving the problem of the scarcity of fresh water and the daily interruptions in supply in northern Algeria. Indeed, Algeria has experienced a 13% reduction in rainfall over the last twenty years (Nichane & Khelil, 2015), which has made drinking water management very problematic (Djaffar & Kettab, 2018). Rainwater could be harvested and used for activities that do not require drinking water (non-potable uses), such as watering plants and gardens, washing cars or floors, and flushing toilets. One of the challenges faced in installing a successful RWHS is inhabitants' acceptance (Campisano et al., 2017). The aim of this article is to investigate the current level of acceptance of an RWHS as a viable method for backing up the public water supply system. Our hypothesis is that acceptability can be improved by increasing the knowledge of inhabitants about the benefits of using an RWHS. More specifically, this study shows that the residents of the apartment building (case study) should be included in constructing the RWHS. This allows them to adjust the parameters of the RWHS to obtain benefits that meet their expectations, ensuring their cooperation in building and managing the RWHS.

2. Materials and methods

Inhabitant acceptance can be defined as an agreement between the residents of a building to use a non-conventional water supply system (Menegaki et al., 2007; Taher et al., 2019). Domènech et al. (2013) conducted a survey investigating the suitability of a non-conventional water supply system in Sabadell (a city close to Barcelona). Their results show that an RWHS is one of the most suitable alternative water supply systems. Nevertheless, several factors were cited as obstacles limiting inhabitant acceptance of an RWHS (Jing et al., 2018). One of the most significant barriers to developing RWHSs is the negative perception most inhabitants of residential buildings have of this solution (Ali et al., 2020). Mukarram et al. (2023) explain several reasons for this negative perception: risk to public health, management difficulties and responsibilities, installation and maintenance costs of an RWHS. For Domènech et al. (2013), health risk is the most important factor affecting residents' perceptions and attitudes toward using an RWHS. Goodwin et al. (2019) and Nkhoma et al. (2021) explain that health risks can be real (chemical or microbial) or perceived (misconceptions about rainwater). Afsari et al. (2022) found that the maintenance and management of the RWHS are also considered obstacles to developing an RWHS because the inhabitants have to manage the RWHS, rather than being simple consumers, as is the case for the conventional water supply system. Finally, for Maskwa et al. (2021) the cost of the RWHS can be a real barrier to implementation. However, they explain that this obstacle can be overcome by public funding or by constructing the RWHS in several phases. The best way to overcome these barriers, and consequently improve inhabitants' acceptance, is to explain the benefits of the RWHS. Indeed, numerous authors support this hypothesis. Takagi et al. (2019) show that one way to improve inhabitant acceptance of an RWHS is to provide information on the quality, quantity, and cost of the RWHS. Campisano et al. (2017) indicate that inhabitants’ acceptance is always challenging. They recommend broadly disseminating information on the benefits of using an RWHS to overcome this challenge. The scientific literature also examines the benefits of using an RWHS. Conserving fresh water supplies and saving money are the two most frequently mentioned benefits. However, other benefits cited include psychological benefits, along with awareness and support from public authorities (Table 1).

Table 1. The benefits of using an RWHS cited in the scientific literature

References	Benefits of using an RWHS		
	Fresh water saving	Money saving	Other*
Ali et al. (2020)	✓	✓	
Concha Larrauri et al. (2020)	✓	✓	✓
Campos Cardoso et al. (2020)	✓	✓	
Islam et al. (2010)	✓	✓	
Alim et al. (2020)	✓	✓	✓
Takagi et al. (2019)	✓	✓	
Pavolová et al. (2019)	✓	✓	
Toosi et al. (2020)	✓	✓	✓
Campisano et al. (2017)	✓	✓	
Thapa et al. (2022)	✓	✓	
Ghisi et al. (2014)	✓	✓	
de Gouvello et al. (2014)	✓	✓	✓
Molaei et al. (2019)	✓	✓	
Belmeziti et al. (2014)	✓		
Herrmann and Schmida (2000)	✓	✓	✓
Domènech et al. (2013)	✓	✓	
Morales-Pinzón et al. (2012)	✓	✓	
Meraj et al. (2021)	✓	✓	
Gu et al. (2015)	✓	✓	✓
Imteaz et al. (2012)	✓	✓	

Note. * Psychological, public authority awareness, reducing over-flow runoff, new business sector.

The fresh water saving is the quantity of fresh water that can be saved as a result of using rainwater from an RWHS instead of the fresh water through the usual supply systems (Ali et al., 2020; Belmeziti et al., 2016). In this case, the indicator most commonly used to evaluate the amount of potable water saved (and by extension the environmental benefits) is potential potable water saving (PPWS; Abdulla, 2020; Belmeziti et al., 2014; Belmeziti & de Gouvello, 2016). Abdulla (2020) defines the PPWS indicator as the amount of potable water that can be saved using the RWHS. For example, if the potable water consumption of an average family is 160 m^3/year, when the same family uses an RWHS, the amount of potable water consumed drops to 130 m^3/year. In this example the PPWS is 30 m^3/year.

Money saving is defined as the money that can be saved by inhabitants when an RWHS is used in conjunction with the conventional water supply system (Dallman et al., 2016). In order to quantify this factor, Maskwa et al. (2021) and Fonseca et al. (2010) suggest using a life-cycle costs approach (LCCA). This approach is based on collecting, understanding, and calculating the costs relating to the RWHS. These costs include all expenses relating to the system in both the short and long term (Fonseca et al., 2010). The costs generated by the RWHS include not only the cost of materials but also installation and maintenance costs. The net present value (NPV) is the most suitable method for assessing the economic benefit of an RWHS (Andrei, 2021; Pala et al., 2021; Sharma et al., 2009). This method considers the costs relating to the RWHS at all stages of its development (construction, use, and maintenance). It involves calculating the difference between spending and savings (Malinowski et al., 2015; Severis et al., 2019; Silva et al., 2015). The indicator most commonly used to calculate the money-saving benefit, in the case of RWHSs, is the benefit-cost ratio (BCR). The procedural approach employed for the computation of the two metrics is expounded as follows: PPWS and BCR are delineated in the subsequent section addressing the quantification of advantages associated with the utilization of RWHSs. Three separate stages were required to achieve the main aim of this study (i.e., to build an RWHS with the buy-in of the inhabitants of our case study apartment building). Three distinct stages were necessary to achieve the main objective of this study (i.e., to improve residents' acceptance —IAR of the RWHS by building the support of the residents of the apartment block in our case study; Figure 1).

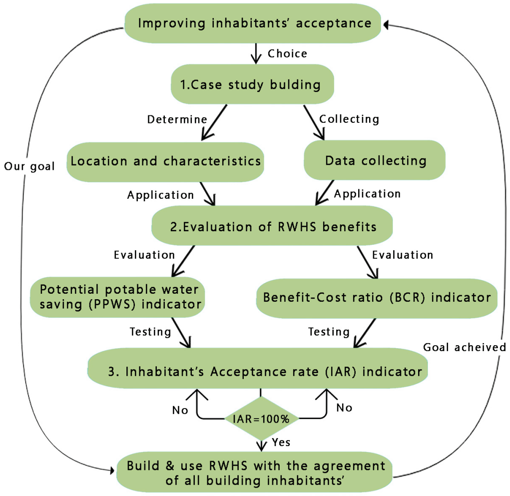


Figure 1. Method adopted to improve the acceptance of building and using a RWHS among inhabitants.

In the initial stage, a representative building in northern Algeria was carefully chosen for the case study, and necessary data for RWHS installation were collected. Ensuring residents' willingness to discuss RWHS installation was a crucial aspect. The second stage focused on measuring RWHS benefits in the chosen building using PPWS and BCR indicators. These results were then employed to persuade residents to adopt RWHS. In the final stage, involving the Results and discussion sections, efforts were made to convince building inhabitants to install an RWHS through meetings where benefits were explained using PPWS and BCR. Residents engaged in collective discussions with the aim of achieving unanimous agreement, measured by the IAR indicator, which calculates the percentage of residents accepting and using an RWHS.

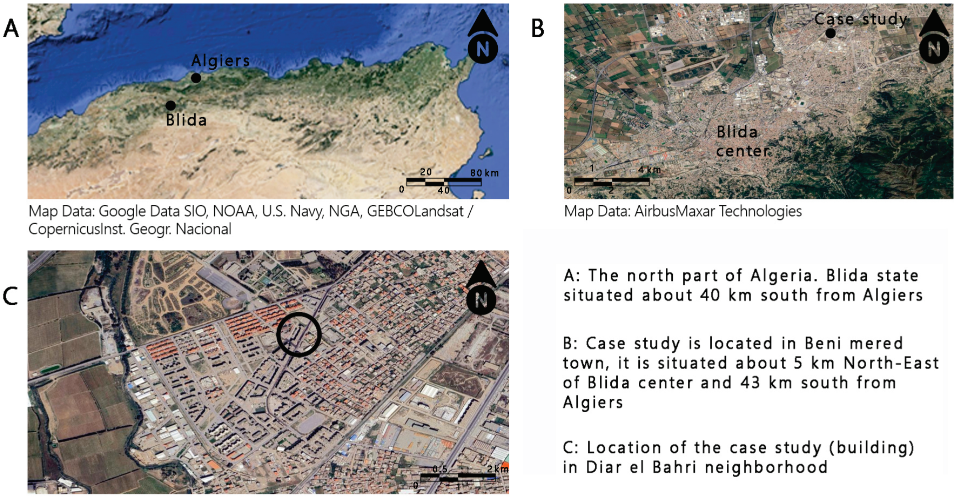
2.1. Case study

To explore the benefits of using an RWHS in northern Algeria we applied our methodology to a building representative of the most common types of residential accommodation found in the region. According to the Algerian National Office of Statistics (as cited in Belguidoum, 2021), 65% of the urban fabric in Algeria is composed of collective residences. In addition, urban analysis shows that most of these collective residences, in northern Algeria, have the following characteristics (Belmeziti, 2019):

- Between four and eight floors;
- No apartments on the ground floor;
- Two apartments per floor (6 to 14 apartments per building); and
- Each apartment is occupied by two to seven inhabitants (24 to 56 inhabitants per building).

2.1.1. Location and characteristics of the case study building

The building chosen for the case study has similar characteristics to those outlined above. It is a multi-story residential building in the department of Blida, 40 km south of the capital, Algiers, specifically, in the Diar-Al-Bahri neighborhood Beni-Mared (Figure 2). The building is situated approximately 5 km north-east of downtown Blida.



Map Data: Google Data SIO, NOAA, U.S. Navy, NGA, GEBCOLandsat / CopernicusInst. Geogr. Nacional

Map Data: AirbusMaxar Technologies

Map Data: Airbus

A: The north part of Algeria. Blida state situated about 40 km south from Algiers

B: Case study is located in Beni mered town, it is situated about 5 km North-East of Blida center and 43 km south from Algiers

C: Location of the case study (building) in Diar el Bahri neighborhood

Figure 2. Location of the case study building.

Note. Panel A: Blida’s department location. Panel B: Case study location from Blida center town. Panel C: Case study location (building). Map data from ”Google Earth (Version 10.43.0.2)” [Web browser app], by the Google LLC, 2023 (https://earth.google.com/). In the public domain.

2.1.2. Data collection

Three types of data are required to design an RWHS:

- Building data—two parameters regarding the building and its inhabitants must be established: the number of inhabitants and roof surface area (Belmeziti & de Gouvello, 2016). For our case study building, the number of inhabitants was determined by means of a survey (asking the inhabitants directly) during the first stage of our study. The case study building was found to be occupied by 45 inhabitants. It has six floors (the ground-floor is reserved for the plant rooms) and ten apartments. The second parameter (roof surface area) was measured directly in situ (Figure 3). The roof surface area of our case study is 219 m^2.

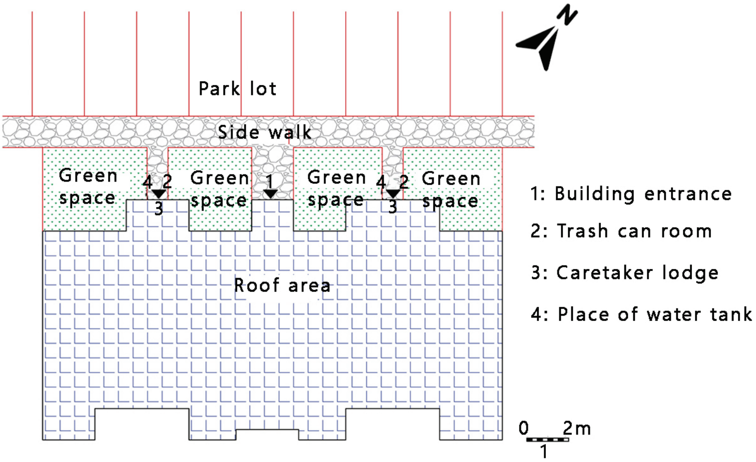


Figure 3. The roof area and outside spaces (top view) of the case study building.

- Rainfall data—the rainfall data used in this study were obtained from the weather station in Bouharoun, about 25 km from the case study building (latitude: 36.63194 °N, longitude: 2.65591 °E). The statistics correspond to the rainfall in the area for over ten years (from 2007 to 2017; Archive météo Blida, 2017). In addition, since the roof area of the case study building is a terrace composed of pea gravel, the runoff coefficient is fixed at 0.85. This means that 85% of the rainwater collected from the roof area runs into the tank. The other 15% is lost in the transfer or through evaporation (Belmeziti et al., 2014)
- Rainwater uses data—the rainwater collected by the RWHS is used for activities that do not require potable water, such as watering plants and gardens and rinsing pavements, car parks, washing the floors in communal areas and apartments, washing cars and flushing toilets.

Rainwater use is closely linked to the different spaces within the building, and three different scenarios were proposed to the inhabitants:

- Scenario 1 (Outside the building)—consists of using rainwater for outdoor watering and cleaning activities only. More precisely, this scenario covers three uses of rainwater: (1) watering plants and gardens, (2) rinsing pavements and car parks, and (3) car washing.
- Scenario 2 (Collective uses inside and outside the building)—includes using rainwater both inside and outside the building, but not inside the apartments. This adds one further use of rainwater (washing the floors in the communal areas) to those included in scenario 1. Thereby, this scenario involves using rainwater for four cleaning activities: (1) watering plants and gardens, (2) rinsing pavements and car parks, (3) car washing, and (4) washing the floors in communal areas.

- Scenario 3 (Outside and inside the building and inside the apartments)—consists of using rainwater both outside and inside the building, as well as inside the apartments. This means that two additional uses of the harvested rainwater are added to those included in scenario 2, making a total of six: (1) watering plants and gardens, (2) rinsing pavements and car parks, (3) car washing, (4) washing the floors in communal areas, (5) washing the floors in the apartments, and (6) toilet flushing.

2.2. Measuring the benefits of using an RWHS

In order to measure the benefits of using an RWHS (conservation of the fresh water supply and financial savings), we used the two indicators most often cited in the scientific literature: PPWS, to measure the amount of fresh water saved by using rainwater, and the BCR, to measure the financial benefits.

2.2.1. PPWS indicator

To calculate the PPWS, Belmeziti et al. (2014) developed a method expressing the curve depicting the Efficiency for water demand (*E*, %) as a function of the rainwater tank capacity (*C*, m^3).

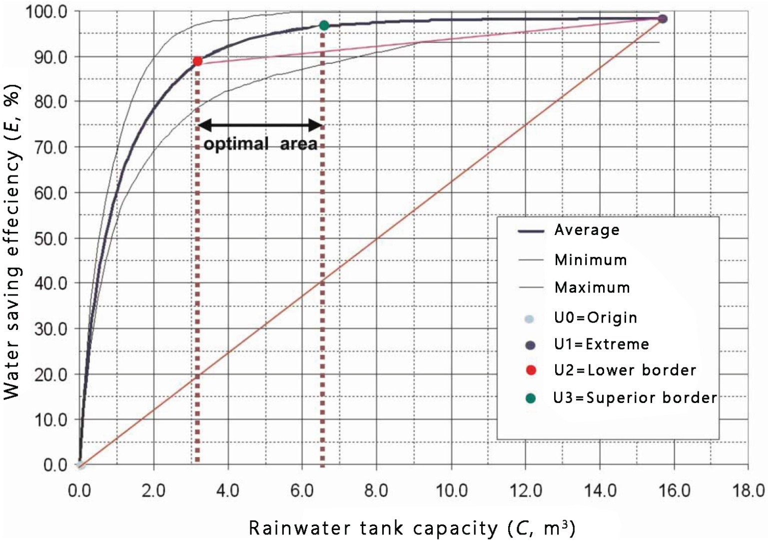


Figure 4. The curve used to calculate PPWS.

Note. Adapted from "Development of a tool to help size recovery tanks adapted to the Mediterranean context" by B. de Gouvello, S. de Longvilliers, C. Rivron, C. Muller, & P. Lenoir, (June 27–July 1, 2010), 10th international conference of urban water "Novatech" (p. 5). Lyon, France (https://hal.science/hal-03296687/document). BY-NC-SA 4.0

This curve is usually used by the engineers as a tool to help the decision-maker to choose the size of storage and to know the average PPWS expected in the RWHS. For this, the engineers determine an "optimal area". It is considered as the most favorable area between the capacity of the tank and water efficiency supply (Figure 4). The decision-maker is able to select a point within this area (optimal point for them). On this curve, the *E* represents the ratio between the rainwater used and total water demand *D*. The PPWS can then be calculated by simply multiplying the *E* by the *D* (Belmeziti et al., 2014).

de Gouvello et al. (2010) introduced an automated method for extracting the "optimal area" by establishing a series of points (Un) on the curve. The sequence is defined as follows: U0 = (0, 0) is the starting point, U1 = (Max *E*, Min *V*) is the initial point on the curve *E*(*V*) where *E* no longer increases, and U (n + 2) is the point where the tangent to the curve is parallel to the right segment [Un, U (n + 1)]. The authors showed that, considering the characteristic shape of this type of curve, points U2 and U3 provide good approximations of the lower and superior borders of the optimal area. The decision-maker decides upon a point (Uopt) within this "optimal area".

Finally, the PPWS indicator is calculated by Equation 1:

$$\text{PPWS (m}^3\text{/year)} = E \cdot D \tag{1}$$

The *E* value depends on the value of the rainwater capacity, it is recommended to choose a point inside the "optimal area" (Figure 4) to obtain a balanced ratio between the *C* and *E*.

2.2.2. BCR indicator

Ali et al. (2020) explain that the BCR can be considered as the ratio between the total profit and the total investment in the RWHS. The total profits cover the money saved by reducing the consumption of potable water through rainwater use. The total investments include both installation and maintenance costs, which are calculated on the assumption that an RWHS has a lifespan of between 20 and 30 years (Zhou et al., 2023). Ali et al. (2020) use Equation 2:

$$\text{BCR} = TB/PV \tag{2}$$

where *TB* represents the total benefits and *PV* the total investments. The following Table 2 summarizes the benefits of RWHS and the indicators used to measure them.

Table 2. Details of the indicators chosen to measure the benefits of RWHS

Benefits	Indicators	Short definition	Principle of the evaluation method	Unit of measurement
Potable water saving	PPWS	The quantity of potable water saved by using the RWHS instead of the current potable water system	Rainwater tank capacity and water saving efficiency curve (Belmeziti et al., 2014)	m^3/year
Money saving	BCR	The ratio between the total profits and total investment in an RWHS	Calculate the overall cost of using the RWHS and compare it with the money saved by not using potable water (Ali et al., 2020)	%

3. Results and discussion

The results are structured around an account of the three meetings held with the inhabitants of our case study building, in which we explained the benefits of using an RWHS based on our theoretical results. Each meeting focused on one aspect of our theoretical results, after which the inhabitants of the building were invited to discuss what had been presented and come to a collective decision.

3.1. Meeting one: presentation of the PPWS indicator

At this first meeting, we presented the results of a simulation of the three different scenarios for the possible uses of rainwater in the form of curves (rainwater tank capacity and water saving efficiency; Figure 5).

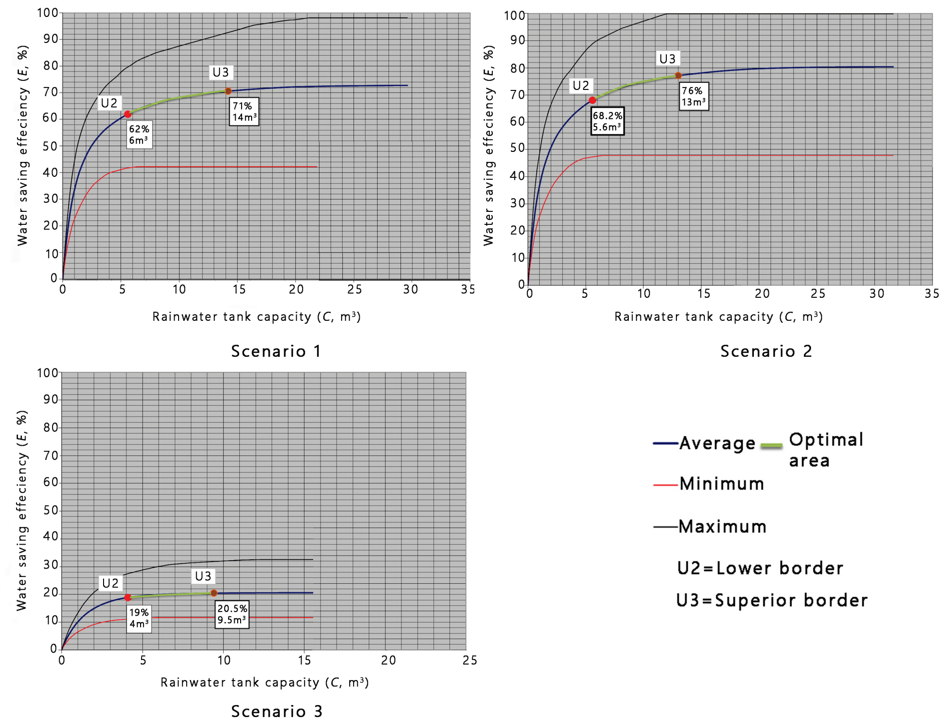


Figure 5. Simulation results of the three rainwater use scenarios 1, 2, and 3.

Table 3 simplifies the interpretation of the curves and calculation of the PPWS indicator. It not only informed the inhabitants of the three water use scenarios and their potable water consumption, but also defined the limits of the optimal area (points U2 and U3). To calculate these points, we use their values in each curve and the Equation 1. For each of these points, the water-saving efficiency and the rainwater tank capacity were taken directly from the curves, and the PPWS indicator was calculated.

Table 3. Explanation and simplification of the results of the curve simulation

Scenario number	Volume of potable water consumed (m^3/year)	E (%)		C (m^3)		PPWS (m^3/year)	
		U2	U3	U2	U3	U2	U3
Scenario 1	38.332	68.2	76.0	5.6	13.0	26.1	29.1
Scenario 2	71.908	62.0	71.0	6.0	14.0	44.6	51.1
Scenario 3	713.920	19.0	20.5	4.0	9.5	135.6	146.3

This table showed to the inhabitants that the *E* and consequently the PPWS indicator values were similar at the two points, U2 and U3. For example, under scenario 1, *E* was 68.2% (PPWS = 26.1 m^3/year) at point U2, and 76% (PPWS = 29.1 m^3/year) at point U3. However, the rainwater tank capacity *C* varied widely between these same two points. For the same scenario, *C* at point U2 was 5.6 m^3, whereas at point U3, it was 13 m^3. Based on these observations, the inhabitants decided to choose point U2 rather than the other points on the curve. They considered that point U2 had the best ratio between the PPWS indicator and the rainwater tank capacity *C*. The residents' second observation focused on scenario 3, noting its low water saving efficiency (19% at point U2) and a disproportionately low PPWS of 135.44 m^3/year compared to the volume of potable water consumed without the RWHS. They were also reluctant to install a second pipe network in their apartments, as scenario 3 involved flushing toilets with rainwater. Consequently, scenario 3 was eliminated. The third observation involved a comparison between scenarios 1 and 2. Residents found similar tank capacities but favored scenario 2 due to its higher PPWS (44.60 m^3/year), additional rainwater uses, and unanimous agreement among inhabitants was reached. As a result, scenario 2 was chosen as the basis for installing the RWHS, and residents requested a cost estimate for its implementation.

3.2. Second meeting: the BCR indicator

To calculate the overall cost of installing a RWHS, we requested estimates from relevant experts based on the specifications for the scenario selected by the building's residents (notably tank capacity). The following table is a summary of these estimated costs.

Table 4. The quote of the overall cost of the RWHS

Scenario number	Construction investment (to install a functional RWHS)			Total (DZD*)	Maintenance investment (annual cost: starting as of the second year after the RWHS is put into operation)	
	Cost of tank (DZD)	Cost of other parts (DZD)	Cost of installation (DZD)		Cost of annual inspection* (DZD/year)	Cost of potential replacement of parts* (DZD/year)
Scenario 2	100,000	20,000	10,000	130,000	2,500	2,500

Note. *This cost is increased by 5% every 5 years to cover future price rises (inflation National Statistics Office, Algeria, 2023). Algerian dinar (DZD; local currency at date 27/11/2023): 1 American dollar (USD) equals 134.21 DZD.

The experts divided the cost into two components. The first component, the cost of installing the RWHS and putting it into service, was further divided into three sub-components: the cost of the tank (the most important and most expensive piece of equipment), the cost of other parts (pipes, faucets, etc.) and the cost of installation. The second component concerned maintenance costs. This covered the estimated expenses to ensure the RWHS's continuity of service over the period of 20 years (the tank has an estimated lifespan of around 20 years). This component included the cost of professional servicing and an estimation of the cost of new parts for the RWHS that might be required over its lifetime.

These costs were considered by comparing the money spent on the RWHS and the money saved by not using potable water from the public network system. The following table summarizes the spending/savings for each 10 years (in order to fully inform residents) after the installation of the RWHS.

Table 5. The BCR indicator calculation

Scenario number	After 10 years			After 20 years		BCR indicator
	Money spent (DZD)	Money saved (DZD)	Money saved/ Money spent (%)	Money spent (DZD)	Money saved (DZD)	Money spent/ money saved (%)
Scenario 2	178,500	7,749	4.34%	237,250	16,292	6.86%

During the second meeting with building residents, Tables 4 and 5 were presented, highlighting that the BCR indicated minimal monetary gains, with only 6.86% savings after 20 years of RWHS use. Despite heated debate among residents, with 4 out of 10 in favor due to environmental benefits, the majority opposed installation, emphasizing the low economic return. To break the deadlock, the suggestion was made to seek funding from the local council. All residents eventually agreed, requesting minimal building changes. The project was submitted to the council, and four weeks later, they confirmed partial financing for the RWHS construction.

3.3. Third (final) meeting: IAR indicator

For this third, and final, meeting with the inhabitants, new documents (Table 6 and Figure 6) were drawn up for their consideration.

Table 6. The BCR indicator calculation with council funding

Scenario number	Part—financed by the municipality			Part—financed by the inhabitants		BCR indicator: Money spent/ money saved (%)
	Cost of tank (DZD)	Cost of other parts (DZD)	Cost of installation (DZD)	Cost of annual inspection* (DZD/year)	Cost of potential replacement of parts* (DZD/year)	
Scenario 2	100,000	20,000	10,000	2,500	2,500	15%

Note. *This cost is increased by 5% every 5 years to cover future price rises (inflation National Statistics Office, Algeria, 2023). Algerian dinar (DZD; local currency at date 27/11/2023): 1 American dollar (USD) equals 134.21 DZD.

As this table shows, even though the council agreed to cover a substantial proportion of the installation costs, the BCR indicator remained relatively low (only 15% compared to

6.86% without council funding). However, the building residents unanimously agreed to install the RWHS. Their decision was based on three factors: (1) the improved ratio between spending and savings compared to the initial proposition (15% instead of 6.86%); (2) the cost would be spread over twenty years (while the overall cost of the RWHS, over the period of 20 years is 100,000 DZD, the inhabitants only have to pay 5% a year (i.e., 5,000 DZD); (3) the council would finance the majority of the work to install the RWHS (55%: 130,000 DZD) in advance (before construction). Finally, a proposed RWHS, based on their chosen scenario, was presented to the building's residents for approval (Figure 6).

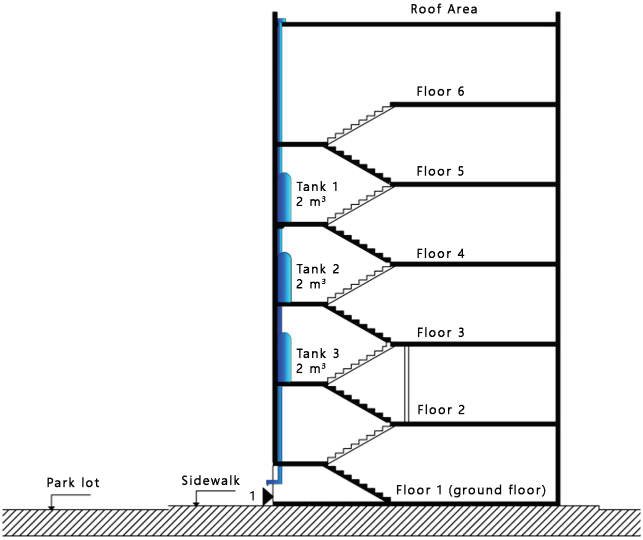


Figure 6. The technical team's proposal for an RWHS (approved by the building's inhabitants).

The inhabitants all agreed to the proposal drawn up by the technical team. The minimal alterations to the building were the main factor in securing this unanimous decision. Indeed, the technical team was able to use the original rainwater gutter which was simply cut into three sections to install the three tanks (each with 2 m^3 capacity, one on each of the upper floors: 3, 4, and 5). The existing faucet outside the building was also used.

4. Conclusion

This paper aimed to boost acceptance of RWHSs in northern Algeria by utilizing the IAR indicator. The study involved informing and engaging residents in the decision-making process for installing an RWHS, considering their needs. For the first indicator, PPSW, the building's inhabitants could choose one of the three possible scenarios of rainwater use: (1) outside the building: using rainwater for outdoor watering and cleaning activities only (PPWS = 29.1 m^3/year); (2) outside and inside the building: using rainwater both inside and outside the building, but not inside the apartments (PPWS = 51.1 m^3/year); and (3) outside and inside the building and inside the apartments: this means that two additional uses for the harvested rainwater are added to those included in scenario 2 (PPWS = 146.3 m^3/year).

They chose scenario 2 (to use the rainwater outside and inside the building, but not inside the apartments). Under this scenario, the PPWS indicator was calculated to be approximately 51.1 m^3/year. Specifically, the rainwater harvested by the system could cover 76% of the water demand outside and inside the building.

Concerning the second indicator, BCR, the building inhabitants observed no real financial benefit from using an RWHS. They argued that, at the end of the RWHS's lifespan, more money would have been spent (237,250 DZD) on installing and maintaining the system than money saved (16,292 DZD) from using rainwater instead of potable water. The BCR at this point was estimated at only 4.14%. Because of the low BCR, the residents refused to install the RWHS in their building. However, with council funding (covering the construction of the RWHS), this ratio increased to 15% which led the residents to agree to install the RWHS. This case study shows that active participation and unanimous agreement from all residents are required to improve inhabitants' acceptance of RWHS. It also shows that an IAR of 100%, meaning that all the building inhabitants agree to use the rainwater, can only be obtained by increasing the inhabitants' awareness of the benefits of the RWHS. Our research highlights three factors that influenced the IAR indicator: 1) the financial benefit of the RWHS, 2) the use of rainwater, and 3) the alterations to the building. Finally, this study will only be fully completed when we have followed up on the RWHS post-installation and are thus able to properly assess the three indicators (PPWS, BCR, and IAR). An inspection of the RWHS once it is fully operational is therefore planned.

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