



**Faculty of Mechanical and Manufacturing Engineering  
Technology**

**DESIGN AND DEVELOPMENT OF VERTICAL HYDROPONIC  
SYSTEM FOR URBAN COMMUNITY**

**WAN MUHAMAD AZAM FIKRY BIN WAN HANAFI**

**B071610626**

**950812035823**

**Bachelor of Manufacturing Engineering Technology (Product Design) with Honours**

**2019**

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URBAN COMMUNITY**

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SESI PENGAJIAN: 2019/2020

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## ABSTRAK

*Apabila keupayaan penduduk bandar semakin meningkat, perubahan iklim, penurunan aktiviti penangkapan ikan, pengeluaran sayur-sayuran hidroponik menjadi lebih umum kepada masyarakat bandar. Secara ringkasnya, hidroponik adalah amalan tumbuh tumbuhan yang menggunakan hanya air, nutrien, dan medium yang semakin meningkat. Walau bagaimanapun, terdapat beberapa masalah yang dihadapi oleh penduduk bandar yang tinggal di kawasan bandar, termasuk kekurangan kawasan atau tempat untuk terlibat dalam aktiviti pertanian. Selain itu, kebanyakan penduduk sangat prihatin terhadap kebersihan rumah. Kebanyakan orang yang tinggal di kawasan bandar bekerja sepanjang hari untuk mengekalkan kehidupan mereka. Oleh itu, mereka tidak mempunyai banyak masa di rumah untuk melakukan aktiviti menanam dan memantau tanaman mereka walaupun ia dilakukan di rumah mereka sendiri. Produk hidroponik yang ada mempunyai reka bentuk yang agak besar dan sukar untuk dipasang dan kurang sesuai untuk diletakkan di ruang terhad. Tujuan projek ini adalah untuk mengenal pasti teknik hidroponik terbaik yang boleh digunakan dan untuk membangunkan reka bentuk baru produk sistem hidroponik menegak. Kajian ini memberi tumpuan kepada komuniti bandar yang tinggal di kondominium dan pangsapuri di Malaysia untuk mencadangkan reka bentuk baru sistem hidroponik menegak yang boleh digunakan untuk ruang terhad. Data dikumpulkan dari maklum balas pelanggan yang diperolehi daripada beberapa pembekal hidroponik untuk menghasilkan data yang tepat. Dengan menggunakan beberapa aspek fungsional dan estetik, reka bentuk baru telah dibangunkan menggunakan rangka kerja proses reka bentuk konseptual sebagai hipotesis kepada kajian lain. Reka bentuk berjaya dibangunkan untuk memenuhi keperluan pelanggan dan keutamaan mereka. Produk ini boleh digunakan dalam kekurangan kawasan dan ruang terhad disebabkan reka bentuknya yang kompak dan produk modular.*

## ABSTRACT

As the city's population capacity is increasing, climate change, a decline in fishing activities, hydroponic production of vegetables is becoming more common to the urban community. In simple words, hydroponics is the practice of growing plants using only water, nutrients, and a growing medium. However, there are some problems faced by urban residents living in urban areas, including the lack of areas or places to engage in farming activities. Furthermore, most of the residents are very concerned about house cleanliness. Most people who live in urban areas work the whole day to sustain their lives. Therefore, they do not have much time at home to do planting activities and monitor their crops even though they are done in their own homes. Existing hydroponic products have a relatively large design and are difficult to install and are less suitable to be placed in limited space. The purpose of this project is to identify the best hydroponic technique that can be applied and to develop a new design of the vertical hydroponic system product. This study is focusing on the urban community living at condominiums and apartments in Malaysia to proposed a new design of the vertical hydroponic system that can be applied to the limited space. The data was gathered from the customer feedback get from several hydroponic suppliers to produce accurate data. Using several functional and aesthetic aspects, the new design has developed using the conceptual design process framework as the hypothesis to another study. The design was successfully developed to meet the customer requirement and their preferences. This product can be used in the lack of area and limited space due to its design that compact design and modular product.

## **DEDICATION**

Alhamdulillah first and foremost, I would like to dedicate this project to almighty god, Allah S.W.T for keep me level headed throughout this process.

This project is also dedicated to my beloved father, Wan Hanafi Bin Wan Majid and my beloved mother, Pn Naimah Binti Mat Nor, who encourage me mentally, physically, and spiritually to keep moving throughout the process and inspire me to break the border of true limitation and reach for my definite set of purpose. In additional huge credit for their sacrifices, financial support through the thick and thin and to my siblings for the extra push of encouragement. In every dark cloud, there's always a silver lining.



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## LIST OF ABBREVIATIONS

<b>pH</b>	Potential of Hydrogen
<b>NFT</b>	Nutrient Film Technique
<b>DFT</b>	Deep Flow Technique
<b>EC</b>	Electrical Conductivity
<b>UHI</b>	Urban Heat Island
<b>UV</b>	Ultra Violet
<b>LED</b>	Light Emitting Diode
<b>LDPE</b>	Low - Density Polyethylene
<b>EPDM</b>	Ethylene Propylene Diene Monomer
<b>PVC</b>	Poly Vinyl Chloride
<b>3D</b>	Three Dimensional
<b>CAD</b>	Computer Aided Design
<b>OP</b>	Osmotic Pressure
<b>OH-</b>	Hydroxyl Ions
<b>H+</b>	Hydrogen Ions
<b>IQM</b>	Infinite Quantitative Method

# CHAPTER 1

## INTRODUCTION

### 1.1 Background

By the middle of the century, the global population is expected to reach nine billion (Wang, Liu and Cheung, 2017). Hence, the increase in global population was expected to stay in urban areas in the future (Soga et al., 2017). Various developments were planned in major cities to meet the population density. This reduces the amount of space available in the urban area. As mentioned by (Despommier, 2011), as the popularity of urban populations rising over time, concerns about climate change, urban overheating, environmental quality problems, insecurity food and food supply declines in urban areas are expected to worsen. Food production will need to be doubled to compensate the parallel increase in demand for food species (Khan, 2018). One way of solving unhealthy or inadequate food access in cities is increasingly considered urban farming (Ackerman et al., 2014).

In recent years, urban farming has become more prominent to promote local food production and distribution, provide urban green space and improve access to healthy food (Poulsen et al., 2014). Urban farming is defined by (Hendrickson & Porth, 2012) as a localized food system in which food and other products are grown, processed, distributed, grown in or around the city by plants. Cultural value and quality of life are enhanced by farming through growing vegetation in various urban areas including schools, rooftops, roadsides, apartments, balconies, abandoned buildings and hospitals (Moon, 2012). There are several urban farm types like community or allotment gardens, private gardens, easement

gardens, rooftop gardens or green roofs, urban orchards and peri-urban agriculture (Lin, Philpott, Jha, & Liere, 2017).

While, there are three major types of urban farm such as backyard gardens, community gardens, and commercial farms (Hui, 2011). The backyard gardeners use the land around their homes to grow plants like rooftops and balconies. Community gardener is a larger piece of land gardened by several households together. Products from both garden types are mainly used for home usage. Urban commercial farms are designed for profits and can be combined with commercial kitchens to produce food products with added value and are sold on to farmer's markets and restaurants. Urban farming activities in cities affect the safety of food, health and poverty rates (Hong, 2016). Urban farming may assume a significant role in the sustainability of food systems with regard to prominent threats, food consumption habits and the potential of local producers (Benis & Ferrão, 2017). A new method to solve the problem of sustainability and the growing demand for food is the design and implementation of vertical farms.

Vertical farming is a concept which includes cultivating livestock plants on vertically inclined surfaces, such as in urban skyscrapers, where land and space lack (Lumpur, 2017). With urban areas growing worldwide, vertical farming methods should be improved to supplement urban food requirements (Game, 2015). The future farming methods in cities be comprised of use of vertical hydroponic farming techniques in backyard gardens, rooftop farm, community garden, greenhouses, balconies and indoor farm. Hydroponic is one soilless farming technique that may be used other than soil-based gardening in vertical urban farming. Hydroponics is a way of cultivating plants in a solution based on water and nutrient. Hydroponics does not use soil, rather it supports the root system with an inert medium such as perlite, rock wool, clay pellets, peat moss, or vermiculite. The fundamental premise for hydroponics is that the roots of the plants have direct contact with the solution of nutrients

while accessing oxygen, which is vital to proper growth. Hydroponic systems offer a range of benefits including water and nutrient reuse capability and easy environmental controls as well as the prevention of soils and pests (Lee & Lee, 2015). Moreover, urban residents can generate their own fresh food at home.

## **1.2 Problem Statement**

Through research that has been done, some issues have been identified as the city's population capacity is increasing, climate change, decline in fishing activities (boosting a higher food burden in products based on vegetation) and the lack of space for farming activities. These study will focus the problems on those living in condominium and apartment at the major cities.

Now, there are some problems faced by urban residents living in urban areas, including the lack of areas or places to engage in farming activities. For those living in low places like residential area, there may be some space for farming activities in the area around the house as in the yard and backyard. But instead for residents who live in high places like condominium and apartment, they have space only in the balcony area and inside the house. Furthermore, there are some residents who are very concerned about house cleanliness. Hence, farming in the traditional way of using soil as the main media in the house or in the balcony area is not suitable for them. Moreover, most people who live in urban areas work the whole day to sustain their lives. Therefore, they will be busy with their working lifestyle and do not have much time at home to do planting activities and monitor their crops even though they are done in their own homes. For a resident who makes cultivation activities as hobbies necessarily want their crops to be well-nourished and get enough nutrient or fertilizer resources to grow fertile. But their working lifestyle may be a barrier. Therefore, the cultivation system using hydroponic techniques is the best way for them. However,

existing hydroponic products have a relatively large design and are difficult to install and are less suitable to be placed in the home or at the balcony area especially in condominiums and apartments. In fact, some existing hydroponic products require a complete guide or way to install. Without the installation guide, the product cannot assembly and function properly. It will be difficult for those living in urban areas to obtain and use hydroponic products.

### **1.3 Objective**

The objective of this project are:

- I. To identify the best hydroponics technique for the vertical garden in urban areas.
- II. To generate a conceptual design that has a compact design and easy to set up.
- III. To fabricate the prototype.

### **1.4 Scope of the Study**

The scope of this study is generally focused on the literature review and comparison of the existing hydroponic product. In the effort to achieve the objectives, several scopes have been outlined:

- I. Conduct research and observations to determine the best hydroponic techniques to be used in urban areas.
- II. This project will focus on the urban community that living at condominium and apartment in Malaysia.
- III. To develop a new design on the vertical hydroponic system.

### **1.5 Significant of Project**

The significance of study is that this project can be used as a medium to encourage more people living in urban areas to be involved in this project as it is an environmentally

friendly product. This is also valuable as it brings beneficial effect towards the environment just as reducing the effect of global warming as in further lower down the greenhouse effect. More than that, citizens are able to obtain fresh food products for their own use despite having limited spaces in urban areas. This study also allows room for better assembly and modification of better designs for future use.

## **1.6 Gantt Chart**

This research was divided into two phases to ensure that this research proceeds well and smoothly. All the phases were well planned to ensure that the project will be completed beyond the due date. Phase 1 is the phase of the Sarjana Muda 1 (PSM 1) Project, which focused mainly on finding out the methodology of this research. In PSM 2, it will more focus on the outcomes of this research and result. It also will be discussed on the project conclusion and recommendation. The project planning table was attached as Appendix A.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

The literature review is one of the important parts of the research process. This process can help to understand and gain knowledge of selected topics. In this chapter, the review was done by studying the journal articles and papers obtained from random online resources, Google search engine, and Mendeley literature review.

These resources were found by searching the online database using some phrases that have relations with hydroponic systems, hydroponic techniques and the system design of the hydroponic system. It also further discussed the comparison of existing hydroponic product/pattern. It helps to generate the design ideas for a vertical hydroponic system. However, not all of the journals or resources were cited in this report but just some of them related to the main project.

#### **2.2 Soilless Farming System**

Soilless farming is a sustainable agricultural practice because the system is not in need of soil to grow crops, therefore it is free from all challenges facing soil today and subsequently, this makes it a viable alternative to soil farming in order to achieve a world population in the future (Tajudeen & Taiwo, 2018). The figure below explains the classification of the new soilless culture trend.

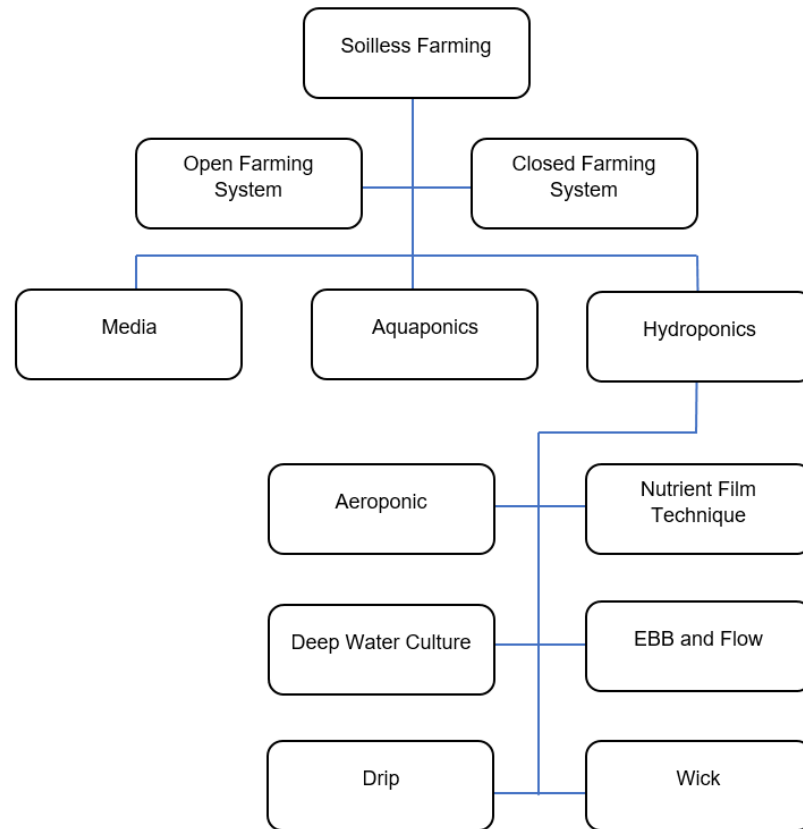


Figure 2.1: Classification of the Soilless Farming system

## 2.3 Hydroponics

Hydroponic system one of the alternatives that can be used for urban farming in urban areas rather than a traditional method in which using the soil as the main media. In simple words, hydroponics is the practice of growing plants using only water, nutrients, and a growing medium.

### 2.3.1 Definition

The term 'Hydroponics' was derived from the Greek word 'hydro' means water and 'ponos' mean labor (Beibel, 1960). According to (Jones, 2013), from the research and study, the author describes the hydroponics in differences meaning in which from various