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A REVIEW OF THE INTEGRATION OF HYDROPONIC AGRICULTURAL GARDENING IN URBAN AREAS AND CONSTRUCTION TECHNOLOGY TOWARDS SUSTAINABILITY

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ABSTRACT

The review examines hydroponic urban agriculture and construction technology for sustainable food production. Hydroponic Gardening is a technology adoption that integrates construction technology and agricultural technology. The structural framework of the device was the utilization of assorted wood products and fasteners—the utilization of a 4" diameter of Polyvinyl Chloride (PVC) Pipe as the main line. The PVC pipe has multi-holes for the flower pots. A controlled submersible pump circulates the liquid nutrient tea from a reservoir through the ½" dia. PVC pipes and back to the pool. The acceptability of the device was highly recommended for entrepreneurship. Hydroponics: efficient, year-round crop production, reduced reliance on traditional agriculture. Integrating construction technology, green materials, and intelligent infrastructure creates resource-efficient hydroponic farming structures. Study evaluates 100 farmers, 50 construction workers, 50 office workers using questionnaire. Based on the results of the experimental methods of the research, the hydroponics construction and the installation of the submersible pump were challenging and a lot of adjustment in terms of slop and levelness of the structures and the PVC chambers. And the conventional gardening methods were also easy to plant, but it was hard to monitor daily by watering the plant twice daily. The review discusses hydroponics gardening's economic viability, scalability, and social acceptance, emphasizing interdisciplinary collaborations and real-world assessments. But we need a greenhouse to shelter the plants and protect them from direct sun and insects for the best production. While the Conventional Methods of Gardening, it also easy to plant but the respondents will store daily water in the container for the plants. And also need a greenhouse for the best production. Therefore, the acceptability of Hydroponic Gardening was very high acceptable in terms of the utilization of a small lot in the house. This integration holds promise for building resilient and sustainable urban food systems for the future.

Keywords: *Agricultural Garden, Construction Technology, Hydroponic, Urban Gardening, Sustainability*

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Introduction

In recent years, urban agriculture has gained significant attention as a means of addressing food security, environmental sustainability, and the efficient use of limited resources in densely populated cities (Specht et al., 2014). The integration of hydroponics, a soil-less cultivation technique, and construction technology offers a promising approach to enhance urban agriculture and contribute to sustainable development goals (Sridhar et al., 2023). This review aims to explore the integration of hydroponic urban agricultural gardening and construction technology, examining the potential benefits, challenges, and implications for sustainability.

Hydroponics, as a cultivation method, involves growing plants in nutrient-rich water solutions, without the need for traditional soil-based agriculture (Venkatraman & Surendran, 2023). This technique offers several advantages for urban environments, including reduced land requirements, efficient water usage, optimized nutrient delivery, and higher crop yields compared to conventional farming methods. By integrating hydroponics with construction technology, urban agricultural systems can be designed to maximize space utilization in buildings, rooftops, and other urban structures.

Construction technology plays a crucial role in enabling the integration of hydroponics into urban environments (Khidoyatov et al., 2022). Advanced building materials, such as lightweight and durable structures, can provide the necessary infrastructure for vertical farming systems, allowing for the efficient use of space and integration with existing urban infrastructure. Moreover, construction techniques, such as modular and prefabricated systems, enable the scalable deployment of hydroponic gardens, providing flexibility and adaptability to changing urban landscapes.

The integration of hydroponic urban agricultural gardening and construction technology holds great potential for enhancing urban sustainability. By bringing agriculture closer to urban populations, food miles can be significantly reduced, leading to a decrease in carbon emissions associated with transportation. Additionally, the controlled environment of hydroponics mitigates the risks of pests, diseases, and extreme weather conditions, resulting in higher crop productivity and stability throughout the year (Fussy & Papenbrock, 2022). These benefits can contribute to food security and resilience in urban areas.

However, the integration of hydroponic urban agricultural gardening and construction technology also presents challenges and considerations. The initial investment costs of implementing such systems, including the construction of infrastructure, procurement of equipment, and maintenance expenses, can be substantial (Maiurova et al., 2022). Adequate training and education are required for individuals involved in the design, installation, and management of hydroponic systems. Furthermore, issues related to energy consumption, waste management, and the use of synthetic nutrients in hydroponic solutions must be addressed to ensure sustainable practices.

This review aims to critically examine the integration of hydroponic urban agricultural gardening and construction technology, considering both the potential benefits and challenges associated with this approach. By exploring the existing literature, identifying knowledge gaps, and discussing the implications for sustainability, this research aims to contribute to the

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understanding of how these integrated systems can enhance urban food production and promote sustainable development.

It is important to consider the reality that agriculture is dying (Evangelista et al., 2022). The Philippine Government has allocated Multi-billion pesos to continue the development of the Agriculture sector. The Philippine Government spares experts to train the people in the mountain areas to sustain the agricultural land. It is saddened reality that agricultural land is now being developed into industrial areas, shopping malls, and subdivisions (Evangelista et al., 2022). Farmers are growing old, and their children have shifted to other careers. The agriculture industry has yet to progress in ages. Many of our agricultural schools produce office-oriented workers who would much rather do the paperwork than help improve the country's agricultural sector. Not to mention the many horror stories of corruption at the Department of Agriculture. Even if the Philippines is primarily a farming country, we have not done anything to "cultivate" this sector. In the sixties, we were ahead in Asia. Yes, we have been blessed with different kinds of bodies of water, lush and fertile lands, and a favorable climate for growing various high-valued types of crops and raising livestock, poultry, and other farm animals. But due to economic industrialization, this industry has been challenged. Our priorities have changed, almost forgetting our fundamental need for survival. And according to reports, the agricultural sector employs only 25.96 percent of Filipino workers as of November 2017. This is very low compared to many countries prioritizing and giving it more importance (Pathak et al., 2022).

Agriculture plays a vital role in the country's economy. This is measured as the value added of the agricultural sector as a percent of GDP (Nyiwul & Koirala, 2022). The reason why Filipinos don't want agricultural work is that they are not well compensated. Most of their time was spent farming, but they only got less from the effort, time, and expenses. The other aspires to another trade, works in industries with less effort, and earns significant income. Usually, people from urban areas want to be in higher positions like managerial or supervisory positions, and honestly speaking, agriculture is outside their vocabulary.

Thus, this study aimed to construct a three-layer “A” frame wooden structure for a hydroponic garden device and install a submersible pump with polyvinyl chloride (PVC) pipes and fittings for the water flow distribution in order to promote technology which can be used to the people for sustainability because the main reason for this technology is for the proposed pangkabuhayan to the people of Pinamungajan, Cebu, Philippines.

Review Related Literature

Patterson D Merrill. Hydroponic Gardening Device. This invention relates to improvements in hydroponic gardening devices, and more particularly to a small portable device of this character which can be used in, a home'. Patterson D Merrill has developed an innovative hydroponic gardening device specifically designed for home use (Al-Kodmany, 2023). This portable device aims to enhance the practice of hydroponic gardening by offering a convenient solution for individuals who want to grow plants without soil within the confines of their own homes. By eliminating the need for traditional soil-based gardening, this invention provides an efficient and space-saving method for cultivating plants.

The Patterson D Merrill Hydroponic Gardening Device features a compact design, making it easy to set up and move around as needed (Rosén et al., 2022). Despite its small size, the device incorporates essential components required for successful hydroponic growth. It includes a

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reservoir to hold the nutrient-rich water solution necessary for the plants, as well as a pump system that circulates and delivers the water directly to the plant roots.

To support plant growth, the device utilizes inert growth mediums like perlite, vermiculite, or coconut coir, which provide stability and nutrients to the root systems. In addition, an artificial lighting system is incorporated into the device, typically utilizing LED grow lights, to ensure that the plants receive the required spectrum and intensity of light for photosynthesis (Neo et al., 2022). Adequate ventilation and air circulation are also taken into account, as the device may feature built-in fans or ventilation systems to promote healthy plant growth.

To optimize the gardening experience, the Patterson D Merrill Hydroponic Gardening Device may include control systems for adjusting parameters such as water flow, nutrient concentration, and lighting schedules. These controls empower users to customize the device's settings and create an ideal growing environment for their plants. With this invention, individuals can engage in hydroponic gardening in a manageable and efficient manner, enjoying the benefits of home-grown produce without the limitations of traditional soil-based gardening.

The primary object of this invention is to provide a device of this character which is simple in construction, light in weight, easy to operate, and effective for its intended purpose A further object is to provide a device of this character which is formed from a foamed unicellular plastic material accommodating detachable connection of fittings thereto with a leak-proof arrangement to accommodate controlled application of liquid and of air under pressure to the device during use thereof.

The invention described is a hydroponic gardening device designed for home use (Stegelmeier et al., 2022). It is intended to be simple, lightweight, and easy to operate, while effectively supporting the growth of plants using hydroponic techniques. The device is constructed using a foamed unicellular plastic material that allows for detachable fittings and incorporates a leak proof system to control the application of liquid and air under pressure.

One of the key features of the device is a false bottom, which has an opening connected to a tube extending downwards to a level near the bottom of the device. The false bottom serves as a support for granular material, keeping it above the level of the liquid supply contained in the chamber below. The chamber is subjected to air pressure generated by a manually operable pump, which is connected to it. The pressure can be released by disconnecting the pressure-generating means.

The false bottom also includes a liquid-confining chamber with an opening near its lower end. This opening tightly accommodates one end of a transparent tube that extends upward and acts as a gauge for the liquid level inside the device, allowing it to be visible. The tube can also be rotated to a downward position to function as a drain for removing liquid from the chamber.

In summary, the invention presents a compact and portable hydroponic gardening device for home use. Its design incorporates a foamed unicellular plastic material, detachable fittings, a leak proof system, a false bottom with a granular material support and liquid-confining chamber, and a transparent tube for liquid level monitoring and draining.

Hydroponic gardening is a method of growing plants without soil, using a nutrient-rich water solution as the growing medium. There are various devices and systems available to facilitate hydroponic gardening, ranging from simple setups to more complex and automated systems.

One popular hydroponic system is the Nutrient Film Technique (NFT) System. This system involves a shallow stream of nutrient solution flowing over the roots of the plants. The roots absorb

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the necessary nutrients and water while being exposed to air. NFT systems typically consist of channels, pumps, and a reservoir to hold the nutrient solution.

Another common hydroponic system is the Deep Water Culture (DWC) System. In this system, plants are suspended in a solution of nutrient-rich water. The roots are submerged, and an air stone or diffuser provides oxygen to the roots. DWC systems often use a large container or tank as the reservoir and require an air pump to maintain oxygen levels.

Aeroponics is another type of hydroponic system. It involves suspending the plant roots in the air and periodically misting them with a nutrient solution. The roots receive nutrients and oxygen directly from the mist. Aeroponic systems may use misting nozzles, pumps, and timers to automate the process.

Drip irrigation systems are widely used in hydroponics. They deliver a nutrient solution to the plants through a network of tubes with drip emitters. The solution drips onto the growing medium or directly onto the roots. Drip systems often utilize a timer, pump, and reservoir.

For home gardeners and beginners, there are all-in-one hydroponic kits available (Fard, 2022). These kits provide a complete package with all the necessary components, including a reservoir, growing medium, nutrient solution, and sometimes even seeds. All-in-one kits often have simplified setups, such as drip systems or DWC systems, and may come with built-in lighting systems.

When choosing a hydroponic gardening device, consider factors such as the size and space available, your level of experience, the types of plants you want to grow, and your budget. It's also important to ensure the device includes essential components like a nutrient reservoir, pumps, timers (if needed), and proper lighting (if not using natural sunlight).

Objectives of the Study

The study aimed to construct a three-layer “A” frame wooden structure for a hydroponic garden device and install a submersible pump with polyvinyl chloride(PVC) pipes and fittings for the water flow distribution. The investigation discoveries were the reason for the proposed pangkabuhayan to the people of Pinamungajan, Cebu, Philippines. It answered the following: 1. The technical requirements for the fabrication of integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for Pangkabuhayan as to its: *1.1. design; 1.2. ergonomics, and work implements. 2. T*he level of acceptability of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for Pangkabuhayan as to its: 2.1. A*cceptability, and 2.2. effectiveness. 3. E*xtent is the acceptability of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for Pangkabuhayan. 4. Comparison between Hydroponics and Conventional Gardening regarding plant growth; 5. A significant difference between the perceptions of the respondent groups on the acceptability of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for Pangkabuhayan.

Methodology

Based on the information provided, it appears that the study aimed to investigate the integration of hydroponic agricultural gardens and construction technology for livelihood purposes, specifically in the context of "pangkabuhayan." The study utilized a quasi-experimental

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research design, with a normative survey as the primary data acquisition method. The main instrument for data collection was a questionnaire.

The participants in the study included 100 farmers, 50 construction workers, and 50 office workers. The questionnaire was distributed to these individuals for evaluation. It's likely that the questionnaire contained items related to the integration of hydroponic agricultural gardens and construction technology, as well as their potential impact on livelihood.

To analyze the gathered data, several statistical techniques were employed. The total weighted points method was used, which suggests that respondents may have assigned weights or ratings to the questionnaire items. The weighted mean was calculated to summarize the overall responses for each group of participants. Additionally, a t-test was conducted, although it's not specified what the t-test was used to compare.

Overall, this study aimed to gather relevant facts for the planning, designing, and fabrication of a green technology project involving hydroponic agricultural gardens and construction technology. The cross-sectional research design, normative survey, and statistical analysis methods employed aimed to provide valuable insights into the integration of these technologies for livelihood purposes in the specific context of "pangkabuhayan."

Results and Discussions

Technical requirements of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan in terms of usefulness and ease of use. The integration of hydroponic agricultural gardens and construction technology for pangkabuhayan (livelihood) purposes requires careful consideration of various technical requirements to ensure usefulness and ease of use. These requirements encompass elements such as structural design, hydroponic systems, automation and monitoring, energy efficiency, water management, easy maintenance, scalability, and training and support. The structural design should provide sturdy and durable structures that optimize space utilization and protect against environmental factors. Hydroponic systems need to be designed for efficient plant growth and water and nutrient conservation. Automation and monitoring technology can enhance management efficiency, while energy-efficient and renewable energy sources should be utilized. Proper water management, easy maintenance, scalability, and comprehensive training and support materials are also vital for successful implementation. By addressing these requirements, the integration of hydroponic gardens and construction technology can offer a user-friendly solution for sustainable pangkabuhayan, supporting economic growth and reducing resource consumption.

The Technical Requirements of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan in terms of usefulness and Ease of Use was rated by the farmers, construction workers and the office workers in the municipality of Pinamungajan, Cebu Philippines. The table has one column for Usefulness indicators and two columns for weighted means and the Verbal Descriptions. It has 200 selected respondents from the respondents.

Table 1
Perceived Usefulness
N=200

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As indicated in Table 3 below, there were eight (8) Technical Requirements in term of Usefulness: 4.90 and 4.82 respondents responded Highly Acceptable(HA) to the questions in terms of integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*;* 4.60 and 4.36 respondents responded Highly Acceptable (HA) to the questions in terms of *Usefulness of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; 4.85 and 4.90* respondents responded Highly Acceptable(MA) to the questions in terms of *Aesthetic of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; 4.68 and 4.60* respondents responded Highly Acceptable(HA) to the questions in terms of *Aesthetic of the Clarity of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; 4.78 and 4.85* respondents responded Highly Acceptable(HA) to the questions in terms of *Aesthetic of the Unremarkable of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; 4.90 and 4.68* respondents responded Highly Acceptable (HA) to the questions in terms of *Aesthetic of the Authenticity of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; 4.60 and 4.78* respondents responded Highly Acceptable(MA) to the questions in terms of *Aesthetic of the Long-lasting of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; and 4.85 and 4.90* respondents responded Highly Acceptable (HA) to the questions in terms of *Aesthetic of the Environmentally-friendly of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan.

PERCEIVED USEFULNESS	**Selected Respondents from Pinamungajan Farmers and construction workers**			
	Farmers (n = 150)		Construction Workers (n = 50)	
	X	VD	X	VD
Innovative integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan	*4.90*	*HA*	*4.82*	*HA*
Usefulness of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan	*4.60*	*HA*	*4.36*	*HA*
Aesthetic of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan.	*4.85*	*HA*	*4.90*	*HA*

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Clarity of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan.	*4.68*	*HA*	*4.60*	*HA*
Unremarkable of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan.	*4.78*	*HA*	*4.85*	*HA*
Authenticity of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan.	*4.90*	*HA*	*4.68*	*HA*
Long-lasting of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan.	*4.60*	*HA*	*4.78*	*HA*
Environmentally-friendly of integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan.	*4.85*	*HA*	*4.90*	*HA*
Average weighted mean	***4.77***		***4.74***	
Interpretation	***Highly Acceptable***		***Highly Acceptable***	

Where: TWP is Total Weighted Points
VD is Verbal Description
MA is Moderately Acceptable
LA is Less Acceptable
X is the Weighted Mean
HA is Highly Acceptable
FA is Fairly Acceptable
UA is Unacceptable

This means that the technical requirements of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan in terms of perceived usefulness *was would be "Highly Acceptable" to the need of the Technology with the average weighted mean of 4.77 and 4.44.* This recent study has been conformed with the previous study conducted by Roa (2023), who opined that by integrating this innovative endeavor would strengthen the individual's enterprise skills and giving them access to living, innovation, and support services to improve practices, and sensitive food chain improvements.

Table 2
Perceived Ease of Use
N=200

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PERCEIVED EASE OF USE	Selected Respondents from Pinamungajan Farmers and Construction Workers			
	Farmers (n = 150)		Construction Workers (n = 50)	
	X	VD	X	VD
Safety in using the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan	*4.90*	*HA*	*4.82*	*HA*
Comfortability of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan	*4.60*	*HA*	*4.36*	*HA*
Rigidity of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan	*4.85*	*HA*	*4.90*	*HA*
Durability of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan	*4.68*	*HA*	*4.60*	*HA*
Safety habits is being applied	*4.78*	*HA*	*4.85*	*HA*
Preparations of tools, machines, materials and accessories	*4.96*	*HA*	*4.62*	*HA*
Construction time frame is enough	*4.66*	*HA*	*4.78*	*HA*
Adequate ventilation of the working area	*4.85*	*HA*	*4.90*	*HA*
Quality of the finished integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan	*4.90*	*HA*	*4.66*	*HA*
Steps of operations are feasible	*4.85*	*HA*	*4.90*	*HA*
Machine Scheduling	*4.90*	*HA*	*4.68*	*HA*
Proper housekeeping of the working area	*4.60*	*HA*	*4.78*	*HA*
Average weighted mean	***4.79***		***4.74***	
Interpretation	***Highly Acceptable***		***Highly Acceptable***	

As indicated in table 4, there were eight (8) Technical Requirements in term of Ease of Use: 4.90 and 4.82 respondents responded Highly Acceptable (HA) to the questions in terms of integration of hydroponic agricultural gardening in urban areas and sustainable construction

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technology for pangkabuhayan. 4.60 and 4.36 respondents responded Highly Acceptable (HA) to the questions in terms of Usefulness of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology.*; 4.85 and 4.90* respondents responded Highly Acceptable (HA) to the questions in terms of *Aesthetic of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan.*; 4.68 and 4.60* respondents responded Highly Acceptable (HA) to the questions in terms of *Aesthetic of the Clarity of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan.*; 4.78 and 4.80* respondents responded Highly Acceptable (HA) to the questions in terms of *Aesthetic of the Unremarkable of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; 4.96 and 4.62* respondents responded Highly Acceptable (HA) to the questions in terms of *Aesthetic of the Authenticity of the* Green integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; 4.66 and 4.78* respondents responded Highly Acceptable (HA) to the questions in terms of *Aesthetic of the Long-lasting of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; and 4.85 and 4.90* respondents responded Highly Acceptable (HA) to the questions in terms of *Aesthetic of the Environmentally-friendly of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; 4.90 and 4.66* respondents responded Highly Acceptable (HA) to the questions in terms of *Aesthetic of the Unremarkable of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; 4.85 and 4.90* respondents responded Highly Acceptable (HA) to the questions in terms of *Aesthetic of the Authenticity of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; 4.90 and 4.68* respondents responded Highly Acceptable (HA) to the questions in terms of *Aesthetic of the Long-lasting of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan*; and 4.60 and 4.78* respondents responded Highly Acceptable (HA) to the questions in terms of *Aesthetic of the Environmentally-friendly of the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan.

This means that the technical requirements of the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan in terms of ease of use *was used in the* integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for pangkabuhayan *would be **"Highly Acceptable"** to the need of the Technology with the average weighted mean of 4.79 and 4.74.* The study of Wilken (1990) clearly emphasized the importance of agriculture when he argues that all farming systems attempt to direct or increase flows of energy and materials into the production of useful products. But farming is not manufacture: the plants themselves combine elements from the environment into new forms without the direct application of labor or other human inputs.

Orthographic Drawing

The drawing presented below is the following: Top View represents the picture of the hydroponics garden when the observer's position is on top; the Front View represent the picture

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of the 6 PVC chamber with the PVC Gate Valves; and the Right-Side View represent the lengths of the PCV and the pot holes for the garden.

The devices stated above are the whole hydroponic garden device that was used for short area for gardening. The materials used are Wood, PVC, Pumps, Plastic pails and net pot.

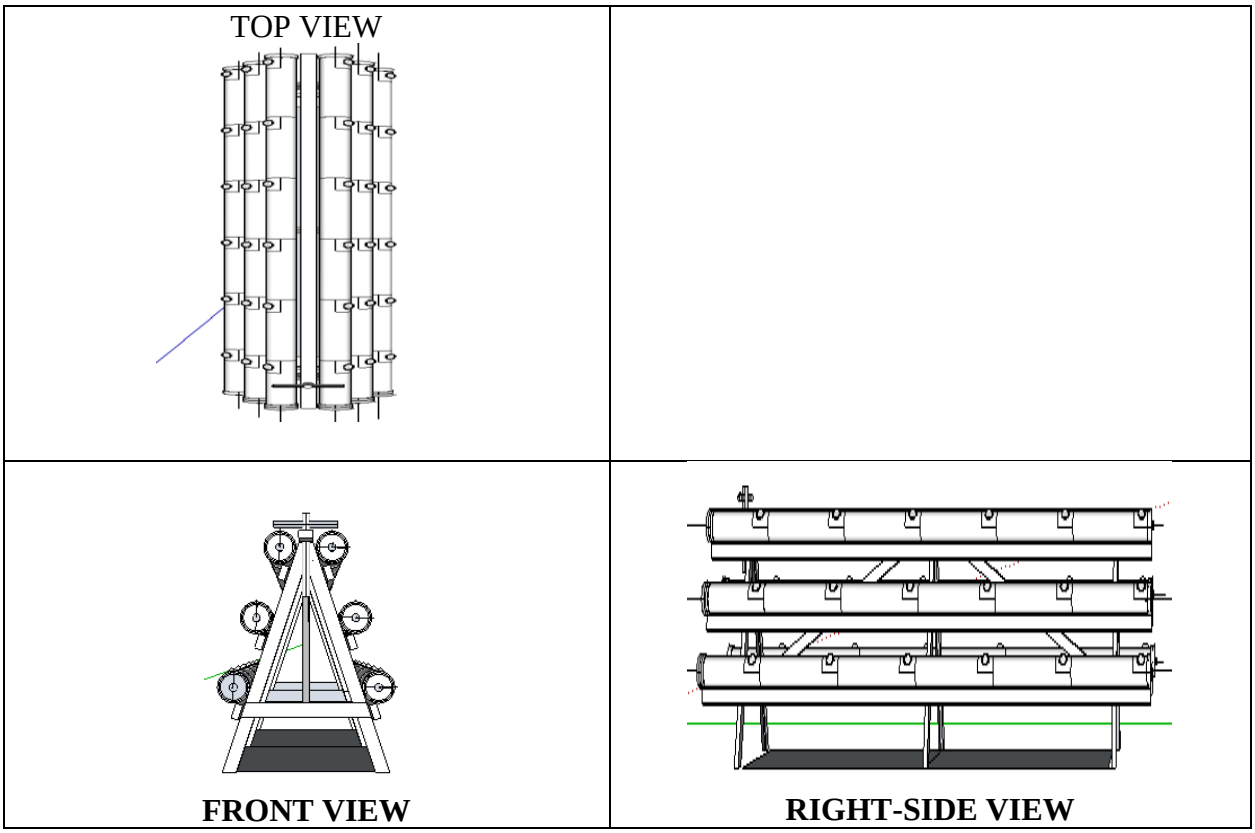

Figure 1. Orthographic Views of Hydroponics Wooden Structures for Pangkabuhayan

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Figure 2. Perspective View of Hydroponics Wooden Structures with plants for Pangkabuhayan

Fabrication Processes

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The fabrication procedures of the structures are the following: 1st process the researcher prepare the detailed plans, elevations and materials needed; 2nd prepare cutting list of the materials and accessories; 3rd acquires submersible pump and other electrical accessories; 4th Assemble wooden structures, Polyvinyl Chlorides, fittings, plastic container and hoses; 5th check the levelness of the pipe chambers with pot holes; and 6th dry run the hydroponics with water.

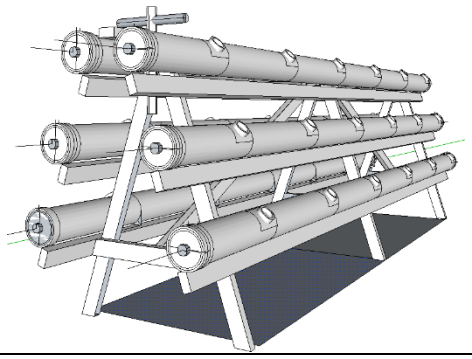

Figure 3. Hydroponic Structure with Polyvinyl Chloride

Figure 4. Hydroponics Construction

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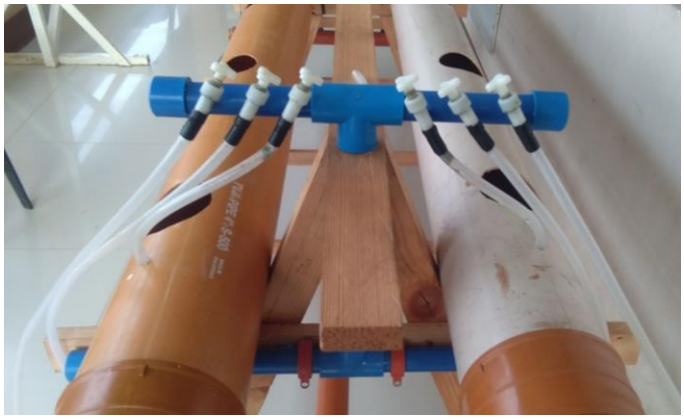


Figure 5. Hydroponics Stand with Submersible Pump


Figure 6. Hydroponics Garden runs 14 days of plants

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Figure 7a. Hydroponics Garden.
14 days of growing plants

Figure 7b. Conventional Garden.
14 days of growing plants

Figure 7c. Hydroponics Garden.
28 days of growing plants

Figure 7d. Conventional Garden.
28 days of growing plants

Figure 7. Comparison of growing plants between Hydroponics and conventional gardening

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Comparison between Hydroponics and Conventional Gardening In Terms Of Growing Plants

The Table 3 presented below are the comparison between two processes of Agricultural Gardening, the Hydroponics and the Conventional Gardening Methodology.

Table 3.
The Hydroponics and Conventional Gardening Methods
N= 200

Legend		Number of days for Growing Plants							
		14 days (mm)		21 days (mm)		28 days (mm)		45 days (mm)	
		HG	CG	HG	CG	HG	CG	HG	CG
A	Length of Stem	30	30	70	50	80	100	110	110
B	Length of Leaves	45	45	60	80	100	100	120	130
C	Length Roots	30	30	55	80	45	50	55	60
D	Colour of the plants	Green	Green	Pale Green	Green	Yellow Green	Green	Yellow Green	Green
E	Growth of the plants	Slow	Slow	Slow	Fast	Slow	Fast	Fast	Fast

Legends: A - Length of Stem; B - Length of Leaves; C - Length Roots; D - Colour of the plants; E - Growth of the plants; HG - Hydroponics Gardening; CG - Conventional Gardening

The Table 3 represented the result of the plants compared the Hydroponics Gardening and the Conventional Gardening. Based on the experimental data, the result after 21 days of growing, the Length of stem were; HG 30mm and CG 30mm; For the Length of Leaves were; 45mm and 45mm; for Length of Roots were; 30mm and 30mm; for the Colour of the Plants were; Green for Both HG and CG are Green; and Growth of the plants were; both HG and CG are slow.

For the result after 21 days of growing, the Length of stem were; HG 45mm and CG 60mm; For the Length of Leaves were; 55mm and 80mm; for Length of Roots were; 55mm and 80mm; for the Colour of the Plants were; Green for Both HG and CG are Green; and Growth of the plants were; both HG was slow and CG was fast.

For the result after 28 days of growing, the Length of stem were; HG 80mm and CG 100mm; For the Length of Leaves were; 45mm and 50mm; for Length of Roots were; 30mm and

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30mm; for the Colour of the Plants were; Green for Both HG and CG are Green; and Growth of the plants were; both HG was slow and CG was fast.

For the result after 45 days of growing, the Length of stem were; HG 110mm and CG 110mm; For the Length of Leaves were; 120mm and 130mm; for Length of Roots were; 55mm and 60mm; for the Colour of the Plants were; Green for Both HG and CG are Green; and Growth of the plants were; both HG was fast and CG was fast.

Based on the results of the experimental processes of the research, the hydroponics construction and the installation of the submersible pump were very difficult and a lot of adjustment in terms of slop and levelness of the structures and the PVC chambers. And the conventional methods of gardening were also easy to plant but it hard to monitor daily by watering the plant twice a day.

Implication of the experiment, the hydroponics gardening was very effective especially when the respondents has no area for gardening. But need to have a green house in order to shelter the plants and protect from direct sun and insect for the best production. While the Conventional Methods of Gardening, it also easy to plant but the respondents will store daily water in the container for the plants. And also need green house for the best production.

Therefore, acceptability of the Hydroponic Gardening was very high acceptable in terms of the utilization of a small lot in the house. These findings are in line with the study conducted by Salas et al (2010) that there is a need of the design of the hydroponic systems to become adapted to different constructions.

LEVEL OF ACCEPTABILITY AND EFFECTIVENESS OF THE INTEGRATION OF HYDROPONIC AGRICULTURAL GARDENING IN URBAN AREAS AND SUSTAINABLE CONSTRUCTION TECHNOLOGY

Table 4.
Level of Acceptability and Effectiveness the Green Technology
N=200

INDICATORS	**Selected Respondents from Pinamungajan Farmers and Construction Workers**			
	Farmers (n = 150)		Construction Workers (n = 50)	
	X	VD	X	VD
Acceptability	*4.90*	*HA*	*4.82*	*HA*
Effectiveness	*4.60*	*HE*	*4.36*	*HE*
Average weighted mean	***4.79***		***4.74***	
Interpretation	***Highly Acceptable***		***Highly Effective***	

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Table 4 presents the findings of a survey conducted among 200 respondents from Pinamungajan, including farmers and construction workers, to evaluate the level of acceptability and effectiveness of green technology. The indicators considered were "Acceptability" and "Effectiveness." The respondents were divided into two groups: farmers (n = 150) and construction workers (n = 50).

The table displays the mean scores (represented by "X") and the level of variation (indicated by "VD"). Under the "Acceptability" indicator, both farmers and construction workers rated the green technology highly, with average scores of 4.90 and 4.82, respectively, indicating a high acceptability rating. Similarly, for the "Effectiveness" indicator, farmers and construction workers rated the green technology highly, with average scores of 4.60 and 4.36, respectively, indicating a high effectiveness rating. The average weighted mean for acceptability was 4.79, and for effectiveness, it was 4.74.

Overall, the interpretation of the results suggests that the surveyed farmers and construction workers perceive the green technology to be highly acceptable and highly effective. This recent study corroborates with the results of the study conducted by Mariano et al (2012), who were found to be consistent between models in terms of the positive impacts on the adoption of certified seed technology and integrated crop management practices of farmers' education, machinery ownership, irrigation water supply, capacity-enhancement activities and profit-oriented behavior. Conversely, soil and nutrient deficiencies are impediments to their adoption. Extension-related variables have the biggest impact on technology adoption.

Conclusion

Based on the findings and after a careful analysis and interpretation of the research study, it is concluded that the Integration of Hydroponic Agricultural Gardening in Urban Areas and Construction Technology Towards Sustainability for Pangkabuhayan meets the standards and is precise functional in performing each functions for Entrepreneurship. The integration of hydroponic agricultural gardening in urban areas, coupled with advancements in construction technology, holds immense potential for promoting sustainability.

Hydroponic agricultural gardening offers several advantages over traditional farming methods, particularly in urban environments where land availability is limited. By utilizing vertical farming techniques and optimizing resource utilization, hydroponic systems can produce higher yields in smaller spaces while reducing water consumption and eliminating the need for chemical pesticides. This technology allows for year-round cultivation, minimizing the dependence on seasonal variations and enhancing food security.

Furthermore, the integration of hydroponics with modern construction technology enhances the overall sustainability of urban areas. Vertical farming structures can be seamlessly incorporated into the architectural design of buildings, utilizing underutilized spaces such as rooftops and unused walls. The combination of green infrastructure and urban farming creates a harmonious balance between human habitation and nature, improving air quality, mitigating the urban heat island effect, and enhancing biodiversity.

The sustainability benefits extend beyond food production and environmental considerations. The integration of hydroponics in urban areas can contribute to the local economy by promoting job creation and entrepreneurial opportunities. Additionally, by reducing the

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dependence on long-distance transportation and minimizing food waste, this approach helps to lower carbon emissions and increase the resilience of urban communities in the face of climate change.

However, despite the potential advantages, there are still challenges that need to be addressed. The initial costs of implementing hydroponic systems and integrating them into existing urban infrastructure can be significant. Adequate training and education are necessary to ensure successful operation and maintenance of these systems. Moreover, addressing regulatory barriers and securing necessary funding are crucial for scaling up the adoption of hydroponic gardening in urban areas.

In conclusion, the integration of hydroponic agricultural gardening in urban areas, along with advancements in construction technology, represents a promising pathway towards sustainability. By optimizing resource utilization, promoting local food production, and enhancing the liveability of urban environments, this approach can contribute to building more resilient and environmentally friendly cities. Continued research, innovation, and collaboration among stakeholders are vital to overcome challenges and fully unlock the potential of this integrated approach for a sustainable future.

Recommendation

It is recommended that the Integration of Hydroponic Agricultural Gardening in Urban Areas and Construction Technology towards Sustainability for Pangkabuhayan must be adopted and disseminate to community for farming. It is because the integration of hydroponic agricultural gardening in urban areas and sustainable construction technology for Pangkabuhayan (livelihood) is a recommended approach that should be adopted and disseminated to the community for farming. By promoting hydroponics, which involves growing plants without soil using nutrient-rich water solutions, and incorporating sustainable construction practices, such as eco-friendly materials and energy-efficient designs, urban areas can address food security, promote self-sufficiency, and enhance sustainability. This can be achieved through awareness and education, community engagement, demonstration sites, local partnerships, knowledge sharing, incentives, and monitoring and evaluation, ultimately leading to increased food production, reduced environmental impact, and improved livelihood opportunities.

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