

AQUAPONIC SYSTEM FOR SELF-SUSTAIN LIVING

YAN YEN QUN

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Specially dedicated to *parents* and *the rest of the family*.
Thank you for everything.

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ABSTRACT

Rapid urbanization has positive effect to promote economic process and environment development, but it can also create negative impact if it doesn't address properly. In a study estimation, there will be 9 billions of people by the year of 2050 and the majority of us which will live in urban environment. Most of the land is shifting to urban and industrial. More countries will not be able to meet the high demand of food consumption. Rapid urbanization and population growth issues will henceforth cause food shortage problem. Therefore, every economic must plan and build sustainable ecological urban infrastructural to protect environment. Architecture design solution has a big influence to the environment. So, this dissertation is conducted to review on how *permaculture full cycle eco-system* (PFCE) can be integrated into urban environment for the purpose of creating a self-sustain community which can solve these issues. It will be introduced by way of vertical development in order to protect the biosphere and further to achieve a sustainable society. The *aquaponic system* (AS) is introduced into building to develop a new lifestyle and it is able to form self-sufficient community with increasing job opportunities and food production. The entire community live, work and consume at the same place. Literature review based methodology is applying in the study process. Case studies have been choosen based on integration level of permaculture aquaponic system in building architecture. This study explore on how the aquaponic system bring food closer to living and henceforth create a self-sustain scheme that can increase financial resource and improve the environmental and living condition. A real sustainable community scheme start from life-style which is a more holistic approach to take care and protect the environment. Knowledge of permaculture can achieve different types of sustainability according to its function of adaption through different approach and integration level.

ABSTRAK

Perbandaran yang pesat mempunyai kesan positif terhadap proses ekonomi dan pembangunan alam sekitar, tetapi ia juga membawa kesan negatif jika tidak ditangani dengan perancangan yang baik. Anggaran menyatakan bahawa menjelang tahun 2050 akan terdapat 9 bilion penduduk dan majoriti akan hidup di kawasan persekitaran bandar. Sebahagian besar tanah itu akan berkembang menjadi kawasan bandar dan kawasan perindustrian. Banyak negara tidak akan memenuhi permintaan terhadap bekalan makanan yang tinggi. Perbandaran yang pesat dan pertumbuhan penduduk akan menyebabkan masalah kekurangan makanan. Oleh itu, setiap ekonomi perlu dirancang seperti membina infrastruktur mampan bandar ekologi untuk melindungi alam sekitar. Penyelesaian reka bentuk seni bina mempunyai pengaruh yang besar kepada alam sekitar. Jadi, disertasi ini dijalankan untuk mengkaji bagaimana permakultur kitaran penuh ekosistem (PFCE) boleh disepadukan ke dalam persekitaran bandar untuk tujuan mewujudkan masyarakat yang mampu mengekalkan ekosistem sendiri yang boleh menyelesaikan isu-isu ini. Ia akan diperkenalkan melalui pembinaan bangunan menegak untuk melindungi biosfera dan seterusnya untuk mencapai masyarakat yang mampan. Sistem Aquaponic (AS) yang diperkenalkan ke dalam bangunan mampu membentuk masyarakat berdikari dengan peningkatan peluang pekerjaan dan pengeluaran makanan. Seluruh masyarakat hidup, bekerja dan makan di tempat yang sama. Metodologi berasaskan kajian literatur. Kajian kes telah dipilih berdasarkan tahap integrasi sistem aquaponic permakultur dalam seni bina bangunan. Kajian ini meneroka bagaimana sistem aquaponic boleh mengalakan pendekatan terhadap penanaman makanan sendiri lebih dekat dengan kehidupan seharian dan seterusnya mewujudkan satu skim yang boleh meningkatkan sumber kewangan dan memperbaiki keadaan alam sekitar dan kehidupan orang setempat. Pengetahuan permakultur boleh mencapai kemampanan mengikut fungsinya serta adaptasi melalui pendekatan yang berbeza dan tahap integrasi.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Rapid urbanization is having a positive effect in promoting economic process and physical environment development in country. On the other hand, it could have serious negative impact if it doesn't addressed properly. Most of the lands are shifting from agricultural to urban and industrial. In addition, it is estimated that the world population will reach 9 billions by the year 2050 (Deepak K. Ray et.al, 2013). Majority of people will live in urban environment. More countries will not be able to meet the high demand of food consumption due to rapid growth of population and decreasing of agricultural land¹.

In addition, these issues bring other side effect to the society as well. Rapid population and rural resident immigrant into urban lead to inadequacy of employment opportunities. The society is having a hard time in adapting to the rapid urbanization environment and it is being reflected in the imbalance between the provision standard of urban services and the rapid growth of population. For

¹ Deepak K. Ray, Nathaniel D. Mueller, Paul C. West, Jonathan A. Foley, 2013, "Agricultural statistics from across the world and found that yields of four key crops, maize, rice, wheat and soybean, are increasing at only 0.9-1.6% every year. At these rates, production of these crops would likely increase by 38-67% by 2050, which is insufficient to meet the estimated demand above."

example, lack of financial resources and job opportunities will lead to urban poverty. Figure 1.1 showed the size and scale of the economics-urban problems being faced by Asian countries. The percentage of urban slum is reducing after getting concern by the relevant authorities, but the average still within 35% in South-east Asia countries (Goswami, 2010). Most of the residents relying on low-income job due to lack of job demand in their environment. Usually they cannot afford a standard house in urban due to high cost of land.

Urban Slum Population (million)						
Major region or area	1990	1995	2000	2005	2007	2010
Northern Africa	19731	18417	14729	10708	11142	11836
Sub-Saharan Africa	102588	123210	144683	169515	181030	199540
Latin America & Caribbean	105740	111246	115192	110105	110554	110763
Eastern Asia	159754	177063	192265	195463	194020	189621
Southern Asia	180449	190276	194009	192041	191735	190748
South-Eastern Asia	69029	76079	81942	84013	83726	88912
Western Asia	19068	21402	23481	33388	34179	35713
Oceania	379	421	462	505	524	556

Proportion of Urban Population Living in Slums (%)						
Major region or area	1990	1995	2000	2005	2007	2010
Northern Africa	34.4	28.3	20.3	13.4	13.4	13.3
Sub-Saharan Africa	70.0	67.6	65.0	63.0	62.4	61.7
Latin America & Caribbean	33.7	31.5	29.2	25.5	24.7	23.5
Eastern Asia	43.7	40.6	37.4	33.0	31.1	28.2
Southern Asia	57.2	51.6	45.8	40.0	38.0	35.0
South-Eastern Asia	49.5	44.8	39.6	34.2	31.9	31.0
Western Asia	22.5	21.6	20.6	25.8	25.2	24.6
Oceania	24.1	24.1	24.1	24.1	24.1	24.1

Source: United Nations Population Division, *World Urbanization Prospects: The 2007 Revision*

Figure 1.1 World slum population by region in Asian countries. (Source: <http://www.resilience.org/stories/2010-05-21/missing-slums-cities/>)

Therefore, every economic must be plan and build sustainable ecological urban infrastructural to protect environment. However, architecture today has yet to incorporate solution for the above issue. Through this study, a self-sustainable community will be achieved with the integration of *permaculture full cycle eco-system (permaculture)* into urban environment building concept and it would be the most potential way to solve the issues. *Permaculture* should be introduced in vertical development to protect the biosphere and to achieve a sustainable society. The whole community live, work and consume in a same place. Natural resources, rainwater and water from river is fully utilized and purified through the ecosystem. Passive design is introduced for more sustainable features for the users.

Consequently, *aquaponic system* will be further introduced into building to develop a new lifestyle which is able to form self-sufficiency through increasing job opportunities and food production for the community. This study discusses how *permaculture aquaponic system* works to achieve self-sustain scheme living that can increase financial resource and improve environmental living condition. Self-sustaining building in urban with vertical farming gain new interest to create a better environment.

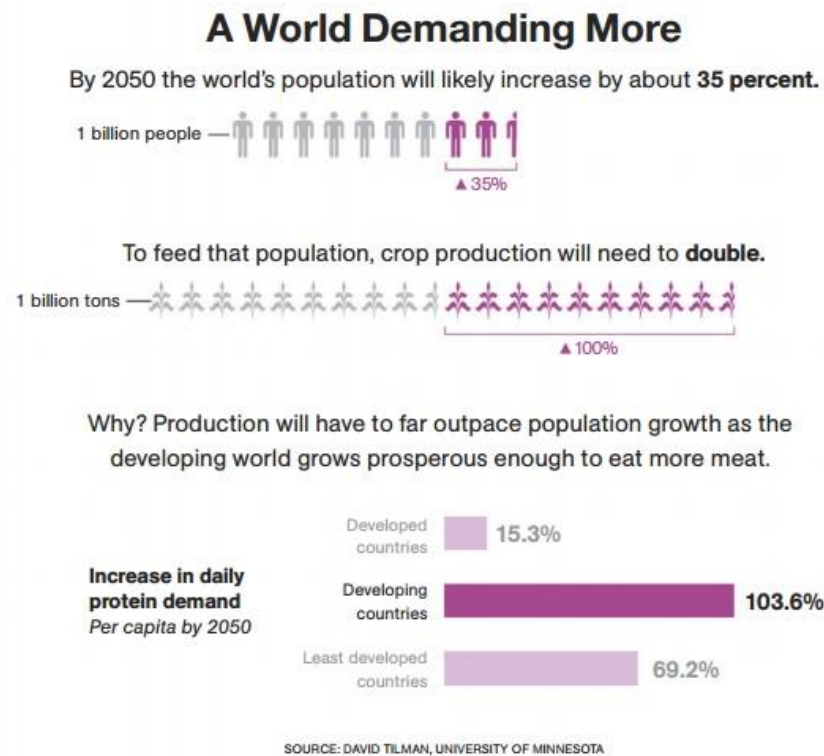


Figure 1.2 Demanding of large amount of food consumption per capital.
(David Tilman, University of Minnesota, 2011.)

1.2 Malaysia's rapid urbanization issues

Growth of population and employment demand, urban development infrastructure, provisions of urban services, planning for sustainable environment, good urban governance are the concerns of developers and planners (Syed H. Loton, 2004). Same as others developing countries, Malaysia is facing industrialized issues (Ramon V. Navaratnam, 2006) due to strives towards developed nation status by the year 2020.

Agriculture contributes as one of the important economic in Malaysia since 1970s. However, huge area of agriculture land has been converted to residential lots (Mahyuddin Ramli Hugh Byrd, 2012) and infrastructure in the name of development and grows of population. In Ninth Malaysia plan 2006, an estimation of 80% of Malaysian will live in urban by year 2020. To achieve the 2020 nation goals, we have to sacrifice most of non-renewable resources. Reduction of agriculture land will reduce the food production. In addition, quality and quantity of water supply will be affected in the process of development. Similarity, runoff of rain water, decreasing of ground water and reduction of normal flows of streams has caused flood. The consequence of construction that ignore these issues and caused pollution are costly sooner for future living condition. For example, rehabilitation of the Sungai Pinang, Penang which has cost billions of ringgit in remedial work due to fast development and construction issue (Mahyuddin Ramli Hugh Byrd, 2012). Henceforth, economic must be plan and build sustainable ecological urban infrastructural to protect environment.

1.3 Problem Statement

Rapid urbanization and growth of population causes scarcity of agricultural lands. Besides that, growth of population causes high housing demand especially in developing countries. If traditional horizontal farming method continues as the world population increases 3 billion by 2050 (Deepak K. Ray et.al, 2013), this will lead food insufficient in the future. Other than that, growth of population causes high housing demand in urban. The vertical backlog housing in urban always unaffordable for this group of people. Housing design today is hardly to solve these issues for urban dweller. An alternative sustainable living should be introduced and integrated in building design to let the community “help from within” through the platform that is provided in building or existing circumstance. Every economic must plan and build sustainable ecological urban infrastructure.

1.4 Research statement

The idea of *permaculture* with *aquaponic system* is introduced into building to develop a new lifestyle and henceforth to form self-sufficient community through increasing food production and job opportunities. There have the potential to develop a sustainable housing scheme through integrating *permaculture aquaponic system* that can really help the community in different aspects. *Aquaponic system* should be introduced vertically to protect the biosphere and to create a sustainable society. The whole community live, work and consume at the same place. Natural resources from the surrounding environment should be fully utilized in the ecosystem according to the principles. Explore *permaculture* and *aquaponic system* principles and possible integration can introduce more passive design to create more sustainable features for the users.

1.5 Research Objectives

The aim of this research is to explore the principles and potential of *permaculture* with *aquaponic system* that can integrated in building architecture especially housing scheme to create a self-sustain community living lifestyle. At the end of the study, it can help to enhance the understanding of *permaculture* and *aquaponic system* on certain aspects when designing buildings and housings with sustainable principles and methods. From this research, there are several objectives that need to be derived which are:

- (i) To identify the definition and principles of *permaculture full cycle ecosystem (permaculture)* and *aquaponic system* beyond building architecture
- (ii) To explore the potentials of *permaculture* and *aquaponic system* that can create a green living environment and accommodate food crisis issue in the future
- (iii) To identify different integration methods between *permaculture aquaponic system* and buildings for a better self-sustaining

1.6 Research Question

Research questions arising based on literature studies are:

- (i) What is the definition of *permaculture* and *aquaponic system* especially in building architecture?
- (ii) What is the principles of *permaculture* and *aquaponic system* that can create green living environment?
- (iii) What are the potential strategies of *permaculture aquaponic system* that can implement into housing design to accommodate food crisis issue?

1.7 Literature Review

This chapter will research on theory and concept of *permaculture* and *aquaponic system* to have a general understanding through literature based methodology. Related data will extract from various writing and paper to make deep understanding of the principles and strategies that can implement into housing design. This will give a thorough understanding of how lifestyle can create a platform for sustainable living and what are the matters that help in building. Best elements and selection of *permaculture* and *aquaponic system* for deepen understanding will further discuss henceforth reduce influences into environment and creates better living environment. Production of *aquaponic system* will be depending on external factor according to the environment. Other than that, method of waste management process will also introduce to deal with organic waste materials.

1.8 Research Methodology

This chapter will discuss the the way of literature finding which has been using in this research. Methodology and framework will be elaborated further in this

chapter. Literature based research is the main research strategy which including systematic literature based and traditional literature based. Firstly, review topic has been selected to do research. Literatures and data related to *permaculture* and *aquaponic system* are gathering from books, literature studies, journal article, internet-based article and previous thesis that related to the self-sustain living. The concern of this dissertation which is *permaculture aquaponic system* concepts will be discussed with sustainable housing solution.

1.9 Limitation

The limitation of this study is mainly depending on secondary data due to it has limited exposure to real built building. Literature review is conducted using data from reading for more understanding of *permaculture* and *aquaponic system* ideas and principles. Case studies of building integrated with *permaculture aquaponic system* will be chosen based on integration method level. Some of the case studies are unbuild building, idea based for future development.

1.10 Expected Findings

Several studies that relate to *permaculture* will be collected to do comparison and analysis. The author will deepen the understanding from vertical *permaculture* and how the community can self-sustain within the provided platform. Author will also compare the criteria and strategies in selected *permaculture* strategies and *aquaponic system*. consequently further describe on how *aquaponic system* can benefit in vertical housing. Additionally, there is a sub-topic that discusses the scenario of *aquaponic system* integrated into housing that can achieve an alternative living environment. All the sub-topics will be summarised in order to find the relationship and to establish common principles, theory and understanding for the author. The information will be analysed to get a new strategies.

1.11 Summary

Residential communities in high-rise urban dwellings are different from the rural big land area. This study focuses on *permaculture* and how it could be integrated into urban living environment and lifestyle. Building function acts as an important role to in defining living lifestyle of people. However, backlog building design today is hardly to face and solve the global issues. Architecture exist with install *permaculture* is the solution to bring it closed to nature and preserve the environmental natural cycles. From this topic, we can understand that the author's perspective is more than *permaculture aquaponic system* but also how it relate to being responsive to sustainable environment. It is a possibility solution would take a big steps contribute to the improvisation of current practices in the country and world.

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