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EMPOWERING URBAN AGRICULTURE: A SUSTAINABLE MODEL OF AQUAPONIC *WAQF*

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ABSTRACT

This conceptual paper introduces a *waqf* model for an aquaponic system aimed at enhancing food security for urban residents, particularly those in flats or apartment housing in Malaysia, which still relies on foreign countries for key food commodities like rice, fruits, dairy, and beef. The proposed model, designed to be simple and adaptable, is in its initial stages and requires validation by experts in Islamic finance and food security. The study outlines the purpose of creating a base model that can be improved and customized to meet various needs, with the hope that it will significantly impact food security practices through *waqf*. However, the model's current limitation is its conceptual nature, necessitating further development and validation. The novelty of this approach lies in its integration of aquaponics and *waqf* to address urban food security challenges.

KEYWORDS: WAQF, FOOD SECURITY, URBAN, AGRICULTURE, AQUAPONIC, SOCIAL FINANCE

ABSTRAK

Kertas konsep ini memperkenalkan model wakaf untuk sistem akuaponik yang bertujuan meningkatkan keselamatan makanan bagi penduduk bandar, terutamanya mereka yang tinggal di flat atau pangsapuri di Malaysia, yang masih bergantung kepada negara asing untuk komoditi makanan utama seperti beras, buah-buahan, tenusu, dan daging lembu. Model yang dicadangkan ini direka untuk menjadi mudah dan boleh disesuaikan, berada di peringkat awal dan memerlukan pengesahan oleh pakar dalam kewangan Islam dan keselamatan makanan. Kajian ini menggariskan tujuan mewujudkan model asas yang boleh diperbaiki dan disesuaikan untuk memenuhi pelbagai keperluan, dengan harapan ia akan memberi kesan yang ketara terhadap amalan keselamatan makanan melalui wakaf. Walau bagaimanapun, limitasi model ini adalah sifat konsepnya, yang memerlukan pembangunan dan pengesahan lanjut. Keunikan pendekatan ini terletak pada pengintegrasian akuaponik dan wakaf untuk menangani cabaran keterjaminan makanan bandar.

KATA KUNCI: WAKAF, KETERJAMINAN MAKANAN, PERTANIAN, AKUAPONIK, KEWANGAN SOSIAL

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1. INTRODUCTION

Urban agriculture has become an increasingly important strategy for addressing the multifaceted challenges posed by rapid urbanization, food insecurity, and environmental degradation. As cities expand and arable land becomes scarce, innovative agricultural practices are needed to ensure sustainable food production within urban settings. Among these practices, aquaponics has garnered significant attention for its efficient use of resources and its ability to produce both fish and plants in a symbiotic, closed-loop system.

In 2007, a significant milestone in world history was reached as more than half of the global population began living in cities (Orsini *et al*., 2013). This rapid urbanisation, particularly in developing countries, has been accompanied by increased urban poverty, environmental pollution, food insecurity, and malnutrition, especially among vulnerable groups like children, pregnant women, and lactating mothers. Unemployment rates have also surged (Feng *et al*., 2024). Urban agriculture emerges as a promising solution to these challenges, offering improvements in food supply, health conditions, local economies, social integration, and environmental sustainability. Across the globe, urban agriculture manifests in diverse farming systems, with 25–30% of urban residents engaged in the agro-food sector. As urban populations grow and rural-to-urban migration continues, the recognition of urban agriculture's benefits is expected to rise (Kanosvamhira, 2024), despite the current lack of widespread knowledge about this practice.

Urban agriculture positively impacts food security, according to Orsini *et al*. (2013) with 100–200 million urban farmers worldwide supplying fresh horticultural products to city markets. This practice significantly benefits the poor, who often spend up to 85% of their income on food (Redwood, 2012), as many urban farmers are among the poorest populations. Socially, urban farming enhances social inclusion and reduces gender inequalities, with women constituting 65% of urban farmers (Van Veenhuizen, 2006). Ecologically, it helps reduce city waste, boost urban biodiversity, and improve air quality, while also decreasing the environmental impact associated with food transportation and storage. The cultivation of fruits and vegetables, in particular, offers high yields, efficient use of inputs, and high market value, making urban horticulture a competitive branch of urban farming (Van Veenhuizen, 2006). Traditional urban horticulture systems include allotment and family gardens, simplified extensive systems, shifting cultivation, and intensive systems, with innovative approaches like organoponics and simplified soilless cultures also gaining traction.

The food price crisis of 2007-2008 had significant implications for food security, particularly in countries that import rice. Malaysia, which imports over a quarter of its rice needs (Tey & Radam, 2011), has seen rice prices remain higher post-crisis compared to pre-crisis levels. According to Demeke *et al*. (2009), many Southeast Asian countries have shifted their rice policies towards increased production. Rice is vital to the Malaysian diet, even though it contributes less than one percent to the country's GDP (Vengedasalam *et al*., 2011). As noted by (Omar *et al*., 2019), Malaysia's rice consumption has steadily increased from 1.585 million metric tons in 1990 to 2.819 million metric tons in 2018, with projections exceeding 3 million metric tons by 2026. Figure 1 also highlights a growing gap between rice consumption and production in Malaysia, signaling the need for a plan to ensure future food supply stability in light of a growing population.

Waqf, a form of endowment, has historically been linked with agriculture. For instance, Egypt's al-Azhar University holds 15,000 acres of *waqf* farmland valued at billions of Egyptian pounds (Ahmad & Hassan, 2015). In the 18th century, the Ottoman Sultanate's Haseki Sultan established a *waqf* "soup kitchen" program in Jerusalem to prevent hunger (Peri, 1992). Early *waqf* examples include the endowment of the Ruma Well, purchased by Uthman al Affan and designated as *waqf* property to provide water for Madinah's residents (Pitchay *et al*., 2014). Due to its permanent nature, *waqf* can provide long-term food security and support food safety programs.

In Malaysia, *waqf* has been practiced since the introduction of Islamic law and has been integral to the Malay Archipelago since the 13th century. Evidence includes a rock inscription from 1302 AD in Jawi script found in Kampung Buluh, Sungai Teresat, Terengganu (Md. Dahlan, 2003). Historically, various classes managed *waqf* administration in Malaysia, but over time, responsibilities were centralized under the State Islamic Religious Councils (SIRCs) in each state. Post-independence, the administration of *waqf* was fully entrusted to SIRCs, which were appointed as the sole trustees following the declaration of Islamic administration laws in each state (Pitchay, 2015).

Wealth circulation through social support mechanisms such as Sadaqah (charity), Zakat (compulsory alms), and *waqf* ensures equitable distribution between the rich and poor, preventing wealth from being confined to the rich alone (Al-Qur'an 59:7). Islam condemns hoarding (Al-Qur'an 9:35-36). *Waqf* has a rich history of enhancing welfare and aiding the poor, making it a significant practice for humanitarian causes in the Muslim world. It represents continuous charitable acts for God, driven by altruism, an integral part of Islamic life. However, there is limited empirical research on *waqf*-based food security, particularly in Malaysia. Understanding how *waqf* contributes to food security and sustainability remains unclear.

Addressing these gaps by developing a *waqf* aquaponic model for urban use will significantly contribute to the literature on *waqf* and food production. Theoretically, this research is significant as it adds momentum to creating a *waqf*-based food security paradigm. Practically, the proposed model can serve as a reference for *waqf* mutawallis in implementing *waqf*-based agricultural or livestock projects.

2. LITERATURE REVIEW

A lot of research has been done on food safety by both academics and people who work in the business. This research looks at food security from different angles, such as food science, agriculture, and economics. A lot of different things have been studied, like how climate change affects food supply. People are ready to pay 25% more for rice to make up for lower subsidies, according to a study that shows how important climate change programmes are (Chen Khee *et al*., 2011). Changes in the climate are bad for welfare and consumption, especially in rural places (Solaymani, 2018). The food industry in Malaysia isn't very developed because the country doesn't invest much in agriculture and focuses on export crops (Arshad & Hameed, 2010). Climate change is a big problem for growing rice, which puts food security at risk (Alam *et al*., 2011; Firdaus *et al*., 2020).

Food spending is going down, which is linked to slower manufacturing in developing countries like Malaysia. Because the food industry is so important to global growth and security, more money and resources should be put into it (Siwar *et al*., 2014). Malaysia may not be able to meet its self-sufficiency goals if it doesn't do enough research and development to deal with industry problems and the dangers of climate change (Arshad *et al*., 2015). Razak *et al*. (2013) look at the Malaysian Federal Agricultural Marketing Authority's (FAMA) current extension programmes. These programmes have helped local farmers and agribusinesses make more food to meet demand in Malaysia and around the world by improving marketing and supply chain management.

Even so, many people still don't know how important it is to use new techniques in livestock farming to make food security better. According to Abdullah *et al*. (2021a), most families were able to keep food on hand during the Movement Control Order (MCO) by switching food sources, shopping online, and giving up favourite foods. Up to 21.5% of monthly cash income in Johor comes from forests, which help keep people fed and lower poverty in rural areas. Without forests, 13.7% more people would be living in poverty (Abdullah *et al*., 2021b). Kedah's paddy farmers, on the other hand, eat less food and depend on cheaper protein sources like chub mackerel and freshwater fish (Ibrahim, 2021).

Food security and sustainability strategies around the world have to deal with tough problems that are affected by political, economic, and moral factors. As a result of low agricultural output and food insecurity, there are food shortages, higher prices, and fewer ways to get food (FAO *et al*., 2018). Taking on problems with food security needs serious and multifaceted work (Abdelhady, 2012). To understand food security, we need to look at how global changes affect threats and weaknesses in food security and understand that food problems are at the heart of global governance, prosperity, and security (McDonald, 2015). Food security has gotten more attention in the classroom and in real life since the global food price disasters of 2007–2008 and 2010 (Candel, 2014). This has helped people in politics and academia have a better understanding of food security (Abdelhady, 2012; Candel, 2014; Moh'd *et al*., 2017).

This is not the first piece to suggest a *waqf* model to help make food from *waqf* model. Shafiai *et al*. (2015) came up with one of the first known examples of people working together in *waqf* to improve agricultural land. They focused on two main points: setting up a *waqf* to deal with the problem of empty land and handling the *waqf* to help agriculture grow. Another idea from Babatunde *et al*. (2015) is to use cash *waqf* to start a chicken business that Baitul-Mal will pay for. Based on a Mudarabah contract, this plan would create jobs in a number of areas, including the feed mill, grinding, crate-making, transportation, management, and security. A good use of this plan would not only give unemployed people jobs, but it would also make everyone healthier.

Moh'd *et al*. (2017) suggested a *Waqf-Muzara'ah*-Supply Chain Model in which commercial organisations, like banks, play a big part by working together with farmers. This model aims to make customers happy and make sure they can get help with the goods right away. In 2018, Allah Pitchay *et al*. (2018a) suggested a hybrid cooperative-*waqf* plan as a way to finance Malaysian *waqf* lands that aren't being used and bring in agricultural investment. This model imagines a *waqf* organisation that is linked to the central government but separate in how it gets money, runs, and does other things. The suggested structure is meant to improve Indonesia's food security by keeping prices, production, and stock of rice stable.

Hossain *et al*. (2019) came up with a way to help poor smallholder farmers in Bangladesh get more money by using *zakat* and *salam* contracts. Mar Iman and Muhammad (2020) looked into a livestock *waqf* system that uses common grazing animals and could help Malaysian farmers. Bilal Khan *et al*. (2021) looked into the money problems Indonesian farmers were having and suggested an Islamic fintech model based on *waqf* to help fund both long-term and short-term farming projects. There is a lot of knowledge and desire among experts to use the *waqf* system to meet their food needs. Researchers in the past have mostly looked at cash *waqf* (Allah Pitchay *et al*., 2018b; Babatunde *et al*., 2015) and land *waqf* (Sanusi & Shafiai, 2015). Some have even combined the two in one model (Mar Iman & Muhammad, 2020). But it's still possible to suggest new forms of *waqf* for food security, especially if the ones that have already been suggested aren't widely used yet.

The studies highlight three key lessons relevant to my work on developing a *waqf*-based aquaponic model for urban food security in Malaysia. First, integrating *waqf* with agricultural initiatives, as demonstrated by Shafiai *et al*. (2015) and Babatunde *et al*. (2015), shows the potential of using *waqf* to mobilize resources for sustainable food production. Second, the importance of innovative financing models, such as the *waqf*-Muzara'ah-Supply Chain Model (Moh'd *et al*., 2017) and hybrid cooperative-*waqf* plans (Allah Pitchay *et al*., 2018a), underscores the need for robust financial frameworks that leverage Islamic principles to support aquaponic systems. Third, the necessity of adapting *waqf* models to local contexts, as seen in the works of Hossain *et al*. (2019) and Mar Iman & Muhammad (2020), highlights the importance of tailoring solutions to fit the unique urban environment and socio-economic conditions of Malaysian cities, ensuring their relevance and effectiveness in improving food security.

3. METHODS

The development of the Aquaponic *Waqf* model employed a literature review-based model development approach, integrating principles of *Shariah* law, previous *waqf* models, and contemporary literature on aquaponics. Initially, a comprehensive literature review was conducted, focusing on *Shariah* law to ensure compliance with Islamic legal principles, existing *waqf* models to understand their structure and implementation strategies, and scientific research on aquaponics to grasp technical aspects and sustainability benefits. Insights from this review informed the design of a preliminary model that incorporated essential elements such as perpetuity and public welfare, adapted successful components from previous *waqf* models, and tailored aquaponic systems for urban settings.

To validate and refine the preliminary model, consultations were held with *Shariah* scholars, *waqf* practitioners, and aquaponics experts. Feedback from these consultations was systematically analysed and incorporated, identifying gaps and making necessary modifications to enhance feasibility and effectiveness. The iterative process culminated in a final round of expert consultations to ensure alignment with *Shariah* law, practical *waqf* management, and aquaponic best practices. The refined Aquaponic *Waqf* model was then comprehensively documented, detailing its components, implementation strategy, and expected outcomes. This structured approach aims to provide a sustainable solution for urban agriculture, enhancing food security through the innovative integration of aquaponics within the framework of Islamic *waqf*.

This model is still an idea stage and needs to go through a very important process which is the validity process from panels that are experts in Islamic finance and food security. The model is purposefully built using a simple model. This allows any party to use FSWM and improve the model to meet their needs. We hope that this study work will have a good and significant impact on the development of food security and practice through *waqf*.

4. CONCEPTUAL FRAMEWORK

Waqf Aquaponic Model

The model in Figure 1 below illustrates the conceptual framework of our *waqf* aquaponic model. Primary funding for the aquaponic *waqf* is sourced from crowd *infaq* and cash *waqf*. Infaq encompasses all types of spending by a Muslim for the benefit of themselves, their family, and society. It is used to cover non-permanent expenditures such as management, research and development, and the purchase of freshwater fish. Cash *waqf*, on the other hand, is intended for financing and purchasing permanent assets like tanks, water pipes, water pumps, and aquaponic equipment.

In addition to crowd funding, the urban *waqf* aquaponic project welcomes government support. Government involvement is crucial as it provides essential funding, training, and regulatory approvals, which facilitate smoother implementation and long-term sustainability. Furthermore, government endorsement enhances the project's credibility and encourages community participation. Once we have acquired the necessary materials to establish the urban aquaponic system, we proceed to the food production phase using aquaponic techniques, detailed in the aquaponic model section. The food produced will primarily be for personal consumption, and any surplus can be sold by project participants. Profits from these sales can be reinvested into the aquaponic system, such as purchasing additional tools or vegetable seeds.

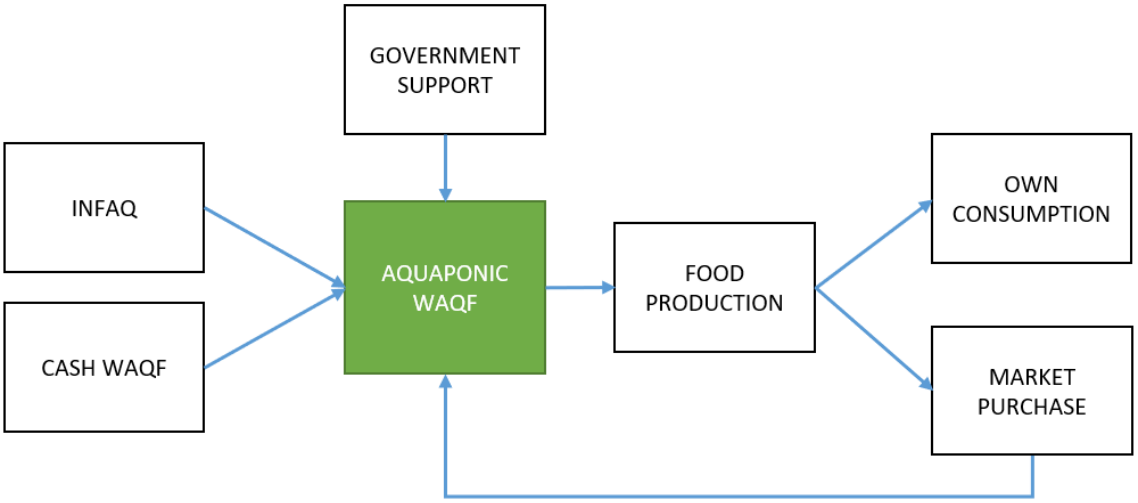

FIGURE 1: *WAQF* AQUAPONIC MODEL
Source: Figure by Authors

Urban Aquaponic Waqf Model

Aquaponics is a method of farming that combines aquaculture (raising fish) and hydroponics (growing plants in water without soil). In an aquaponic system, fish produce waste that is converted by beneficial bacteria into nutrients for the plants. The plants, in turn, help filter and clean the water, which is then recirculated back to the fish tanks. This creates a sustainable, closed-loop ecosystem where both fish and plants can grow efficiently.

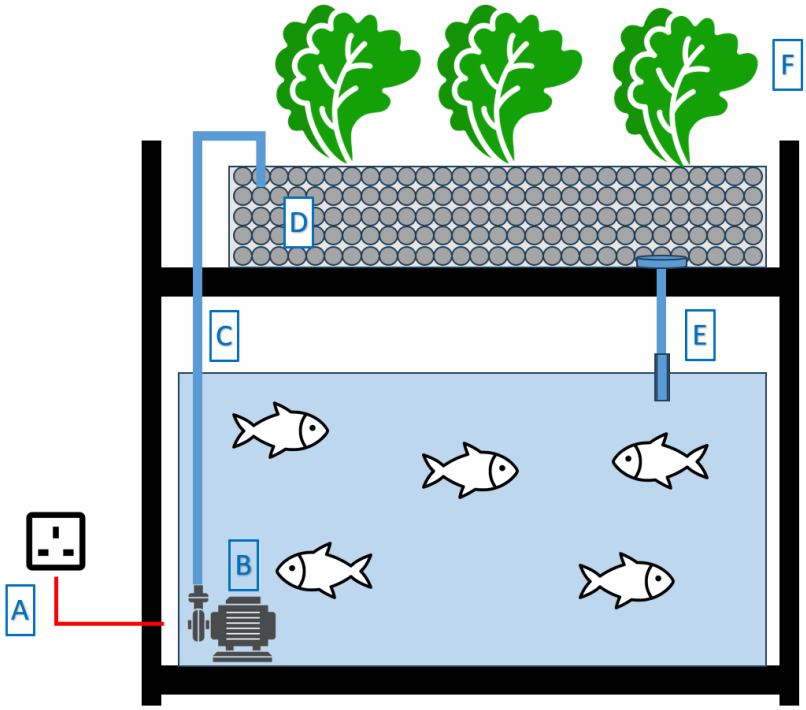

FIGURE 2: URBAN AQUAPONIC *WAQF* MODEL
Source: Figure by Authors

Figure 2 illustrates an aquaponic *waqf* model suitable for urban environments. We propose placing this setup in apartment corridors where plants can receive sunlight. The aquaponic system operates as follows: Initially, at point A, low voltage electricity is required to power the water pump at point B.

The water pump at point C draws water from the fish tank, along with fish waste, and sends it to point D, known as the grow bed. At point D, the fish waste acts as a nutrient-rich fertilizer for the vegetables. The water then flows back from the grow bed to the fish tank at point E. This cycle enables the vegetables to grow using the water and nutrients from the fish waste, while the fish benefit from the clean water filtered by the plants. Participants need to feed the fish daily to ensure their health and growth.

FIGURE 3: EXAMPLE REAL AQUAPONIC SET
Source: www.inhabitat.com

Figure 3 demonstrates that others have already implemented urban aquaponic systems, similar to our proposed model. However, our suggested aquaponic setup aims to utilize more cost-effective materials. For instance, instead of using glass for the fish tank, we recommend using a poly tank, which is more affordable. Additionally, the stand for the system can be constructed from aluminium steel, commonly used in roofing, to further reduce costs.

5. DISCUSSION

The suggested *waqf* aquaponic plan aims to improve food security in cities by using how aquaponics and the Islamic *waqf* system work well together. Not only does this integration make it possible to grow food in a sustainable way, it also fits with Islamic values of charity and social care. The design of the model, which gets money from crowd *infaq* and cash *waqf*, makes sure that the aquatic system can be maintained and grown without ever running out of money. In cities, where land and resources are limited and new ways to meet the growing food demand are needed, this is especially important.

The fact that the aquaponic system can grow both fish and veggies in a closed loop is helpful in many ways. Recirculating water and nutrients cuts down on waste and makes the best use of resources, making it an effective and eco-friendly way to farm. This system can be especially helpful in cities where fresh produce is hard to come by because it offers a local source of healthy food, lowering the need to import food and the pollution that comes with it.

Support from the government is seen as a key factor in the success of this plan. By giving money, training, and legal approvals, the government can help get things started and make sure they will last for a long time. Also, getting support from the government can boost the project's reputation, which can bring in more money and community involvement.

In cities, one important thing to think about is how practical it is to put the aquaponic system in hallways between apartments so that the plants can get sunshine. This design makes the best use of room so that food production can happen in residential areas. This helps people in cities become more self-sufficient. Using inexpensive materials like poly tanks and aluminium steel stands also makes the model easier to get and more flexible, which could lead to more people from all walks of life using it.
Even though this model has a lot of promise, there are some problems that need to be fixed. Regular upkeep is needed for the system, which includes feeding the fish every day and checking the water quality. It is important for the success of the model to teach participants about these duties and offer ongoing help. Not only that, but the plan is still just an idea and needs to be checked out by experts in Islamic finance and food security to make sure it can work.

Future Research
In the future, researchers should focus on doing pilot studies to see how well the *waqf* aquaponic model works in real life in different urban areas. These studies would give us useful information about how well the system works, how often it needs to be maintained, and how long it will last generally. Also, more study should be done on the model's social and economic effects on urban communities, especially on food security, economic empowerment, and social cohesion. It would also be helpful to look into how the model could be expanded and changed to work in different social and economic settings.

More research should be done on how to make the technical parts of the aquaponic system work better. For example, the nutrient cycles should be improved, water quality should be better managed, and the system should be powered by green energy sources. To make sure that the aquaponic systems work well and are maintained, researchers need to work on creating training programmes and educational tools for participants. This last point can help you figure out the best ways to make this new model easier to use by looking closely at the laws and rules that guide *waqf* and urban farming in various parts of the world.

Research Constraint
It's important to recognise the limitations of this work. Right now, the plan is just an idea; it hasn't been tested or proven to work in the real world yet. We can't correctly predict problems and outcomes in the real world because of this. That being said, the plan may or may not work depending on how willing people in cities are to take part and commit to daily maintenance of the aquaponic systems.

The original setup costs and ongoing maintenance costs might be too high for some communities to handle without enough funding and support. It's not always clear if the project will be able to continue if the government changes its policies or goals. To make sure that religious and legal rules are followed, combining Islamic *waqf* principles with modern farming methods needs to be carefully thought out. To do this, a lot of time and resources need to be spent talking to Islamic banking and farming experts. The suggested *waqf* aquaculture model seems like a good way to improve food security in cities. However, these research limitations need to be fixed and more studies need to be done to make it work perfectly.

6. CONCLUSION

The proposed *waqf* aquaponic model represents a promising solution to address urban food security in Malaysia, leveraging the principles of Islamic endowment and the sustainable practices of aquaponics. This model combines crowd *infaq* and cash *waqf* to create a continuous funding mechanism that supports the establishment and maintenance of aquaponic systems in urban settings. By producing both fish and vegetables in a closed-loop environment, the model offers an efficient and environmentally friendly approach to urban agriculture.

Government support plays a crucial role in the success of this initiative, providing necessary funding, training, and regulatory approvals, and enhancing the project's credibility. The practical design of the

aquaponic setup, suitable for placement in apartment corridors, ensures efficient use of space and resources, making fresh produce accessible to urban residents and reducing reliance on external food supplies.

However, the model faces several challenges, including the need for regular maintenance, participant education, and validation from experts in Islamic finance and food security. Future research should focus on pilot studies, socio-economic impact analysis, technical optimization, and the development of training programs to address these challenges and ensure the model's feasibility and effectiveness. Overall, the integration of *waqf* principles with modern aquaponics presents a unique opportunity to enhance food security, promote social welfare, and foster community participation in urban agriculture. Addressing the identified constraints and conducting further studies will be crucial in realizing the full potential of this innovative model and ensuring its successful implementation across diverse urban contexts.

The proposed *waqf* aquaponic model, while promising, is still in its conceptual stages and requires significant validation and refinement. Initial setup and ongoing maintenance costs could be prohibitive without adequate funding and sustained financial support. The model's success hinges on the active participation of urban residents, who must commit to daily maintenance tasks such as feeding fish and monitoring water quality. Additionally, the support of government agencies is crucial, as funding, training, and regulatory approvals are necessary for implementation. However, changes in government policies or priorities could impact the project's sustainability. Technical challenges such as nutrient cycling, water quality management, and system integration also necessitate continuous monitoring and expertise.

The placement of aquaponic systems in apartment corridors may face spatial limitations and regulatory restrictions, and ensuring adequate sunlight and ventilation could be challenging. Cultural and social acceptance of the model may vary, requiring community engagement and education to overcome resistance and ensure widespread adoption. Integrating Islamic *waqf* principles with modern aquaponics demands careful consideration of legal and religious guidelines, necessitating collaboration with experts in Islamic finance and law. Furthermore, the scalability of the model to different urban contexts and varying socio-economic conditions remains to be determined. Environmental impacts, such as energy consumption and waste management, need careful evaluation and mitigation. Addressing these limitations through pilot studies, community engagement, and further research will be essential for the model's successful implementation and broader application.

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