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Research Paper

Analyzing hydroponic rack design for apartment house

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Abstract

This study analyze users who are living in condominium and apartment in an urban area to practice the farming activity. Almost 75% type of house in Malaysia is apartment. A major problem living in condominium and apartment is the limited space to do farming activity. To-day's users do not know where their food comes from and uncontrolled using pesticide among the farmers. Over 80% of food supplies were imported and local crops products were exported. About 65% from a person salary is for food consumption. The existing design of hydroponic system is not suitable for the current lifestyle needs. This help users to farm within a limited space in the urban area and create awareness the importance of planting their own food. Hydroponic system can reduce 40% of living cost for food. The compact rack system design has been proposed based on the functionality and practicality for crops planting in a small area using deep water culture system. The compact rack design using a simple system that can easy to assemble and disassemble that suit home interior. The result shows the hydroponic rack with modular system is suitable for the condominium and apartment area which are small and compact.

Keywords: *Hydroponic; Compact Rack System; Vertical Farming; Deep Water Culture System; Urban Farming; Urban Lifestyle.*

1. Introduction

Malaysia is a developing country. A rapid development and a leading nation. Hence, it makes a big city like Kuala Lumpur becoming a city crowded with developing infrastructure [2] and development. Through this study, it was found out that the area and agricultural activities are increasing every day. Large-scale agricultural activities in urban and rural areas cannot be implemented following the rapid development.

This research is aimed at renewing the existing hydroponics design to a more compact and modular design. This kit will be used by users who want an easy and convenient equipment, especially those staying in condominium and apartment. According to Director of Center for Horticultural Research, Malaysian Agricultural Research and Development Institute (MARDI), Tengku Ab. Malik Tengku Maamun, the country's urbanization rate is estimated to be around 2.4% per year and nearly 72% of Malaysians are concentrated in 20 major cities.

He also estimated that in 2020, about 40 to 45% of the poor will be concentrated in cities and major cities. From this research, the problems statement are:

1.1. Limited space

The residents of condominium and apartments do not have enough space and suitable place for agricultural activities because of limited space and management does not allow people to farm in the corridor area. In [3] stated that space was a major problem faced by consumers for agricultural activities. In addition, there are some housing areas that do not allow residents to conduct agricultural activities in the residential area yard.

1.2. Uncontrolled pesticide among farmers

Over 80% of our food [5] was imported and local crops produced were exported. Uncontrolled used of poisons pesticide among hawkers and vegetable market traders is too dangerous. In fact, in [1] mentioned that over 35,000 types of pesticide applied among the farmers nowadays.

1.3. Not user-friendly design

Nowadays, many hydroponic products are manufactured and sold in the market that consumers can easily get one in the market or even online. A variety of designs, shapes and styles that attract users' attention. However, existing listings now still do not meet those features. The producer only thinks of the product system and leave behind the aesthetic features to the product. Figure 1-3 show the existing product that available in market nowadays.

Fig. 1: Tube (Mardi).

Fig. 2: Produk Kazz Hydroponic, 2014.

Fig. 3: NFY-V30 (Maha 2014).

Fig. 4: Rak Kazz Hydroponic 2014.

The objective of this research is to solve the problem by identifying how consumers can conduct appropriate agricultural activities for small areas that have limited space [4], and produce appropriate hydroponic kit designs that can be used for urban lifestyle in order to validate the final product design of hydroponic kit towards the user.

This study was conducted to get information about urban agriculture applications using hydroponic at apartments and condominiums around the city of Kuala Lumpur and its surrounding area. Kuala Lumpur was chosen as it is the premier city in Malaysia and has the largest housing estates in Malaysia.

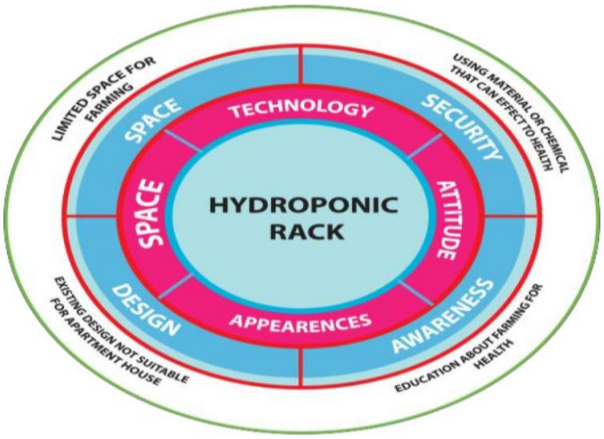


Fig. 5: Research Framework.

2. Methodology

Two methods were applied in this research data collection such as quantitative methods questionnaire and experimental methods, which are carried out by researchers to achieve the objectives of the study.

2.1. Experiment

Researchers have used this method to determine the suitability of physical properties and functions that are appropriate for product design, as well as conducting processes and experiments on hydroponic plants. The experimental process starts from taking samples from existing products such as polystyrene, iron and plastic materials to develop the prototype. Researchers conducted experiments at workshops and open space around Universiti Putra Malaysia aimed at identifying the best designs and methods for producing hydroponic products design. Figure 6 shows the methodology of the research process.

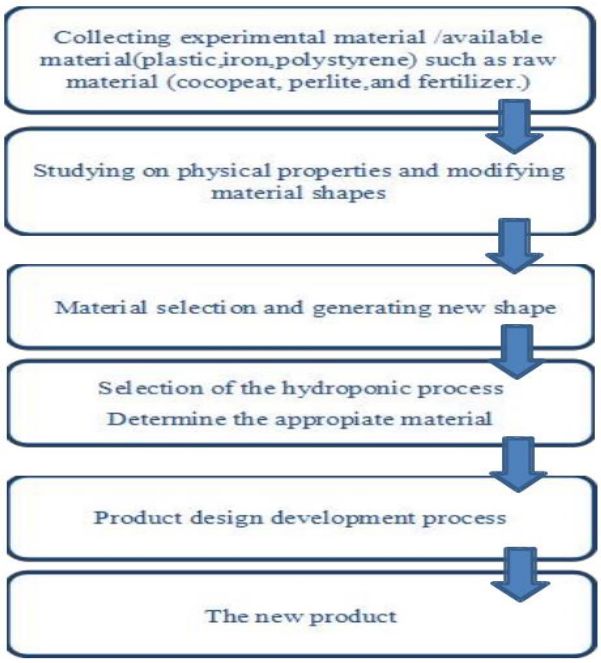


Fig. 6: Product Design Experiment Process.

Growing with hydroponics comes with many advantages, the biggest of which is a greatly increased rate of growth in the plants. With the proper setup, the plants will mature up to 25% faster and produce up to 30% more than the same plants grown in soil.

Plants will grow bigger and faster because they will not have to work as hard to obtain nutrients. Even a small root system will provide the

plant exactly what it needs, so the plant will focus more on growing upstairs instead of expanding the root system downstairs.
Deep Water Culture (DWC) is selected as a suitable system for compact hydroponic rack. DWC is the easiest method for growing plants with hydroponics. In a deep water culture hydroponic system, the roots are suspended in a nutrient solution. An aquarium air pump oxygenates the nutrient solution, this keeps the roots of the plants from drowning. Figure 7 shows the system of DWC method.

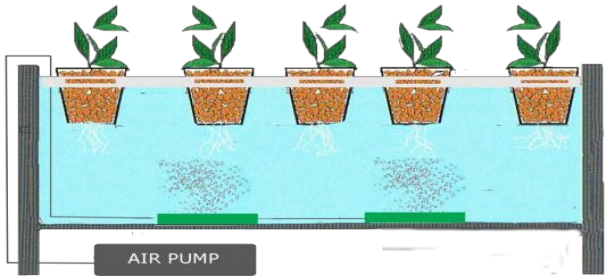


Fig. 7: Deep Water Culture System.

2.2. Questionnaire

Close-ended questionnaire is a method used by researchers to conduct validation process on product design. This method allows researchers to assess the needs and acceptance of the users on the products they produce. The methods used make it easier for researchers to obtain the details and to design the product through the collected information. The questionnaire was distributed to over 200 respondents and researchers recorded data analysis.

2.3. The process of collection and preparation of test data

Information is what needs to be acquired and collected for a prototype test and media materials. The diagram below shows the procurement process and the preparation of test material information. Researchers have provided stages in the procurement and preparation of experiment information as shown in Figure 8.

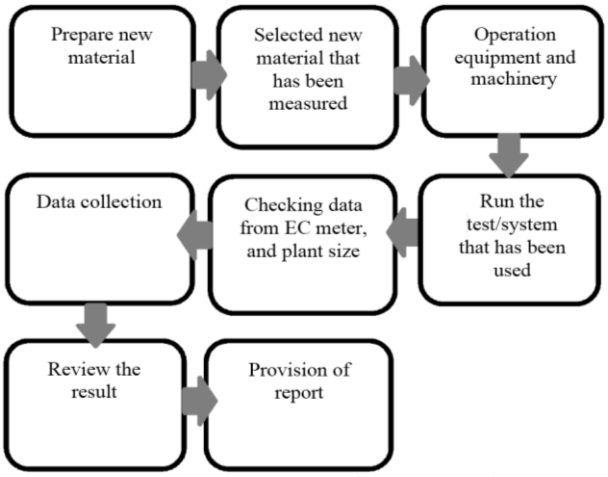


Fig. 8: Procurement and Preparation of Experiment Information.

3. Results and discussion

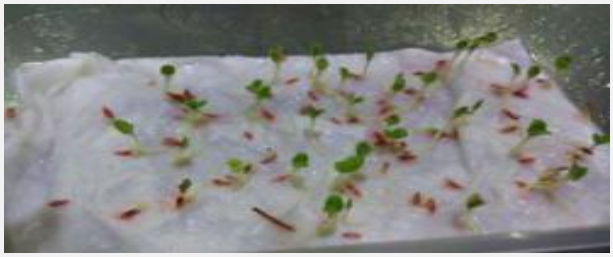
The findings of the study were conducted through the experimental and questionnaires method used by the researchers by using hydroponics methods and products that were designed based on the data and the results of the study. Table 1 shows the growth rates and expectations of vegetable crops by using hydroponic methods.

Table 1: Rates and Expectations of Plant Growth

No.	Rates and Expectations of Plant Growth Type of Plants	Term / Day
1	Lettuce	28 - 30 days
2	Bak Choy	25 - 30 days
3	Green spinach	25 - 30 days
4	Kailan	35 - 45 days
5	Water spinach	25 - 28 days
6	Sawi	35 - 40 days
7	Cauliflower	90 days and above

Table 2 shows the cultivation process conducted by researchers using prototypes that have been designed.

Table 2: Cultivation Process

No.	Experimental Process	Figure
1	The researchers identified the seedlings that would be used for the hydroponic experimental process. Seeds used are salad seedlings and the use of perlite media.	
2	Seedlings that have been placed in perlite will be left for 3 days to produce the buds. Then, the seedlings that have produced 1mm or 2mm buds can be transferred into a more comfortable and large plant container.	

3	Seedlings that have been transplanted into a large plant container and left exposed to sunlight for growth. In addition, AB fertilizer has been mixed in accordance with the measurement of 1:1	
4	After a week, the tree will begin to produce larger leaves. Leaves have grown and widened by 2cm.	
5	After 4 weeks left in the former crop, the vegetables can now be pick. It has reached the edible stage. To reach a more mature stage, the plant should be stripped within 2 weeks.	

The design process has been conducted based on the collected data. Figure 9 shows the findings.

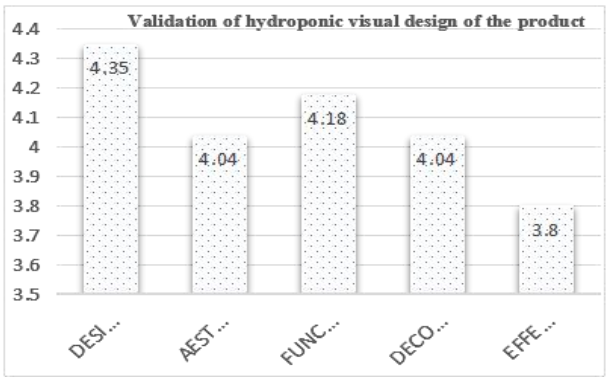


Fig. 9: Mean Results Obtained by the Visual Validation of the Hydroponic Rack System Design.

Based on the data, researchers have created designs according to the specification of users need. The design attribute priority is design concept, function, aesthetic value, decorative and effectiveness. The feature must meet the criteria that can be applied to the apartment house. Figure 10 and 11 show the final design of this project:

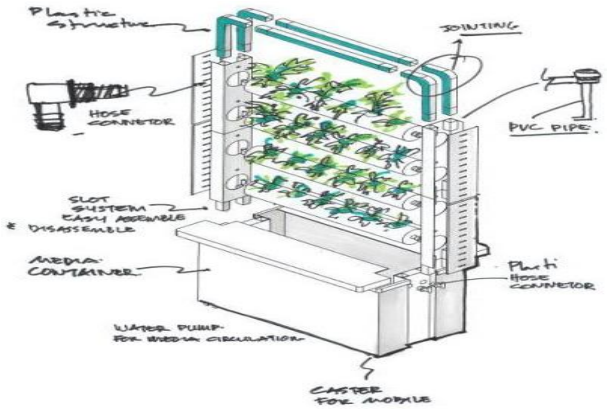


Fig. 10: Sketches.

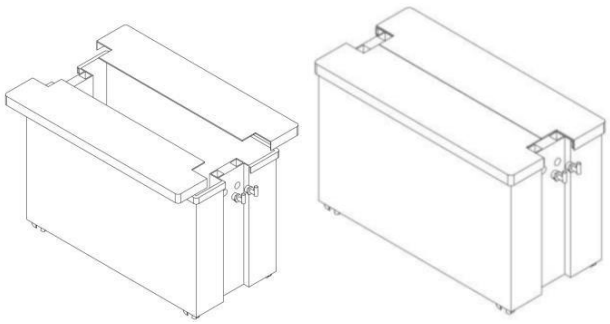


Fig. 11: Components Storage and Water Tank.

The design come with a storage tank that function as a storage of the rack components. It also function as a compact packaging. The structure is easy assemble and disassemble. The tank also equipped with caster for easy mobility display. 20 liters of water and mixed fertilizer media will be circulated through the four tiers of planting cups using a small water pump. This is to oxygenate the

nutrient solution for the plant. Figure 12 shows the water flows movement.

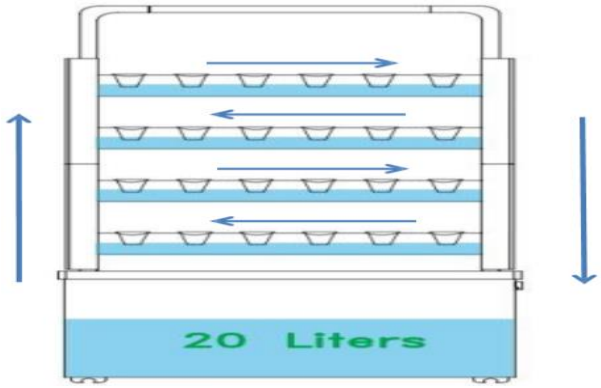


Fig. 12: Final Prototype.

Figure 12 shows the final design that has been build is suitable for small house that have the limited space. User can put the product at any part of the house especially balcony area. The main specialty of this product is modular system. User can handle this product easily without need special skill. User can assemble and disassemble easily without use any special tool, just need to slot in and out.

4. Conclusion

The research findings have shown that products and systems produced from hydroponics techniques can be utilized as a product for consumers who live in apartment houses in the city. The modular system applied to the product helps consumers in the city to conduct farming activities [6-7] in their house. Furthermore, the compact hydroponic rack systems able to reduce the household expenditure when they plant their owned food supply.

Acknowledgement

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