Empowering Mosque Communities with Recycled Ablution Water for Urban Hydroponic Food Resilience

Lestari Rahayu[1]*, *Diah Rina* Kamardiani[1], *Sukuriyati Susilo* Dewi[2], *Akmal Dhiyaa* Ulhaq[2], and *Arief Abdillah* Nurusman[3]

[1]Agribusiness Department, Universitas Muhammadiyah Yogyakarta, Indonesia 55183
[2]Agrotechnology Department, Universitas Muhammadiyah Yogyakarta, Indonesia 55183
[3]Biology Education Study Program Universitas Ahmad Dahlan Yogyakarta, Indonesia

Abstract. The problem of ablution water waste at the Al-Ittihad Mosque in Yogyakarta, which amounts to more than 3,000 liters per day, and the limited availability of land for farming in urban environments, highlights the need for sustainable innovation. This program aims to develop a mosque-based hydroponic system that utilizes recycled ablution water as a source of irrigation to enhance community food security. The method employed is a community-based participatory research approach with a mixed methodology. A total of 40 participants were involved in the training and implementation of a water recycling system (sand filtration, activated carbon, and UV) and simple hydroponics. Perception surveys, KAP (Knowledge, Attitude, Practice) tests, and multidimensional sustainability assessments were conducted. The results indicated that the KAP score significantly increased by 10.5 percent, with high perceptions in the dimensions of observability and compatibility. However, complexity and cost are still cited as barriers. This program was also found to improve environmental awareness, ensure community participation, and is replicable. It is suggested that the program be scaled up by collaborating with other mosques, providing initial subsidies, and advocating for policy changes to incorporate water recycling technology into their community food security programs. This model aligns with Islamic values and supports the achievement of SDGs 2, 6, 11, and 12.

1 Introduction

Indonesia is one of the countries with the largest Muslim population in the world, where ablution (wudhu) is an essential ritual performed before each of the five daily prayers. The ritual cleansing is spiritually significant and involves using large quantities of clean water. [1] Studies indicate that a typical ablution session uses approximately 2.5 liters of water per person. When someone does ablution (wudu) five times a day, they use about 12.5 litres of water. The high number of people in urban mosques makes them use a lot more water. Every

* Corresponding author: lestari@umy.ac.id

day, more than 900 people pray at the Al-Ittihad Mosque in Yogyakarta, and on Fridays, approximately 1,500 people gather for prayer. During peak worship times, it may need more than 3,000 litres of water per day for ablution (Fig1).

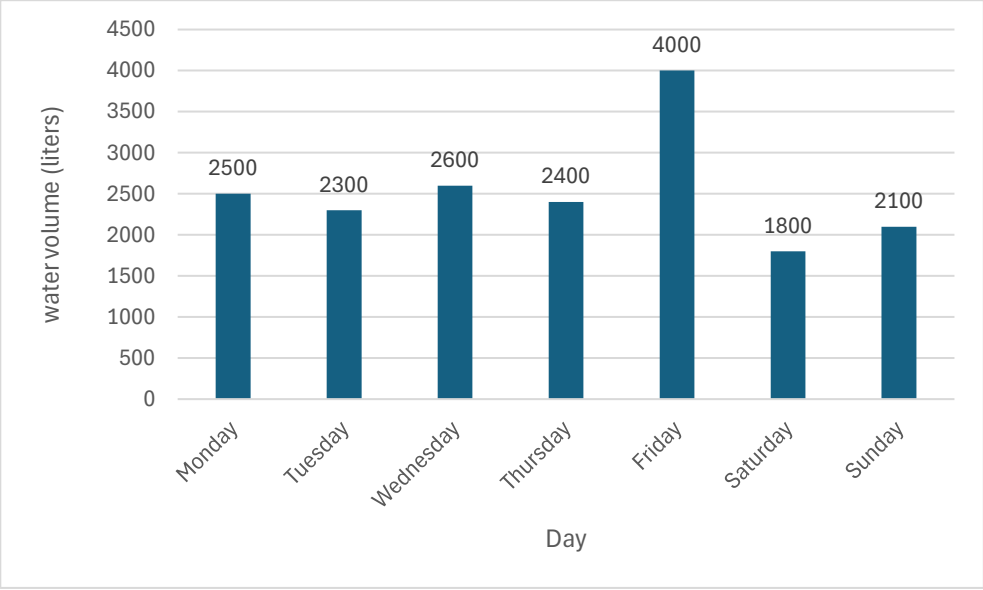

Fig. 1. Average Daily Ablution Water Volume at Al-Ittihad Mosque (liters/day).

.Greywater, which includes water from hand washing and bathing, is wastewater that is relatively lightly contaminated because it comes from activities other than using the toilet [2]. Unlike blackwater, greywater contains fewer pathogens and can be effectively treated using simple, low-cost technologies such as sedimentation, sand filtration, activated carbon, and ultraviolet sterilization [3]. Graywater contains far fewer pathogens than blackwater and can be treated with simple, inexpensive technologies such as sedimentation, sand filtration, activated carbon, and ultraviolet sterilization [4]. Several research works have also revealed that graywater is appropriate for reuse in non-potable applications, especially in urban agriculture. In mosques, ablution water provides a clean, readily available, and largely untapped source of water [5].

Hydroponics is a way to grow plants that use water without using soil as a planting medium, and it is known as a soilless system [6]. This method only requires a little space and water, making it suitable for urban agriculture with limited land. Studies show that hydroponic systems can reduce water use by up to 70% compared to traditional agriculture but still produce highly productive plants. Using recycled wastewater in hydroponic agriculture provides two main benefits: helping urban communities that experience food shortages and encouraging wiser water use. Using recycled wastewater in hydroponic agriculture offers two main benefits: assisting urban communities that experience food shortages and encouraging wiser water use. When applied in mosques, the system aligns with Islamic values about resource management and can be a model of ecological awareness integrated into religious practices.

Technologies in CEA (Controlled Environment Agriculture), like hydroponics, manage temperature, humidity, light, and nutrients to maintain stable yields and efficient use of resources. However, these technologies are not yet widely adopted in low- to middle-income citie.

Some obstacles faced include limited technical knowledge, limited access to funding, and minimal support from related institutions. Handling these obstacles requires technological readiness and culture-based platforms to support community involvement and educational activities.

The mosque represents a religiously embedded institution that greatly influences the values, norms, and behaviours of the surrounding community [7]. Mosques located in Muslim-populated cities are used for worship purposes, learning, socializing, and working together. Mosques can be a very strong vehicle for introducing new ideas that meet the needs of society because they are always there and people trust them. Using mosque buildings for eco-friendly ideas like recycling wastewater and growing plants without soil in cities is a culturally appropriate way to encourage sustainable development. This model is helpful in places that do not yet receive full government support or have limitations in implementing environmental programs.

Rogers stated that five essential aspects of perception influence how someone accepts new ideas: relative advantage, compatibility, complexity, trial, and observability. These dimensions provide a broad view of how the adoption or rejection of new technologies is done at the individual and group levels [8]. Where an innovation is advocated by a trusted organisation, for example, a mosque, the idea becomes more visible, relevant, and valuable for members of the community. This study endeavours to (1) analyze community perceptions of a mosque-based hydroponic system using recycled ablution water; (2) assess the effectiveness of training in enhancing KAP; and (3) evaluate Sustainability based on economic, social, environmental, and institutional dimensions.

This study designs a model for sustainable wastewater utilization in religious environments. The project combines ecological concerns with spiritual practices. The project also supports the achievement of the SDGs. The study shows sustainable innovations are more effective when embedded in local institutions and cultures that build trust and participation.

2 Methodology

This study adopted a mixed-methods approach within the framework of community-based participatory research (CBPR). This method enabled a complete picture of how the community felt about using recycled toilet water for hydroponic systems in mosques, how well the capacity-building training worked, and how long the program would last in many ways.

2.1 Study Site and Participants Options

The research was conducted at Al-Ittihad Mosque, Yogyakarta, Indonesia, which was purposively selected due to its high congregational activity and potential for greywater-based hydroponic development. A total of 40 respondents were selected through a purposive sampling of mosque administrators, active worshippers, youth members, and cleaning staff who are in contact with the pilot hydroponic program.

2.2 Data Collection Techniques

Three main instruments were used to collect primary data for the research objectives:

2.2.1 Perception Survey

The survey used a structured questionnaire designed from Rogers' Diffusion of Innovations Theory. It included five key dimensions : relative advantage, compatibility, complexity, trialability, and observability. All items were rated on a five-point Likert scale.

2.2.2 Pre- and Posttest on KAP

Pre- and posttests were administered to assess the effectiveness of training in improving participants' knowledge, attitudes, and practices (KAP) regarding using greywater for hydroponic agriculture. Experts in agricultural extension and Islamic environmental ethics validated the instruments.

2.2.3 Sustainability Assessment Matrix

A perception-based matrix was utilized to assess program sustainability across four dimensions: economic, social, environmental, and institutional. Data were analyzed and depicted using radar charts to illustrate changes pre-and post-intervention.

2.3 Data Analysis Techniques

Data analysis followed several steps:

a. Descriptive Statistics were used to summarize respondent characteristics and the distribution of perception scores.
b. The Wilcoxon Signed-Rank Test was applied to determine significant differences in KAP scores between the pre-and post-training phases.
c. Radar Chart Visualization was employed to depict multidimensional sustainability scores comparatively.

3 Results and Discussion

3.1 Community Perception Toward Recycled Greywater Hydroponics

This study collected perception data from 40 community members using a Likert-scale questionnaire. The questions were developed from Rogers' five innovation dimensions: relative advantage, compatibility, complexity, trialability, and observability. Each dimension helped describe how prepared the community was to accept hydroponic systems that make use of greywater, particularly the recycled ablution water gathered from mosques.
Each dimension is operationalized through a series of statements, representing core attitudes toward efficiency, cultural fit, technical difficulty, testability, and visibility of results. Responses are measured on a five-point Likert scale, where one indicates "strongly disagree" and five indicates "strongly agree."

Table 1 shows a detailed breakdown of the observed variables, grouped by innovation dimension and their mean scores. These numbers give a general idea of how people in the community feel about each part of the recycled hydroponic innovation. The scores help identify which aspects are perceived as enablers or barriers to adoption. In Table 1, the results of the study show that Observability (average = 3.775) and Complexity (average = 3.695) are the most widely perceived dimensions, while Trialability has the lowest average (3.500). However, all dimensions scored above the midpoint (3.0), indicating a good perception of the wastewater recycling hydroponic system.

Table 1. Perception Scores by Innovation Dimension (Relative Advantage, Compatibility, Complexity, Trialability, and Observability).

Innovation Dimension	Statement	Mean Score	Dimension Average
Relative Advantage	Recycled wastewater hydroponics seems more efficient than conventional irrigation.	3.525	3.585
	The perception is that technology contributes to enhancing urban food security.	3.500	
	The belief is that the system has the potential to generate additional household income.	3.700	
	The belief is that hydroponic veggies grown in ablution water are as good as regular ones.	3.575	
	The perception is that the system offers an innovative solution for managing mosque greywater.	3.625	
Compatibility	The belief is that the technology aligns with Islamic environmental ethics on water conservation.	3.450	3.615
	Acceptability of the system for mosque-based and Muslim community use.	4.075	
	The perception that technology fits the local culture and social norms.	3.375	
	Expectation that locals would support greywater hydroponics	3.425	
	The perception is that the system aids in water conservation and Sustainability.	3.750	
Complexity	Perceived difficulty in understanding how the hydroponic system operates.	3.525	3.695
	The belief is that training or external support is needed before implementation.	3.750	
	Concern that the initial investment cost is prohibitively high.	3.800	
	Concern regarding long-term maintenance and system reliability	4.025	
	Preference for conventional farming methods over hydroponics	3.675	
Trialability	Willingness to test the system on a limited scale before full adoption.	3.375	3.500
	I am interested in participating in hydroponic training programs or workshops.	3.450	
	Increased confidence in adopting if local demonstration sites are available.	3.675	
Observability	Desire to observe live demonstrations of system operation.	3.775	3.775
	Confidence in adopting the system increases upon witnessing tangible results (e.g., vegetable harvests).	3.825	
	Interest in visiting communities that have successfully implemented the system.	3.725	

Relative Advantage. This dimension reflects respondents' perceptions of the overall benefits offered by the hydroponic system using recycled ablution water compared to conventional agricultural methods. The moderately high average score (3.59 on a 5-point Likert scale) suggests that most community members view the technology as offering practical advantages and contextual relevance in urban settings [9].

Respondents said that the system could be a way for households to make extra money by growing high-demand vegetables in small spaces with little water use. This fits with research

that shows that urban hydroponics can help people make more money and get more food, especially in places without much land.

Also, people liked that the system was good for the environment, especially since it could turn mosque greywater into something useful for farming. People saw this benefit as a way to help cities stay green and follow Islamic teachings that stress the importance of not wasting resources and ethically managing them. [10]

. The implication is that economic viability, environmental care, and spiritual values determine the relative advantage of such technology. Such hydroponic systems based on recycled ablution water would be quite suitable for a Muslim urban population because they are in concert with their religious and social ideals.

With the average compatibility score of 3.62, most respondents believe that the technology fits well with Islamic teachings on environmental protection, such as conserving water, avoiding waste, and using resources wisely. Water in Islam is considered a sacred trust (Amanah) given by God to human beings and, therefore, must be used judiciously. Therefore, using ablution water for hydroponics is seen as both technically appropriate and spiritually meaningful.

Respondents regarded the system as socially acceptable, largely because it can be implemented in mosques and Islamic schools that hold an important place in community life. They regarded the initiative as compatible with Islamic teachings on environmental stewardship, a view that reflects Rogers' notion of value congruence and helps explain the quicker acceptance of such practices. This view is in line with research that shows that religious groups that promote environmental technologies often get more trust and support from the community. In this case, compatibility means that the community is willing to use the system and is also committed to protecting the environment

The complexity dimension refers to how difficult a respondent perceives it to understand, set up, and maintain a hydroponic system using recycled ablution water. This dimension receives a high mean score of 3.70. In essence, this means that while likability for the technology is generally high, there still seems to be some doubt over how it works or the methodology in building it

The respondents had concerns about the complexity of the system's installation; these included the requirement for specialization in knowledge, calibration of equipment, and routine maintenance. Other concerns were the cost of initial investment, which was perceived to act as a barrier to entry, especially for those of low-income status or first-time adopters. Similarly, several community members indicated that they require structured training and field-level assistance before being able to successfully operate the system independently. These findings point to the fact that, as stated by Rogers, innovations perceived as difficult to use or requiring new skills will have lower adoption rates. This is compounded within community-based settings where agricultural extension services are inaccessible, and people have a very low level of awareness of the technology of soilless cultivation systems. Furthermore, smallholder communities experience significant barriers to accessing information and technical assistance with which to adopt more sustainable technologies. Even exciting new ideas that would reduce environmental degradation can appear daunting or unrealistic without proper support systems.

To make these problems less harmful, [11] suggests using localized technical training, participatory workshops, and peer mentoring, especially in urban agriculture programs based in mosques. These changes not only make things appear to be less complicated but also make people more confident in the system. In the final analysis, while the community members view the technology favourably, long-term adoption is highly dependent on institutional support, technical literacy, and the availability of accessible demonstration units that can simplify the learning process.

Trialability is the extent to which an innovation can be tested on a small scale before full adoption. At 3.50, the community members are willing to try the hydroponic system with recycled ablution water but prefer it in safe, low-risk conditions. They felt a need to see the system at work before they invest any time, money, or effort.

Trying a technology, as the theory by Rogers would suggest, increases adoption by showing people actual results without major cost. Most respondents expressed interest in the workshops organized in mosques or community centres; these are trusted spaces to learn in groups and be open to new ideas.

It is suggested that piloting, interactive training, and community-led trial gardens raise the level of adoption by making the technology easier to test and build confidence and creating local champions that will facilitate others in decreasing uncertainty.

Observability is the degree to which the results of the innovation are visible and communicative to others. This dimension of innovation, among the five, received the highest average score of 3.78, indicating that community willingness to adopt a hydroponic system using recycled ablution water is highly influenced by tangible demonstrations of success. Generally, the respondents were more certain of this whenever they could see the outcome or workings of the technology itself good growth of vegetables, clean functioning of the system, and water reuse from mosques are examples. Visible markers like these are a demonstration that the system can be applied in real life.

. According to Rogers' diffusion theory, the speed of adoption of new ideas is accelerated when the consequences of their adoption are observable. This should be particularly true for collective cultures where social pressures to conform are strong.

Most participants also emphasized visits to other communities or mosques that had already applied such hydroponic systems. These site visits made the technology easier to understand, creating a sense of achievable possibility. In Islamic contexts, visibility is also tied to shariah-compliant transparency, meaning that tangible evidence of effectiveness helps strengthen trust within religion and society

In Muslim-majority farming communities, visual confirmation and word-of-mouth support are the most critical factors in determining whether to adopt a practice [18]. In this case, observability serves as an informational and motivational driver, increasing credibility, lowering uncertainty, and encouraging replication. Majority farming communities, visual confirmation and word-of-mouth support are the most critical factors in deciding whether to adopt something [18]. In this case, observability serves as an informational and motivational driver, increasing credibility, lowering uncertainty, and encouraging replication.

To capitalize on this strength, program designers should invest in well-maintained pilot plots, organize open-house demonstrations, and document success stories that can be shared through community networks, particularly mosque-based communication channels.

3.2 Knowledge, Attitude, and Practice (KAP) Enhancement

The training outcomes were evaluated by analyzing changes in participants' Knowledge, Attitudes, and Practices (KAP) related to hydroponic systems and recycled ablution water. The assessment utilized ten core indicators, with scores measured before (pretest) and after (posttest) the training.

The training evaluation applied ten KAP (Knowledge, Attitude, and Practice) indicators related to hydroponics and ablution water recycling. Participants' average scores increased from 79.75% (pretest) to 90.25% (posttest), reflecting a 10.5% improvement.

The greatest progress was observed in understanding the advantages of hydroponic systems, which rose from 62.5% to 85%, while awareness of disadvantages improved from 75% to 92.5%. Knowledge of suitable plants remained stable at 100%, indicating strong prior understanding.

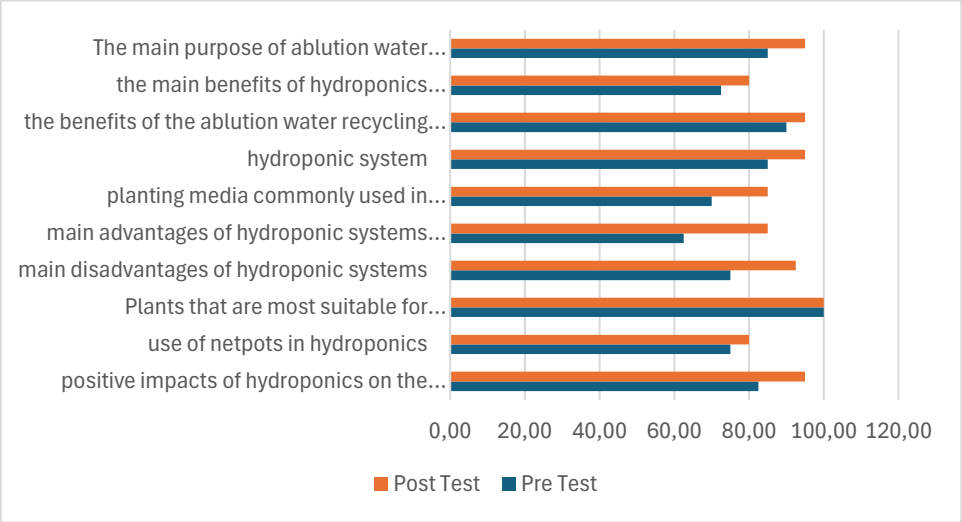

Fig. 1. Knowledge, Attitudes, and Practices (KAP) before (pretest) and after (posttest) the training.

Overall, the findings show that contextualized training, combining hydroponics with Islamic practices such as ablution, significantly improved participants' knowledge and awareness. The improvement was statistically significant ($p < 0.05$), confirming the program's success in encouraging the adoption of hydroponic systems that utilize recycled ablution water. The Wilcoxon Signed-Rank Test was utilized to ascertain the statistical significance of the observed score changes. The summary of the test outcomes is as follows (Table 2).

Table 2. The summary of test results Wilcoxon Signed-Rank Test.

Statistic	Value
N Total	40
Positif Rank (Post > Pre)	30
Ties (Post = Pre)	10
Negatif Rank (Post < Pre)	0
Z	4.922

The findings are in line with earlier research showing that the Wilcoxon test is well suited for assessing knowledge-based training results. Using a pretest–posttest approach makes it possible to observe real changes in how participants think and act. Studies have also shown that hydroponic technology training greatly improves people's knowledge and practical skills.

The findings suggest that training held within the mosque setting can link religious guidance with everyday environmental practices in a meaningful way. This blend produces a program that operates effectively from a technical perspective and delivers benefits that are genuinely valued by the community. As it continues to be implemented and strengthened, this approach has the potential to develop into a lasting, community-driven model that supports broader empowerment in the future.

Training that utilized recycled ablution water for hydroponic practice substantially improved participants' knowledge levels. The findings suggest that this type of program

should reach a wider audience and become part of mosque-led efforts to strengthen local food security.

The results are consistent with earlier research, which highlights the suitability of the Wilcoxon test for evaluating changes in knowledge after training. Studies using a pretest–post-test approach also report that hydroponic training can markedly improve both understanding and practical abilities within communities. Taken together, the evidence shows that mosque-based initiatives can blend religious values with environmental practices in a way that works well and brings clear social benefits. Expanding these activities and integrating them into broader community strategies for food resilience could reinforce their long-term effectiveness.

3.3 Sustainability Evaluation

Sustainability analysis across economic, environmental, social, and institutional dimensions showed an overall increase in perception scores [12]. The community acknowledged the system's contribution to (a) Water conservation (environmental dimension), (b) Economic feasibility through reduced vegetable expenditures, (c) Social cohesion via collective action at the mosque, and (d) Institutional legitimacy backed by the mosque leadership and religious narratives. These results align with prior findings that mosque-based environmental programs enhance collective efficacy and are more likely to be sustained when aligned with communal values [13]

Economic Sustainability. Respondents expressed firm confidence in the market prospects of hydroponic produce (Mean = 4.08) and indicated both a willingness to buy the harvest and an expectation that the initiative could generate community income (Mean = 3.78 for both indicators). The main issue raised by respondents is the cost of operating the system. The low mean score for long-term affordability (Mean = 1.98 after reverse scoring) indicates that they do not view the system as financially sustainable at this stage. This pattern is consistent with earlier work noting that, although hydroponic systems use resources efficiently, high start-up and maintenance costs can limit broader adoption. Overall, the market outlook appears favorable, but the economic aspect remains the most vulnerable. Long-term viability will depend on lowering operational costs, improving energy efficiency, and securing wider financial support.[14]

Social Sustainability. The high score for communal support (Mean = 3.70) suggests that the community gives the initiative a positive reception This pattern is consistent with earlier studies showing that agricultural programs grounded in community participation often thrive where social ties are close. In this setting, the hydroponic program contributes not only to economic and nutritional benefits but also offers an avenue for strengthening collective empowerment. In this context, the hydroponic initiative serves not only to meet economic and nutritional needs but also to create a space that reinforces collective empowerment.

Environmental Sustainability. Environmental indicators received the highest overall ratings among all four dimensions. The statement "This program helps reduce wasted ablution waste" was the highest among all indicators, with a mean of 4.38, reflecting a great awareness of water reutilization and the benefits of saving water. Saving water resources was rated at M = 4.05; being more environmentally friendly compared to traditional farming was rated at M = 3.88; and having the potential to be a model for environmentally friendly agriculture in cities was rated at M = 3.63. These results are supported by studies such as [15] They focused on how decentralized hydroponic systems could be applied in cities, especially when combined with greywater recycling. Also, using water again in religious places like mosques aligns with Islamic environmental ethics, which encourages responsible use of natural resources. The program demonstrates exceptional environmental relevance and may serve as a prototype for sustainable agriculture in other urban religious communities.

Table 3. Indicator-Level Descriptive Statistics of Economic, Social, Environmental, and Institutional Sustainability in a Community-Based Hydroponic Program.

Sustainability	Indicators	Score	Analysis
Economic	The hydroponic program can generate income for the community.	3.78	Most respondents believe the program has economic potential as a community-based income source.
	The hydroponic products can compete in the market.	4.08	A high level of confidence in hydroponic products' market competitiveness indicates promising commercial prospects.
	The operational cost is too high for long-term Sustainability.	1.98	After reversing the score, this low mean suggests that respondents still perceive operational costs as a significant barrier to Sustainability.
	I am willing to buy the hydroponic harvest to support the program.	3.78	A strong indication of local market support and community willingness to participate economically in the program.
Social	The community supports the Sustainability of the hydroponic program.	3.70	There is general agreement that the program is socially endorsed, though some respondents remain neutral or uncertain.
	I am willing to be part of the hydroponic management team if needed.	3.78	A positive attitude toward active involvement in program operations.
	This program increases social solidarity in my community.	4.00	The strong agreement suggests the program has a unifying social effect.
	The program provides real social benefits to society.	4.18	The highest social score confirms that respondents see this program as delivering tangible social value.
Environmental	This program helps reduce wasted ablution water.	4.38	Respondents overwhelmingly agree on the environmental benefit of water reuse, especially in a religious context.
	Hydroponics using ablution water is more eco-friendly than conventional farming.	3.88	General agreement on the ecological advantage of the system, though slightly lower than other environmental scores.
	The program helps conserve water resources.	4.05	High recognition of the water-saving potential of the system.
	This program can serve as a model for sustainable urban agriculture.	3.63	Moderately positive views on replicability suggest more awareness-building is needed.
Institutional	The program has clear and organized management.	3.98	Respondents express confidence in the current management structure.
	There is a sound management system to maintain Sustainability.	3.93	Reinforces the perception that systems are in place to ensure long-term function.
	I am willing to help in the program's management if needed.	3.83	Indicates community readiness to support program operations.
	I would be confident if there were clear regulations from relevant institutions.	3.83	Highlights the need for formal regulations or support from external agencies.

Institutional Sustainability. Institutional aspects showed strong performance. Most respondents expressed trust in how the program was managed within the community. They stated that roles and responsibilities were clearly defined (M = 3.98) and that daily coordination worked effectively (M = 3.93). Participants demonstrated a strong sense of responsibility, although some external support was still needed. Several respondents were willing to take part in management activities (M = 3.83) and hoped the government would establish clearer regulations to strengthen the program (M = 3.83). These findings indicate that the local management system is functioning well. However, the program's legitimacy and long-term Sustainability would be stronger with formal recognition from local authorities.

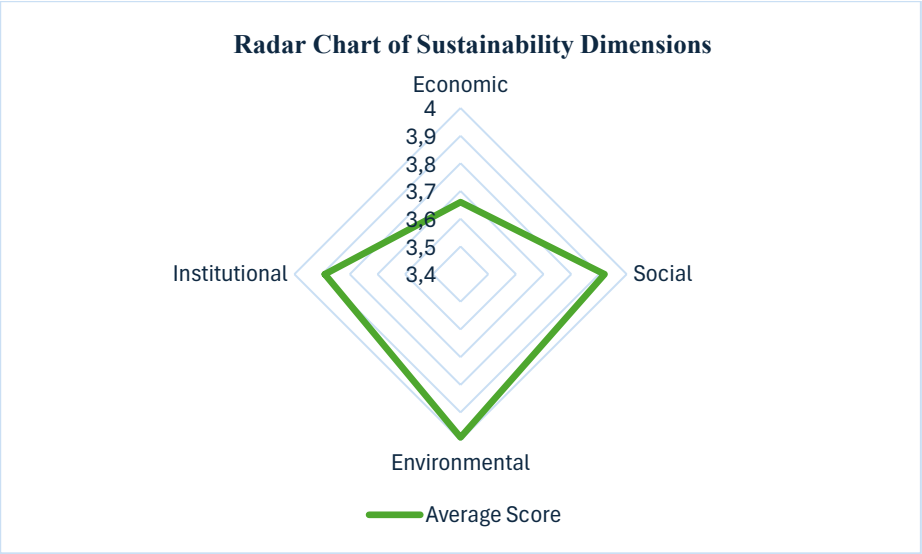

Fig 2. Radar Chart of Sustainability Dimensions.

The radar analysis shows the strongest environmental dimension, followed closely by the social and institutional dimensions. The economic sustainability dimension is still the weakest link. These results suggest that these community-driven systems need policy changes, better technology, and targeted training to keep going financially. Also, because of its high social and environmental ratings, the model has a lot of potential to grow through partnerships with other mosques or with local governments and green NGOs.

4 Conclusion

A program utilizing recycled ablution water for hydroponic systems in mosques has proven effective in improving air efficiency and food security in urban communities. Through a community-based approach and Islamic values, this activity improves community knowledge, attitudes, and practices toward sustainable agriculture. The community has shown high acceptance because this innovation aligns with religious teachings and environmental needs. However, challenges remain in technical aspects and operational costs. Capacity building, institutional support, and cross-stakeholder partnerships are needed for this program to be unified and sustainable, while also supporting the achievement of the SDGs, particularly in the areas of clean water, food, and sustainable cities.

Acknowledgements

The author would like to express his gratitude to the Research and Innovation Institute Universitas Muhammadiyah Yogyakarta for providing funding for the implementation of applied research activity.

References

1. M. F. Mukhtar, N. A. H. Hasim, M. I. F. Rosley, M. S. F. Hussin, A. A. M. Damanhuri, and A. Samsudin, Potential Analysis Of Mosque Wudhu Waste as a Picohydro Power Plant. ARPN J. Eng. Appl. Sci. **16**, 51 (2021)
2. M. O. Sulaiman, H. R. Mackey, M. A. Al-Ghouti, J. Saththasivam, and M. H. Abu-Dieyeh, Perspectives of Utilizing Greywater in Agricultural Irrigation with a Special Reference to Vegetated Wall Agrosystems. Water (Switzerland) **17**, 1 (2025)
3. M. F. Yusof, M. R. R. M. A. Zainol, A. Riahi, N. A. Zakaria, S. Shaharuddin, S. F. Juiani, N. M. Noor, M. H. Zawawi, and J. Ikhsan, Investigation on the urban grey water treatment using a cost-effective solar distillation still. Sustainability **14**, 9452 (2022)
4. O. E. Aringbangba, F. Oluwafemi, A. L. Kolapo, A. I. Adeogun, and T. O. S. Popoola, Ind. J. Teknol. Elimination of aflatoxins from two selected Nigerian vegetable oils using magnetic chitosan nanoparticles. *Industria: Jurnal Teknologi dan Manajemen Agroindustri*, **10**, 1 (2021)
5. A. Mahmoudi, S. A. Mousavi, and P. Darvishi, J. Environ. Greywater as a sustainable source for development of green roofs: Characteristics, treatment technologies, reuse, case studies and future developments. *Journal of environmental management*. **295**, 112991 (2021)
6. L. A. Ibrahim, H. Shaghaleh, G. M. El-Kassar, M. Abu-Hashim, E. A. Elsadek, and Y. Alhaj Hamoud, *A Sustainable Path to Food Sovereignty and Enhanced Water Use Efficiency.* Water (Switzerland) **15**(1), *4310*. (2023)
7. Abdul, S., Manzoor, Z., & Shabir, R. "The Green Mosques: Catalysts for Environmental Stewardship and Sustainable Development in Muslim Communities" dalam IJISH (International Journal of Islamic Studies and Humanities). Vol. 7(2), pp. 125–131. (2024). https://doi.org/10.26555/ijish.v7i2.11691.
8. E. M. Rogers, A. Singhal, and M. M. Quinlan, Diffusion of innovations." *An integrated approach to communication theory and research*. Routledge, pp. 432–448 (2014)
9. Gumisiriza, Margaret S.; Ndakidemi, Patrick A.; Mbega, Ernest R. A simplified non-greenhouse hydroponic system for small-scale soilless urban vegetable farming. *MethodsX*, 9: 101882, (2022) https://doi.org/10.1016/j.mex.2022.101882
10. M. Tanko, M. A. Muhammed, and S. Ismaila, Reshapping agriculture technology adoption thinking: Malthus, Borlaug and Ghana's fail green revolution. *Heliyon*, **9**(1), (2023)
11. L. Kura, A. Safo, A.-R. Safo, S. Biliyitorb, and E. Kwame, Green spaces in Ghana's built environment: analyzing perceptions and urban planning perspectives through the lens of the new environmental paradigm. *City and Environment Interactions*. **24**, 100168 (2024)
12. Z. Rozaki, R. S. B. Yudanto, N. Triyono, S. Alifah, R. A. Ardila, H. W. Pamungkas, Y. E. Fathurrohman, and N. Man, Assessing the sustainability of organic rice farming in Central Java and Yogyakarta: An economic, ecological, and social evaluation. *Organic Farming*, **10**, 142 (2024)

13. B. Ran and S. Weller, An Exit Strategy for the Definitional Elusiveness: A Three-Dimensional Framework for Social Entrepreneurship. *Sustainability, **13***(2), 563. (2021)
14. O. O. Oyadeyi, C. O. Ibukun, S. Arogundade, O. A. Oyadeyi, and M. Biyase, Unveiling economic resilience: exploring the impact of financial vulnerabilities on economic volatility through the economic vulnerability index. *Discover Sustainability* **5**, 253 (2024)
15. A. Acevedo-De-los-Ríos, A. Dyson, D. Claeys, and U. Cardenas-Mamani, Environmental performance of urban agriculture in the global south: A comprehensive literature review and life cycle analysis approach. *Environmental Impact Assessment Review*, **115**, 108040 (2025)