A REVIEW OF URBAN FARMING RESEARCH: TAXONOMY, CHALLENGES AND FUTURE RESEARCH DIRECTION

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Abstract

The activities of urban farming in Southeast Asia are still very limited and dispersed. In order to give valuable insights in relation to urban farming activities in Southeast Asia and to support researchers, there is a need to know in details the available options and gaps in this research direction. Thus, this study is conducted using a structured literature review to provide a coherent taxonomy and future research direction. This research focuses on the following subject matters: urban farming activities, technology application for urban farming and their use in the urban farms and smallholder farming activities in Southeast Asia. The process of reviewing literatures started with selecting the three major digital databases, namely, ScienceDirect, Web of Science, and Scopus. The study selection process consists of research into literature sources, followed by three iterations of screening and filtering, excluded duplicate articles, screening the titles and abstracts and reading of the full-text articles. The final included result is 88 articles, which will be adopted on in this study. Further, a review in details of the layout of the research landscape of literature is conducted into a cohesive classification with its descriptive analysis. We also identify the basic characteristics of this emerging field in the following aspects: benefits of using urban farming activities in Southeast Asia, challenges hindering utilisation, and recommendations to improve the acceptance and use of urban farming applications in literature.

Keywords: agriculture**,** Southeast Asia, taxonomy, urban farming

Article history:
Submitted: 31/01/2019; Revised: 03/07/2019; Accepted: 08/07/2019; Online: 01/10/2019

INTRODUCTION

Across the globe, metropolitan area and peri-urban communities are experiencing a growing interest in urban farming (Surls et al., 2015). This new momentum has developed in recent years whereby urban farming activities not only happen in garden plots or urban brownfields but also in and on urban buildings (Specht et al., 2015). Urban farming or urban agriculture refers to a farming activity in urban areas, which are commonly used to connect food production and built the environment of the city (Cameira et al., 2014). The practice of producing food in and around cities is championed as a method to reduce environmental impacts of urban food demands while conferring several supplementary benefits to host cities and ex-urban environments (Goldstein et al., 2016). It also contributes to food security, food safety, and improve the quality of the environment and greening the country, especially the urban area. Urban farming program focuses on providing food security to people in urban areas and economic diversification. The program also supports the use of unproductive land and encourages the population to construct small farm gardens in homes by following spatial characteristics in each region. The creation of an agricultural community in each target city leads to increased environmental awareness (Prasetiyo et al., 2016).

Urban farming activities are very important in urban areas as they grow to meet the needs of a constantly evolving urban life. A variety of systems may fall under the concept of urban agriculture in a different range and possession, ranging from small community gardens (Cabalda et al., 2011), peri-urban farming (Mintorogo et al., 2017), small farming, urban gardens, building of vertical farming or greenhouse (Taufani, 2017). These farms provide a part of the community with the self-sufficiency of the food system and food safety. Urban farming has real potential for achieving more productive and sustainable agricultural production for urban areas. Intelligent agriculture is the application of modern information and communication technology within agricultural fields. These technologies can control agricultural fields, such as precision equipment, internet of things (IoT) (Chieochan et al., 2017), (Sureephong et al., 2017), (Yolanda et al., 2016), sensor devises (Aimrun et al., 2007), (Mastura et al., 2011), geographic positioning systems (GPS) (Aini et al., 2014), data collection devices (Mohammad Mehdi Saberioon et al., 2013), robot devises (Gholizade et al., 2013) and etc. This technology contributes and helps many farmers to monitor the farms in a simplified and accurate way that causes the success of agriculture. Assessment devices are utilised by measuring, agricultural crops, soil properties, organic substance content, moisture levels, nitrogen levels etc. This study aims to provide valuable insights that related to urban farming and support researchers by understanding the available options and gaps in this line of research. It aims to shed light on the efforts of researchers in response to new and disruptive technology, map the research landscape into a coherent taxonomy, and determine the various features that characterize this emerging line of research in urban farming. The remainder of this paper is organized as follows: In section 1, presents the overview and general meaning of urban farming from different scholars. In section 2, presents research methods steps, research scope, literature sources and steps of filtering process papers exclusion criteria. In Section 3, the paper will provide results and statistical information of the included articles. In section 4, it presents benefits, challenges and recommendations. Section 5 and 6, presents the limitation and conclusion of the review paper.

RESEARCH METHOD

The keyword used for this paper is “Urban Farming in Southeast Asia”. This excludes any urban farming activities that not related to Southeast Asia such as those found in China, Japan, Taiwan, Korea and other countries. We also limit our scope to the English literature but consider all studies in exploring determinants towards enhancing quality of life through urban farming activities in Southeast Asia. Three digital databases were explored to search the target articles. Web of Science database cover services indexing cross-disciplinary research in agriculture, engineering, medical and life sciences, biological sciences, physical and chemical sciences. ScienceDirect and Scopus is the largest scholarly research database that provides the most reliable and wide range of topics such as, monitoring system, IoT applications, urban farming support livelihood, food and few more related topics. These three databases sufficiently cover the agriculture studies especially topic the urban farming activities in Southeast Asia.

Study selection involved a search for literature sources, followed by three iterations of screening and filtering. The first iteration process excluded the duplicate papers between databases. The second iteration process screening the titles and abstracts papers and excluded unrelated articles, while another iteration of items after a thorough reading of the full-text articles. The search was conducted in January 2018 using the search boxes of ScienceDirect, Web of Science database and Scopus. A mix of keywords that contained “smart farming”, “home farming”, “town farming”, “city farming”, “homegrown farming”, “home-grown farming”, "home-based farming", “Precision Livestock Farming”, PLF , “urban farming”) on different variation and combined with the “OR” and “AND” operators followed by Southeast Asia countries (Malaysia OR Brunei OR Cambodia OR Indonesia OR Laos OR Myanmar OR Philippines OR Singapore OR Thailand OR Vietnam OR “Southeast Asia”). The exact query text is shown at Figure 1 below. The advanced search options in the search engines were used to exclude book chapters, short communication, correspondence, and letter and gain access to up-to-date scientific works relevant to urban farming activities in Southeast Asia. The final analysation was done using Microsoft Word and Excel formats. Particularly, the final set of articles was categorized in detail using taxonomy. This taxonomy is classified into several classes and subclasses. The text is categorized according to the preferred author style, and the collected data and related information are

saved in Word and Excel files. All articles are analysed from a variety of sources in depth to give readers a comprehensive look at the subject.

RESULTS AND STATISTICAL INFORMATION OF ARTICLES

The initial query resulted 851 papers: 17 from the Web of Science database, 378 from ScienceDirect, and 456 from Scopus. The filtered papers published until January 2018 were adopted in this research and divided into three categories. In the three databases the included papers are filtering in three parts; the first part, 2 out papers were duplicates from the total number 851, the second part, after reading the titles and abstract, 719 was excluded from the number of 849, the result become 130, in the second parts of filtering process 42 papers were excluded, from the number of 130 the final included papers 88 eighty-eight.

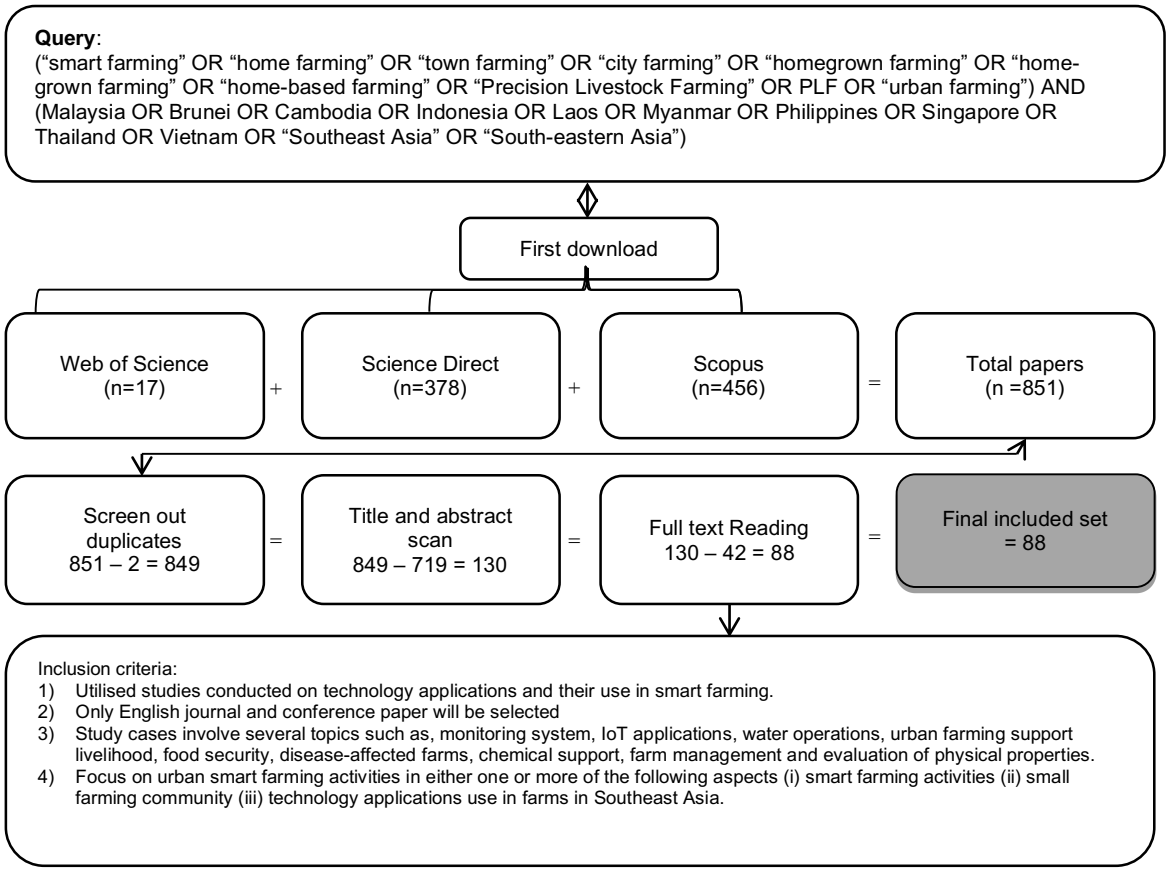


Figure 1: Flow chart of study selection, including the search query and inclusion criteria

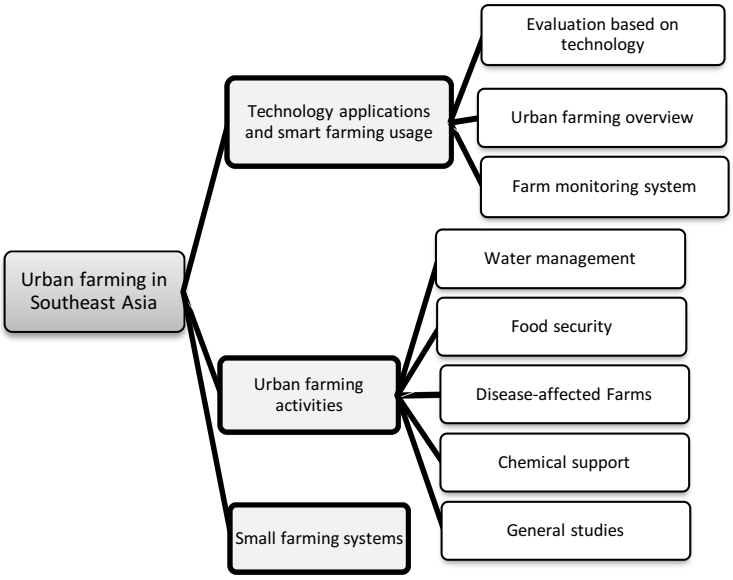


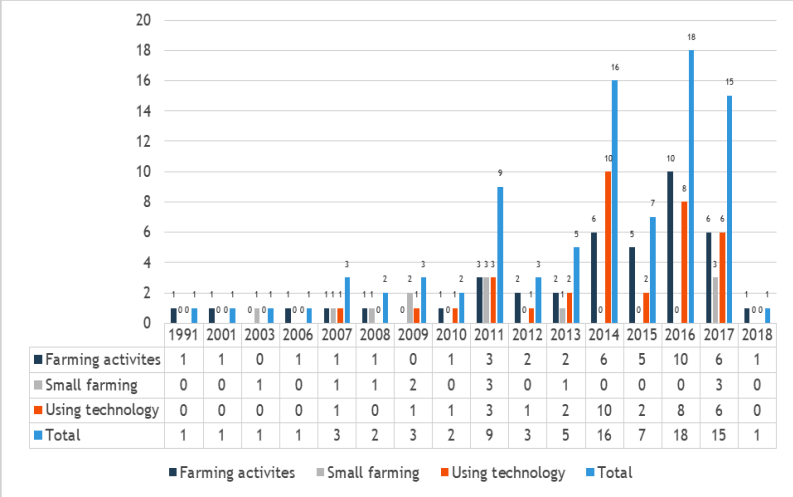
Figure 2: Taxonomy of literature on urban farming activities in Southeast Asia

Studies conducted on smart farming technology application and their use in the urban farms.

This section will discuss different type of technologies that has been used for urban farming activities. For example, the paddy farmers will use the soil electrical conductivity (VerisEC) sensor to evaluate the soil properties for precision farming of rice (Aimrun et al., 2007). While another related studies discussed the use of electrical conductivity (VerisEC) sensor to measure and evaluate the chemical properties and plant nutrients for paddy farms soil in Malaysia (Aimrun et al., 2011; Ezrin et al., 2016). The use of EC sensor to evaluate the physical and chemical properties of soil paddy farms from different spatial locations and it give soil information quickly (Mastura et al., 2011) also be reviewed. Soil apparent electrical conductivity (ECa) is also used to measure and determine the water management in poorly drained soils farm in different locations (Tenzin et al., 2017). The usage of organic material on agricultural soils gives a significant impact on soil quality and productivity. This study using Soil Organic Matter sensor (SOMSENSE) and Global Positioning System (GPS) techniques to help the farmer and farm manager to evaluate the soil fields properties (Ezrin et al., 2016). Another study uses the optical and near-infrared spectroscopy analysis to assess the chemical properties of the paddy soil in the farm (Aimrun et al., 2014). Robots are used in many aspects of the fields to increase the efficiency of the agriculture, thereby reducing the cost of human work. Lingzhi mushroom farms in Malaysia has used Internet of things (IoT) technology with a sensor to evaluate and monitors the humidity of their plantation (Chieochan et al., 2017). The WFD is divides into two sensors type, Frequency Domain Reflectometry sensor (FDR) and Resistor-based sensor (RB). This technology attempts to measure and monitor the soil properties and water management in the precision farming (Sureephong et al., 2017). Nitrogen is very important in rice plantation. Thus, there are few studies that present the use of digital camera to measures and determine the status of nitrogen and chlorophyll content in the rice leaf for the paddy plantation in Malaysia. The digital camera techniques attempted to analyse and considering all visible bands derived from images captured (Mohammadmehdi M Saberioon et al., 2014), (Mohammad Mehdi Saberioon et al., 2013). This study also uses digital camera technologies to capture images from the palm oil farms. The purpose of this technology to analyse and select the best time for harvest at the optimum maturity stage to optimize the quality of palm oil fresh fruit bunches (FFB) in the farms (Kassim et al., 2012). Further, the evaluation of different aspects for irrigation systems performance in farming also presented in this study (Rowshon et al., 2006).

Distribution Results

Figure 3 indicates the number of included articles in the three categories by year of publication. The distribution of scholarly papers until 2018 is shown.



	1991	2001	2003	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Farming activites	1	1	0	1	1	1	0	1	3	2	2	6	5	10	6	1
Small farming	0	0	1	0	1	1	2	0	3	0	1	0	0	0	3	0
Using technology	0	0	0	0	1	0	1	1	3	1	2	10	2	8	6	0
Total	1	1	1	1	3	2	3	2	9	3	5	16	7	18	15	1

Figure 3: Number of included articles in different categories by year of publication

Figure 3 highlights the number of articles published from year 1991 until 2018 according to its respective themes. In general, the rate publication is increasing every year with year 2016 shown the highest number of articles published. It also shown that the highest theme of articles published for that year were come from farming activities with total of 10 articles published. Additionally, two papers were published from year 2008 and 2010 and three articles were published from 2007 and 2009. While in year 2013, five articles were published from all the three categories which are farming activities, small farming and using technology application for urban farming. The variation of total number of publications from three different main themes have shown that there are lots of potential to publish articles in relation to urban farming activities especially in Southeast Asia countries.

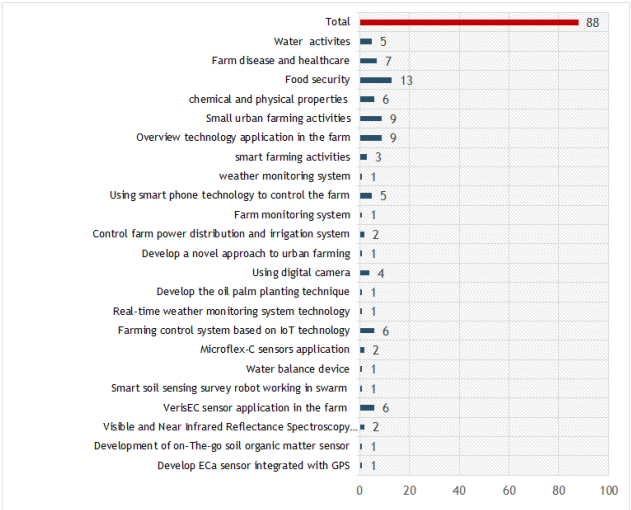


Figure 4: The distribution of papers according to topic.

While Figure 4 illustrates the number of articles that have been published according to their respective topics. The chart also shows a very clear contrast number if studies presented on different subject matter. For example, articles that related to food security in urban farming contributes to the highest number of publications followed by small urban activities and technology application in the farm with nine articles been published. This has shown that these topics get more attention from past researchers to investigate more on those topics.

DISCUSSION

This study provides the latest studies and state-of-the-art of urban farming activities in Southeast Asia. Further, this study also aims to highlight the future research trends and helps the researchers to find the general overview of the latest urban farming activities in Southeast Asia. The classification of relevant literature helps to classify these different actions and activities into meaningful, manageable and cost-effective planning. To know first possible research trends in this area, mapping on urban farming activities in Southeast Asia into a distinct category highlights the weak and powerful features in terms of research coverage. In addition, this research also provides a taxonomy of articles related to this topic. This will assist researchers that interested in the future trends of urban farming to find the specific topic and publication that relevant to their research interest. The taxonomy that shown in Figure 2 was developed based on the literature and has been analyzed systematically. A taxonomy of published works imposes organization on a set of publications. A new researcher who is interested urban farming activities may be overwhelmed by the large number of publications written on the topic when no organizational structure exists and fails to gain a proper sense of the actual activities in this field. Various articles treat the topic from an introductory perspective, others examine a selected number of existing technology applications, and some involve smart farming activities. Providing a taxonomy helps sort the different works and activities collected from the literature into a meaningful, manageable, and coherent framework. A taxonomy can also provide researchers with important insights into a topic in several ways.

Benefits of urban farming activities

Studies that provide the discussion on urban farming benefits are immersed. Thus, this section will provide the review of urban farming activities. The development of new technology for agriculture purposes has been actively implemented. For example, the use of Electrical Conductivity sensor (ECa) in agriculture provides huge impact. This technology is very important to improve the field management and evaluation of soil chemical, physical properties such as, nitrogen (N), exchangeable potassium (K) and available phosphorus (P), and biological parameters, and crop yields. It also helps farmers to manage farms, improve the production costs and reduce environmental degradation by applying the optimal quantity of the required nutrients (Ezrin et al., 2016), (Asa Gholizadeh et al., 2011), (Aimrun et al., 2011), (Ezrin et al., 2010), (Mastura et al., 2011), (Aimrun et al., 2007), (da Silva Dias, 2014). This study uses Organic Matter Sensor (SOMSENSE) technology with the integration of software developed using MATLAB based on Red, Green and Blue (RGB) scales to help the farmers to manage the farm and measure the soil properties. This technology relies on the smart camera, where the farmers will take pictures and then analysed using the laboratory analysis (Maina et al., 2014b). Another study presents Visible and Near Infrared Reflectance Spectroscopy technology to evaluate the soil properties such as, moisture content, bulk density, silt, clay and sand in Malaysian paddy field (A Gholizadeh et al., 2014), (Gholizade et al., 2013). Modern agriculture is moving towards utilisation of robots to inspect crop, check the weather conditions, soil fertility, and soil and crop diseases (PobkrutKerdcharoen, 2014). Few studies have discussed on the utilisation of smart farming technologies. For example, a study has discussed the use of soil saturated hydraulic conductivity (Ks) devices to measure and calculate the irrigation requirement of the water balance equation in the soil farm, and also measure a soil physical and chemical properties such as, sand, clay and dry bulk density (AimrunAmin, 2009). This study displays technology Microflex-C sensor for measuring evaporation within agricultural crops and crop water requirements inside the farm (Maina et al., 2014b), (Maina et al., 2014a).

Challenges of urban farming activities

Despite numerous benefits acquired from the urban farming activities, there are some challenges and disabilities facing from these activities that been discussed in past studies. For example, the excessive use of animal fertilizers would affect the properties of the arable soil. It is difficult to see how animal fertilizer is considered a valuable source of crop nutrients. Some fertilizer is not a soil nutrient, and an increase in fertilizer usage has caused damage to agricultural crops (Hedlund et al., 2003). Some fertilizers also contain harmful properties that will lead to many adverse effects on the environment and the characteristics of the soil on the farm and production efficiency as well as on the crop itself (Ezrin

et al., 2016), (Maina et al., 2014b). The excessive use of pesticide has led to the failure of pre-harvest agricultural soils in many urban farms in Southeast Asia. Pesticide residues affect consumers' and farmers' health, environmental pollution and restricted trading opportunities. Farms tat close to railways, car roads and industrial zones can be contaminated with heavy metals such as lead, sulphur and nitrate. These toxic materials will be transported to farms and cause a lot of diseases (da Silva Dias, 2014). Some organic waste is harmful and effects on urban agriculture because it may cause crop and vegetable crops to be damaged and render crops inedible (HubbardOnumah, 2001), (Moglia, 2014). In Southeast Asia some plantations in urban areas use a large proportion of nitrate fertilizers to increase the productivity of vegetables, vegetables and water may contain higher concentrations of nitrates and may cause a serious threat to human health (da Silva Dias, 2014).

Recommendation of urban farming activities

Despite the poor management of small farms in many areas of Southeast Asia, there are few recommendations that have been discussed in past studies. For example, it is recommended that the local authority to establish a close cooperation with the government to draft a protective laws and regulations for open spaces farming. Such cooperation contributes to the success of small farms, for example: climate reporting, waste management, grain and fertilizer supply and water management. This effort will facilitate the successful uptake of gardening programs (Weinberger, 2013), encourage small-scale urban agriculture in buildings leading to a sustainable economy (Mintorogo et al., 2017). In another study, it also recommended that attention to be given in developing and increasing the spread of small farms, advocacy training and gardening and address issues that could hinder the success of the home gardening inside the urban cites in Philippines. A comprehensive policy is also required for joint management in city authorities as cities become larger, more ethnically diverse and with larger numbers of the population(HubbardOnumah, 2001).

LIMITATION

There are few limitations identified from this study. For example, the number and identity of the databases sources that have been highlighted in this research, although we believe that these sources are a reliable and representative collection and cover the subject of wide-ranging research. Second, rapid progress in this study is determined by a specific time of the survey. Third, we emphasize in this research the limited application of urban agriculture in Southeast Asia research, which happens to be our own goal in this article.

CONCLUSION

Recently, there is a significant emergence towards the adoption of smart farming especially in urban areas. Considering global issues such as climate change and resource scarcity, new approaches are needed to reduce urban footprints and make cities more sustainable. Further, the harmful impact of urban development on the natural environment has intriguing urban dwellers to find a quality, liveability, cultural diversity and healthy urban developments. This effort has also attracted more researchers to investigate this research area. Thus, this study highlights few important issues that map the research landscape from literature into coherent taxonomy and determine various features that characterize this emerging line of research in urban farming activities, technology applications and their use in the urban farms and smallholder farming activities in Southeast Asia. Certain patterns can be derived from various works of previous authors such as urban farming activities, small farming and using technology application for urban farming. The variation of total number of publications from these three themes could also be observed from this research findings. In addition, this research highlights the variation of topics published in relation to urban farming. The variation of this publication has shown the potential of urban farming topic to be investigated and merge the discussion with other disciplinary of research. A detailed analysis of the articles that recognise and define the issues, limitations, advantages and recommendations related to the urban farming in Southeast Asia was also conducted. The recommendation that this study highlighted could help solve the issues and potential challenges in adopting urban farming activities. Some of the issues that discussed and provide the recommendation are associated with protective laws and regulation in relation to urban farming and open spaces usage.

This study also recommends the authority to provide more urban farming training which will encourage more dwellers to embrace to urban farming activities at the same time optimise the utilisation of open space area. This study is significant for future research. The research community will continue to work and focus on this approach; hence, researchers should explore the evolving trends on urban farming activities in Southeast Asia particularly and globally in general.

This research partially funded by Universiti Pendidikan Sultan Idris Research Grant (2017-0054-106-61).

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