



Ministry of Foreign Affairs of the
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Exploring Sustainable Solutions: A Study on Wastewater Treatment and Reuse in Car Wash Services in Duhok, Kurdistan.

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Abstract

Water scarcity is a critical global issue, and the city of Duhok, Kurdistan, faces similar challenges due to increasing water demand and regional environmental constraints. This study, *Exploring Sustainable Solutions: A Study on Wastewater Treatment and Reuse in Car Wash Services in Duhok, Kurdistan*, investigates innovative methods to address water conservation in the car wash industry. Car wash facilities consume substantial water resources and generate significant wastewater, making them a prime focus for sustainable practices. The research evaluates the feasibility of wastewater treatment and reuse in local car wash services through diverse methods, including gravity settling tanks, hydro cyclone systems, and UV disinfection. Data collection involved participatory action research (PAR) methods such as interviews, focus group discussions, and questionnaires with 131 participants from varied backgrounds. The results highlighted strong community support for implementing wastewater treatment systems, with 66% of participants willing to pay extra for services utilizing recycled water. Challenges such as high initial costs, limited awareness, and space requirements were identified as barriers. The findings underscore the importance of integrating government support, public education, and technical innovations to promote sustainable water practices. By adopting wastewater treatment systems, car washes in Duhok can contribute significantly to water conservation and environmental sustainability while setting an example for other industries facing similar challenges.

Introduction :

Around one billion people in the world lack access to clean drinking water, with many living in arid or semi-arid regions [1]. Additionally, three out of four jobs worldwide are water-dependent, and lack of access is limiting economic growth in some developing countries [2].

Water security in Duhok, Iraq, faces significant challenges due to a confluence of factors, including climate change, increasing water demand, and regional water disputes. This necessitates a multifaceted approach that prioritizes water conservation, infrastructure development, and regional cooperation to ensure a reliable and sustainable water supply for the growing population. With all the environmental problems and water shortages, going green is a must for every business, including car washes, which use tons of water. This study, "Exploring Sustainable Solutions: A Study on Wastewater Treatment and Reuse in Car Wash Services in Duhok, Kurdistan," investigates new ways to save water and protect the environment in that industry.

Duhok, a rapidly growing urban area in Kurdistan, is witnessing an increase in car wash facilities, each contributing to significant water use and wastewater generation. The study will explore various wastewater treatment methods and their feasibility, focusing on the application and benefits of reusing treated water in car wash operations. By analyzing the efficiency, cost-effectiveness, and environmental impact of different filtration technologies, the research seeks to propose viable solutions that can be implemented locally to enhance sustainability. Through this research, we intend to shed light on the importance of adopting eco-friendly practices in car washes and provide actionable insights that can help mitigate the environmental footprint of such services. By advancing our understanding of wastewater treatment and reuse, this study will contribute to the broader goal of water conservation and sustainable development in Duhok and beyond.

Our aim of this research is to find a way or a solution for wastewater treatment and reuse in car wash surfaces. If we asked our self What Is a Car Wash Water Reclamation

System? The answer will be A car wash water reclamation system collects leftover water, treats it to remove contaminants and pollutants, and reuses it for subsequent washes. Like (Gravity Settling Tanks, Hydro cyclone Systems, Sand Filtration Systems, Activated Carbon Filtration Systems) , Each of them have their different way to work , for example UV (Ultraviolet) Disinfection Systems: UV disinfection systems are utilized in everything from reusable water bottles to McDonald's restrooms in Japan. Though UV filtration doesn't filter out particulate matter, it does deactivate or kill microorganisms, such as bacteria and viruses. It's a great final treatment in your water reclamation process. UV disinfection addresses potential microbial concerns by subjecting the water to intense UV-C light before refilling your car wash tank.

There are other countries that use this system like Germany, Australia, Belgium, Scandinavia countries, and the United States. For instance, in Belgium, car wash facilities implemented wastewater recycling proactively, preceding the 70% recycling mandate. Similarly, in Scandinavian nations, water usage restrictions, exemplified by the Netherlands' 70-liter-per-vehicle limit, have spurred the development and adoption of water-efficient technologies. And here are some of those systems, And water treatment and reuse practices in car washes are likely to expand in the future as environmental awareness and water scarcity issues intensify globally.

Data Collection Activities:

Interviews:

- Number of interviews conducted: 26
- Interviewees: The interviews conducted as part of the Participatory Action Research (PAR) project on wastewater treatment and reuse in car wash services included 26 individuals aged between 19 and 60, from diverse professional backgrounds. The participants included:
 1. Teachers (9 individuals)
 2. Engineers (5 individuals)
 3. Students (5 individuals)
 4. Lawyer (1 individual)
 5. Taxi Driver (1 individual):

6. Doctor (1 individual)
7. Nurse (1 individual)
8. Cafe Server (1 individual)
9. Farmers (2 individuals)

The diversity in professions and age groups ensured a comprehensive understanding of the challenges and opportunities related to wastewater treatment and reuse in car wash services. This data will inform actionable strategies tailored to the local context of the Duhok region.

▪ Summary: The interview data involves feedback from individuals regarding car wash services, focusing on water use, wastewater treatment, and environmental practices. Below is a summary of the key points:

1. Frequency of Car Wash Use: Responses range from weekly to as needed, with some participants using car wash services more in specific seasons (e.g., winter for dirty weather or summer for increased car use).
2. Spending on Car Washes: Typical spending ranges from 5,000 to 10,000 IQD per service.
3. Seasonal Use: The most common seasons for car washes are summer (due to increased car usage) and winter (to combat weather-related dirt).
4. Awareness of Environmental Practices: Most respondents are unaware of water-saving measures in current car wash services, though one participant had heard of such systems.
5. Support for Wastewater Treatment: All participants expressed positive views on implementing wastewater treatment systems in car washes, citing potential water conservation and environmental benefits.
6. Filtration Systems: Participants agreed that filtration systems in car washes could reduce water scarcity and waste, with some highlighting potential reductions in water use by up to 50%.
7. Community Support: Many believe people will support and use car washes with wastewater treatment systems, though cultural acceptance may vary.
8. Impact of Pollution: Air pollution and the rising number of cars are seen as significant contributors to increased car wash use.

9. Policies to Limit Home Car Washing: Most respondents supported policies limiting home car washing if wastewater treatment is available in car washes, provided there is government and media support.

10. Government Role in Water Scarcity Management: Participants believe implementing wastewater treatment in car washes would be highly effective in helping the government manage water resources.

11. Willingness to Pay More: Many respondents are willing to pay extra for services that use treated or recycled water, provided the service quality is maintained.

12. Barriers to Implementation: The main barriers identified include high initial costs, space requirements, and societal acceptance.

13. Additional Comments: Some suggest using advanced filtration mechanisms or government support to make such initiatives successful.

o Focus Group Discussions (FGDs):

- Number of FGDs conducted: 3 FGDs
- Locations: Cafe, College, Car Wash Services
- Participants: [Number of participants per FGD, description of participants]
 - Cafe FGD: 5 participants.

1. Muhamad, Volunteer, 25 years old

. 2. Jotyar, Teacher, 41 years old.

3. Azady, Student, 21 years old.

4. Zeravan, Teacher, 33 years old.

5. Planting Engineer, 36 years old (Name not provided).

- College FGD: 5 participants.

1. Mahabd, Student, 22 years old.

2. Hivi, Student, 20 years old.

3. Derin, Student, 21 years old.

4. Muhamad, Student, 19 years old.

5. Mahir, Student, 20 years old.

- Car Wash FGD: 4 participants.

1. Aryn, Manager of Car Wash, 35 years old.

2. Omid, Worker, 26 years old.

3. Hady, Worker, 33 years old.

4. Ayad, Worker, 24 years old.

▪ **Summary:** To address water scarcity in Duhok City, wastewater treatment systems in car wash services were explored through three FGDs held at a café, a college, and a car wash, involving 14 participants from diverse backgrounds, including students, teachers, and car wash workers. Key insights emphasized the importance of equipping car wash services with affordable filtration systems, supported by government subsidies, technical training, and awareness campaigns. Encouraging residents to use treated water services and regulating home car washing were highlighted as essential strategies to promote sustainable water use and reduce waste, combining technical feasibility, stakeholder perspectives, and policy support.

o **Questionnaires:**

▪ Number of questionnaires distributed: 91

▪ Type of collecting data: The data can be categorized into the following:

1. Quantitative Data (Numerical Data) - Count of individuals based on gender (e.g., Male: 46, Female: 45).

- Count of individuals by profession (e.g., Teacher: 30, Student: 33, Engineer: 8).

- Total sample size (91).

- Age range (17–56 years).

2. Qualitative Data (Categorical Data) - Gender (Male, Female).

- Occupations (e.g., Engineer, Taxi driver, Doctor, Housewife).

▪ Number of questionnaires returned: 91

▪ Target population: community from ages group between 17-56 from a variety of occupational backgrounds including professionals, workers and students

▪ **Summary:** The results obtained give insights into car wash service usage in Duhok City, emphasizing public opinion on water conservation and wastewater treatment in car wash services. Key findings include:

1. **Demographics:** Participants were nearly equally distributed by gender (46% male, 45% female). Occupations ranged widely, with students (31%) and teachers (21%) being the largest groups.

2. **Car Wash Usage Patterns:** ○ Frequency: 38% use car wash services weekly, and 28% monthly. ○ Spending: The majority (66%) spend 5,000–10,000 IQD per visit. ○ Seasonality: Summer is the peak season (50%).

3. Awareness and Attitudes:

- Environmental Practices: 59% are unaware of water-saving practices in car washes.
- Support for Wastewater Treatment: A significant majority (86%) agree or strongly agree that installing treatment systems could reduce water scarcity.
- Willingness to Pay Extra: 66% are willing to pay more for services using treated or recycled water.
- Regulations on Home Washing: 75% support or strongly support limiting home car washing if wastewater treatment is available.

4. Challenges and Effectiveness:

- Key Challenges: Lack of government support (56%), limited public awareness (48%), and high costs (44%) are the main obstacles to implementing water treatment systems.
- Perceived Effectiveness: Most respondents (79%) believe these systems would be very or somewhat effective in addressing water scarcity.

5. Sustainability:

- 88% agree or strongly agree that sustainable water usage in car washes would help preserve resources for essential uses.

6. Additional Comments: Suggestions include modernizing car wash equipment, improving worker awareness of water conservation, and introducing government regulations to encourage efficient water use.

Current Status of the Project

- preliminary data analysis are done

Challenges Faced

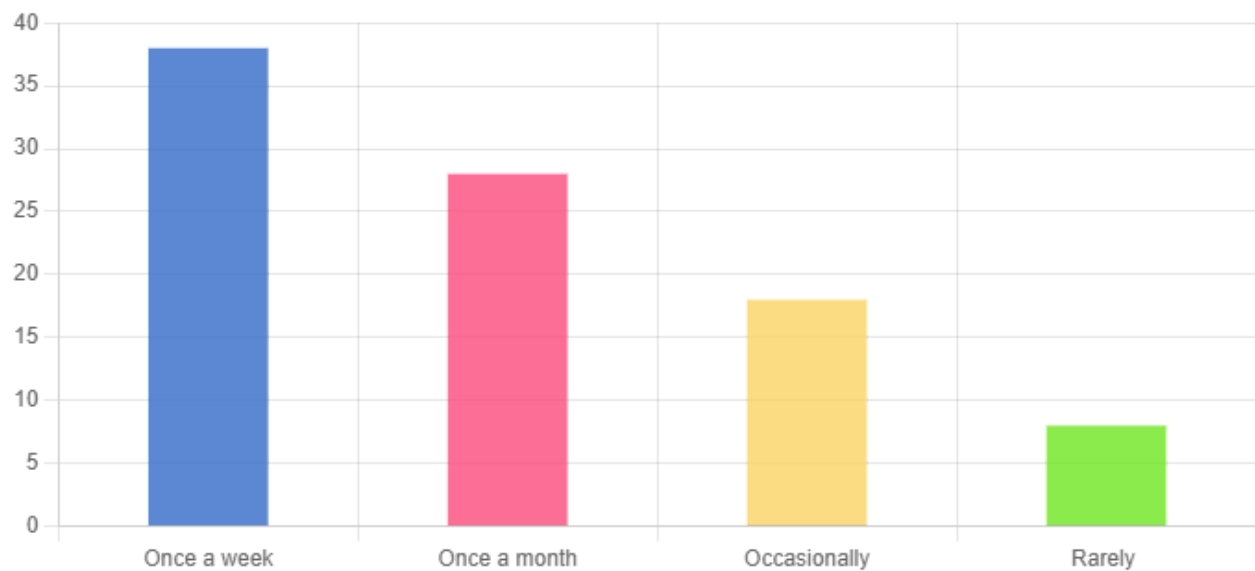
- None

Results:

Questionnaire Method:

1- How often do you use car wash services?

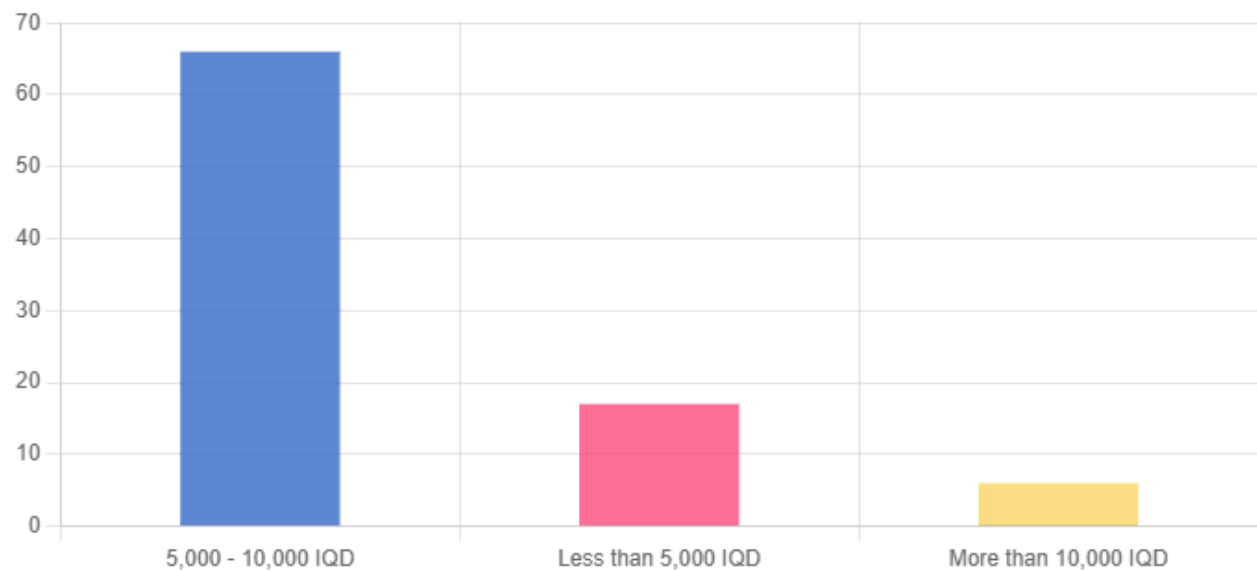
This chart describes 41.7% of participants say once a week. And 30.77% say it once a month.



Value	Frequency	Percentage
Once a week	38	38
Once a month	28	28
Occasionally	18	18
Rarely	7	7

2-On average, how much do you spend on car wash services per visit?

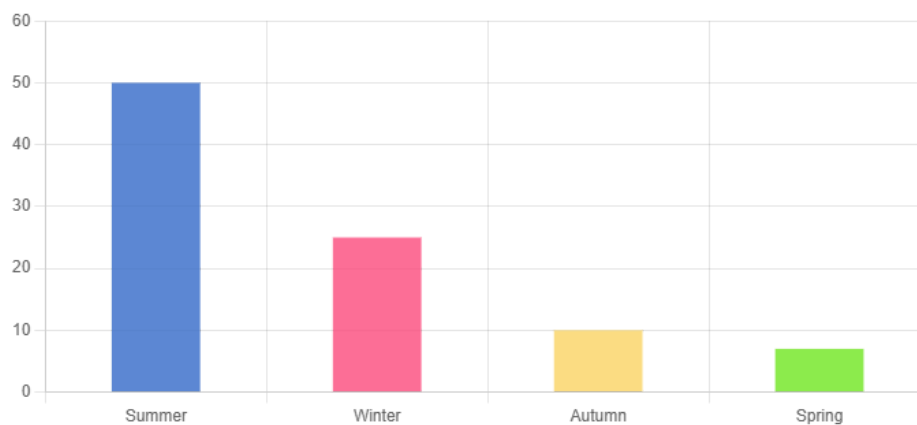
The below shows that 73.5% of participants say 5,000 - 10,000, Because most of the car washes charge people 5,000 IQD. And maybe some places charge more than 10,000.



Value	Frequency	Percentage
5,000 - 10,000 IQD	66	66
Less than 5,000 IQD	18	18
More than 10,000 IQD	7	7

3- During which season do you most frequently use car wash services?

The below chart shows that 54.9% of the participants say summer is says because of dust of the street and they say we use cars more in other seasons.



Value	Frequency	Percentage
Summer	50	50

Value	Frequency	Percentage
Winter	24	24
Autumn	10	10
Spring	7	7

4-Are you aware of any water-saving or environmental practices in the car wash services you use?

Value	Frequency	Percentage
No	59	59
Not sure	19	19
Yes	13	13

5-Do you think installing wastewater treatment or filtration systems in car wash services could help reduce water scarcity in Duhok City?

Value	Frequency	Percentage
Agree	48	48
Strongly agree	37	37
Neutral	5	5
Disagree	1	1

6- Would you be willing to pay a little extra for car wash services that use recycled or treated water?

Value	Frequency	Percentage
Yes	66	66
No	13	13
Maybe	12	12

7- If wastewater treatment is available at car wash services, would you support regulations to limit car washing at home?

Value	Frequency	Percentage
Support	42	42
Strongly support	32	32
Neutral	16	16
Oppose	1	1

8- Do you think air pollution and the number of cars in Duhok City contribute to increased demand for car washing?

Value	Frequency	Percentage
Yes	80	80
Not sure	10	10

Value	Frequency	Percentage
No	1	1

9- In your opinion, what are the biggest challenges to implement water treatment systems in car wash services?
(Choose all that apply)

Value	Frequency	Percentage
Lack of government support	56	56
Limited public awareness	48	48
High costs	44	44
Lack of technical expertise	27	27
Other	1	1

10-How effective do you believe implementing wastewater treatment systems in car washes would be in helping the city address water scarcity?

Value	Frequency	Percentage
Somewhat effective	43	43
Very effective	36	36
Neutral	10	10

Value	Frequency	Percentage
Not very effective	2	2

11- Do you think more sustainable water usage in car wash services would help preserve water resources for other essential uses?

Value	Frequency	Percentage
Agree	59	59
Strongly agree	29	29
Neutral	3	3

Interview method:

1-How often do you use car wash services?

options	values
once in week	7
2-3 times in month	10
once in month	4
vary little (as I need)	5

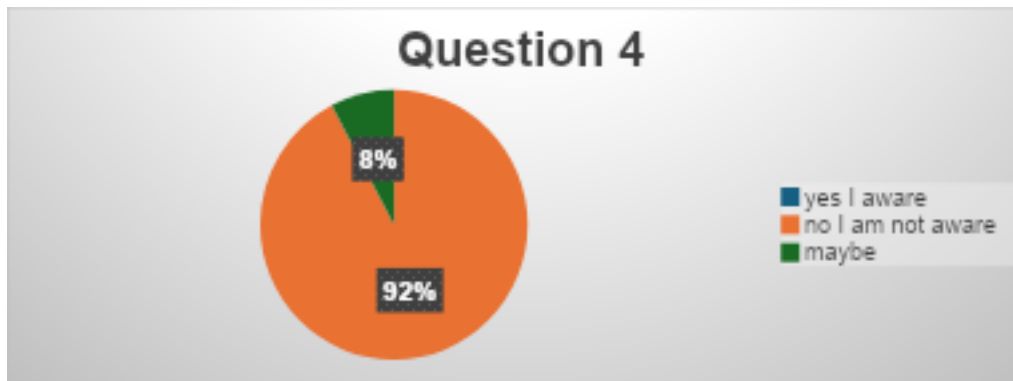
2-How much do you typically spend on car wash services?

Options	Values
less than 5000	1
5000-10000	24
more than 10000	1

3- Which season do you use car wash services most?

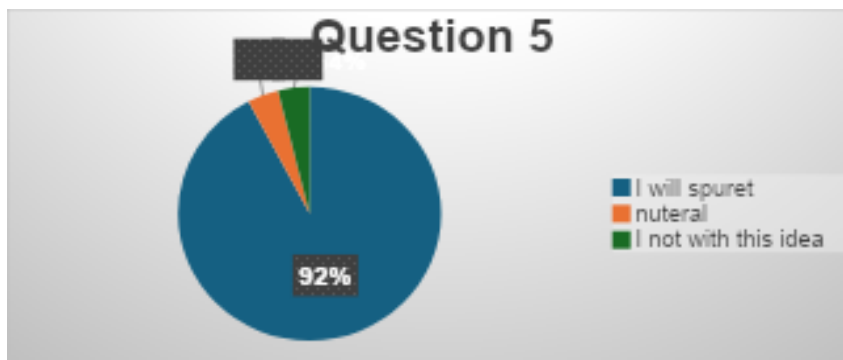
Options	Values
spring	0
summer	12
autumn	1
winter	13

4- Are you aware of any existing water-saving measures or environmental practices in the car wash services you use?



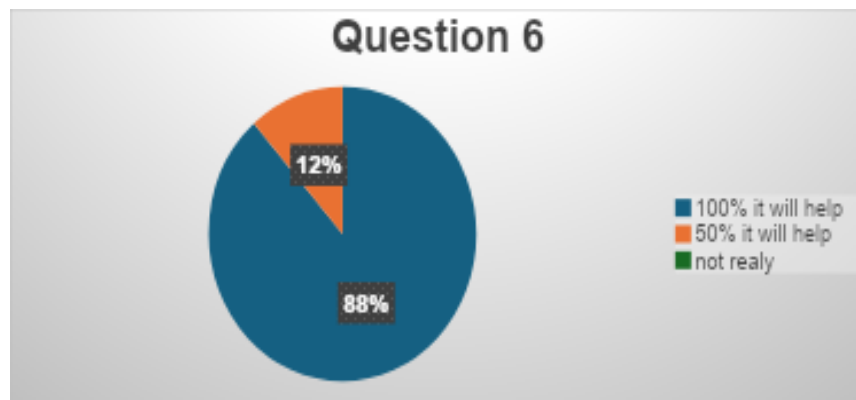
Options	Values
yes I aware	0
no I am not aware	24
maybe	2

5-How would you feel about car wash services implementing wastewater treatment systems on-site?



Options	Values
I will support	24
neutral	1
I not with this idea	1

6- Do you think filtration systems in car washes could help reduce water scarcity?



Options	Values
100% it will help	23
50% it will help	3
not really	0

7-If wastewater treatment systems are implemented in car washes, do you think people will support and regularly use these services?

Options	Values
most of the people	14
half of the people	4
some of the people	7
very little	1

8-Do you think air pollution and the number of cars in the city contribute to increased use of car wash services?

Options	Values
Both of them	17
Air pollution	4
Increasing car	4
None	1

9-If wastewater treatment is available in car wash services, would you support policies limiting car washing at home to save water?

Options	Values
Yes they will support	18
Yes if the government puts taxes	3
Most of them will not support	5

10-How effective do you think implementing wastewater treatment in car washes would be in helping the government manage water scarcity?

Options	Values
Very helpful	10
Helpful	14
Maybe	1
Not helpful	1

11-Would you be willing to pay a little more for car wash services that use treated or recycled water?

Options	Values
Yes I am agree	22
Maybe	3
No I am disagree	1

12-In your opinion, what are the main barriers to implementing wastewater treatment in car wash services?

Options	Values
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High costs	5
Lack of government support	5
Limited public awareness	3
Lack of technical expertise	4
Two or mor of them	4
Others	5

13-Do you have any additional comments?

Options	Values
Filters idea is a good solution	7
Others	9
I have no comment	10

FGD method :

- 1- How often do you think people in this city use car wash services, and why? What factors drive this demand?

Options	Values
most of the people as needed	5
one-two time a week	1
2-3 times in the month	3

- 2- Are you aware of any water-saving or environmentally friendly practices currently in place in car wash services? What do you think of these efforts?

Options	Values
I' 'm not aware	12
yes I aware	0
may be	2

- 3- What are your thoughts on installing wastewater treatment systems in car wash services? Do you think it would make a difference in managing water scarcity?

options	Values
I supported it because it will make a difference	14
naturally, It could make a difference	0

- 4- Do you think car wash customers would be willing to pay slightly more for services that use treated or recycled water? How would this impact your decision to use or operate a car wash?

Options	Values
100% it will help	9
50% it will help	4
25% it will help	1
Not ready to help	0

- 5- What role do you think the government should play in promoting water-saving practices in car wash services? Should there be incentives, regulations, or support for businesses?

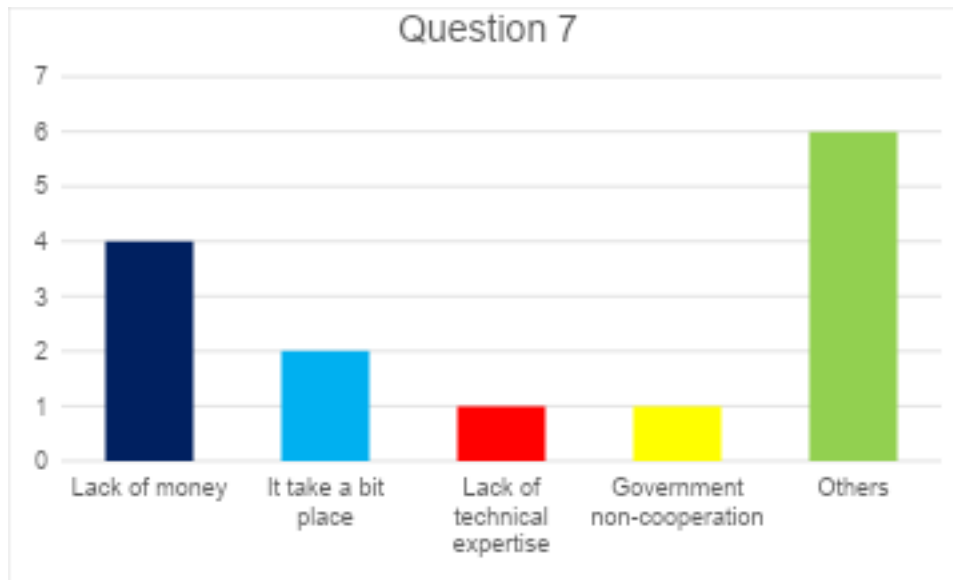
Options	Values
The government should put taxes	4
The government will help them financially	4
The Social Aspect	4
Others	2

- 6- From your perspective, should people reduce car washing at home if more sustainable car wash options are available? What would make them change this habit?

Options	Values
The government should put taxes	3
It remains according to the culture of the people	4
Others	7

7- What do you see as the main obstacles to implementing wastewater treatment or water recycling in car washes? How could these be overcome?

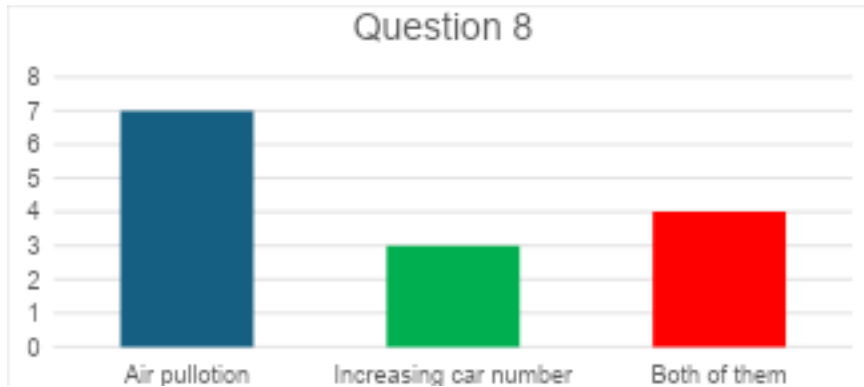
The chart below shows most of the participants agree on one opinion: it is a lack of money and other ideas also and some of them have different opinions that we define it by others .



Options	Values
Lack of money	4
It take a bit place	2
Lack of technical expertise	1
Government non-cooperation	1
Others	6

8- Do you think air pollution and the growing number of vehicles in Duhok contribute to the demand for car washing? How might this trend affect water use in the long term?

The chart below shows that the best number of participants nearly agree on all the options but the air pollution seems to act more .



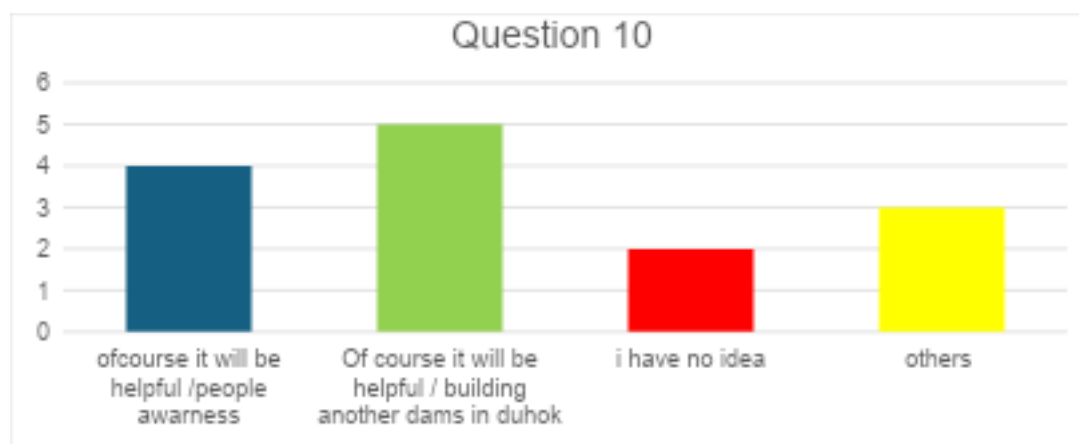
Options	Values
Air pollution	7
Increasing car number	3
Both of them	4

- 9- How does the demand for car wash services change with the seasons? Are there specific times of year when water-saving measures are more crucial?

Options	Values
winter	7
summer	5
spring	1
autumn	1

- 10- In your opinion, could implementing wastewater treatment systems in car wash services help the city better manage water scarcity? What other solutions do you think would be effective?

The chart below shows that the participants are sprouting this project and say building dams in Duhok .



Options	Values
of course it will be helpful /people awareness	4
Of course it will be helpful / building other dams in Duhok	5
I have no idea	2
others	3

Discussion:

The findings from the Participatory Action Research (PAR) project highlight significant opportunities and challenges regarding wastewater treatment and reuse in car wash services in Duhok. This discussion addresses the implications of the results while considering cultural, technical, and policy-related aspects. For Car Wash Usage Patterns and Environmental Practices, The frequent use of car wash services, particularly in summer and winter, indicates a high water demand during these seasons. However, the limited awareness of environmental practices among participants reflects a lack of public education on sustainable water use. This gap highlights the need for awareness campaigns to promote water-saving techniques and encourage the adoption of environmentally friendly practices in car washes. Public Support for Wastewater Treatment Systems, The overwhelming support (86%) for wastewater treatment in car washes suggests that the community recognizes its potential to address water scarcity. Furthermore, 66% of respondents are willing to pay extra for treated or recycled water services, indicating a readiness to invest in sustainability if service quality is maintained. However, cultural factors and public acceptance must be considered to ensure the successful implementation of such systems. For Barriers to Implementation, Participants identified several barriers, including high initial costs, limited space, and societal acceptance. Addressing these challenges requires government intervention in the form of subsidies, technical training, and incentives for car wash owners. Additionally, community engagement and stakeholder collaboration can help mitigate societal resistance and ensure widespread acceptance. The Role of Policy and Regulation, The support for policies restricting home car washing (75%) indicates a public willingness to adopt regulations aimed at conserving water. However, this requires coordinated efforts between the government and media to promote the benefits of such policies and ensure compliance. Effective policy frameworks should also include incentives for car wash businesses to adopt filtration systems. Sustainability and Water Conservation, The high agreement (88%) that sustainable water usage in car washes would preserve essential resources underlines the importance of integrating wastewater treatment systems into broader water conservation strategies. This could significantly reduce water

scarcity while addressing environmental concerns. Stakeholder Insights from FGDs, The focus group discussions revealed valuable insights into the practical aspects of implementing wastewater treatment systems. Participants emphasized the importance of affordable filtration systems and government subsidies, which align with the identified barriers. Technical training and awareness campaigns were also highlighted as critical components for success, ensuring that both service providers and users understand the value of water conservation. Community-Centric Approach, The diversity of participants in interviews, FGDs, and questionnaires ensures a comprehensive understanding of the local context. Tailored strategies must address the unique needs of the Duhok community, balancing technical feasibility with cultural and economic considerations.

Recommendations:

- 1-The government should support car wash owners and share more information about this project. Also, for bringing more machines.
- 2- We should get more of these courses from UNICEF, so more people get notified about water chemistry.
- 3- This project was supported by so many participants; we strongly believe that if we take small steps It will be implemented.

Conclusion:

The Participatory Action Research (PAR) project emphasizes the importance of wastewater treatment in car wash services as a key strategy to address water scarcity and promote environmental sustainability in Duhok. The findings reveal strong public support for eco-friendly initiatives, with many individuals willing to adapt to sustainable practices. However, challenges such as high costs, limited space, and societal acceptance must be addressed through targeted government support, public education, and effective policy implementation. By launching awareness campaigns, providing technical and financial support, and investing in modern filtration systems, Duhok can foster a community-driven approach to water conservation. These efforts will not only enhance resource sustainability but also contribute to long-term environmental protection and water resource management in the region.

Challenges:

We faced a lot of challenges during the PAR project, but we managed to push through. The biggest challenge we faced was the timing. We were all students with midterms and finals. Getting information about the system that is not available in our society is hard.

Limitations:

While this study contributes valuable insights, it is important to acknowledge its limitations. The research primarily focused on the system that we actually didn't have in here , that is the reason limited our data collection. and also the awareness of people about this project was much less than we expected.

Appendices :

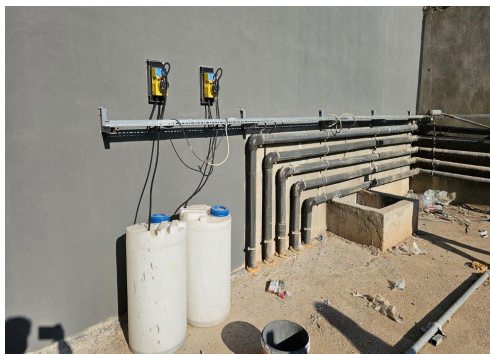
A) Mixed method questions :



B) List of participants :



C) Detailed data tables and additional statistical analyses:



Reference:

[1] The United Nations World Water Development Report, Managing Water Under Uncertainty and Risk, UNESCO, Paris, 2012.

[2] The United Nations World Water Development Report, Water and Jobs, Paris, UNESCO, 2016.

[3] <https://ncswash.com/car-wash-water-reclamation-system-types-and-benefits/>

Acknowledgments:

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