Urban farming: people preference towards *verticulture* model in small housing type-settlements in Malang as sustainable landscape movement

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Urban farming: people preference towards *verticulture* model in small housing type-settlements in Malang as sustainable landscape movement

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Abstract. The rapid growths of Malang city as education and tourism city makes a higher demand for housing and increases land prices. The number of small housing type-settlement development with no adequate garden or open space is always increase. Housing that lack of greenery has led to many problems such as bad quality of fresh air, lack of playing area for kids and mental problem. On the other side, the widespread of city development has resulted in reduced agricultural space which has led to inadequate domestic food supplies and the declining quality of food crops availability. In the wake of various issues on food and energy security, urban farming by Food Oriented Development (FOD) is a concept of urban development that can make the city as a food provider for its own citizens on an ongoing basis. This concept considers aspects of food security as well as socio-economic considerations in urban physical development. The objective of this research is to get the information of people preference of *verticulture* model as urban farming method in small housing type-settlement. The questionnaire survey using Likert scale is conducted to measure people perception and preference. This study explores factor analysis for decision-making process. The result indicate that people tend to choose simple and smart system of *verticulture* model as a vertical garden in private residential. Giving recommendation of the *verticulture* model, hopefully this study can be implemented in small housing-type settlement in Malang city in order to be self-sufficient in food supply.

Keywords: small housing, sustainable landscape movement, urban farming, verticulture model

1. Research background

1.1. The Rapid growth of population in Malang and small housing type settlement

The rapid growths of Malang city as education and tourism city makes a higher demand of housing and increases land prices. According to the head of Demography information of Malang city in 2016, the population of Malang always grow every month as Malang is education city. The population growth is about 1,58 % [1]. The increasing number of the population mainly because of many newcomers. With the land size of 252.1 km2, the population of Malang city in the last five years has increased. By 2015 there are 50.116 people that increase from 2012 which is only 845.271 people [2].

The number of small housing type-settlement development with no adequate garden or open space is always increasing. Housing that lack of greenery has led to many problems such as bad quality of fresh air, lack of playing area for kids and mental problem.

1.2. Agriculture issues and food resilience

On the other side, the widespread of city development has resulted in reduced agricultural space which has led to inadequate domestic food supplies and the declining quality of food crops availability. In 2000-2012 the agricultural land in Malang reduced and left about 1300 ha, and in 2015 the Head of Department of Agriculture of Malang City Hadi Santoso said productive agricultural land in the area currently only left 865 Ha spread in District Blimbing, Kedungkandang, Sukun, and Lowokwaru [3]; [5]. From year to year agricultural land continues to shrink. The agriculture land reduces about 68 Ha Every year [4]. even in the District Klojen now there is no agricultural area at all because it has changed functions into public facilities, offices, trade and industrial centers and housing. It causes an effect on the availability of regional food. Because of these conditions, the productivity of rice produced by farmers has not been able to meet the food needs of residents of Malang, although the productivity per hectare is quite high, reaching 7.25 tons of rice equivalent. The demand of rice in Malang residents reaches 96,600 tons per year, while the production is only about 13,500 tons, so every year the average rice shortage reaches 83,000 tons. Hence, the innovation of development is needed to protect the food security.

1.3. The important of the vertical urban farming

In the wake of various issues on food and energy security, urban farming by Food Oriented Development (FOD) is a concept of urban development that can make the city as a food provider for its own citizens on an ongoing basis. This concept considers aspects of food security as well as socio-economic considerations in urban physical development. Recently, hydroponic culture technology started to gain favor in the developing because of population growth in urban areas represented an opportunity to grow food near consumers. The 100-200 million urban farmers worldwide providing the city markets with fresh agricultural products are the evidence of how food security can be achieved by urban agriculture [1].

The objective of this research is to get the information of factors that become people preference of vertical agriculture model as an urban farming method in small housing type settlements.

2. Theoretical Approach

According to Druckman & Lupia (2000) about the nature of Human preference, a preference is a comparative evaluation of (i.e. a ranking over) a set of objects. A preference serves as a cognitive marker that reminds people how to interact with various aspects of their environment. Preferences are stored in memory and drawn on when people make decisions. The objects of preference are aspects of the environment that are evaluated relative to one another. They can include observable, physically continuous phenomena (such as bowling balls) and unobservable, physically discontinuous phenomena [2].

The objects within a preference are those that a person can imagine as substitutable. On the other side, the predominant view of human cognition for nearly 2000 years has been that the objects of preference (alternatively, the categories of phenomena over which preferences can be held) are strictly external. In recent years, the evidence against this view of cognition has been piling high. For example, architecture objects. Most people prefer some architecture objects to others, and people have a favorite. People treat architecture objects as basic attributes of other objects.

Consumer preference might change since the experiences change. The preference of customers changes over time because of changes in demographics and lifestyle or more attractive competitors product, a target of marketing after a certain time. Consumer preference according to Kotler is like or dislike choice by someone to one product (goods and service) that consumed. Customer preference

analysis is an analysis to decide product important hierarchy/order of important which is important or mostly preferred [3].

One of the fundamental issues in consumer behavior is the way consumers develop, adapt and use decision-making strategies. Consumer decision making could be defined as the "behavior patterns of consumers, that precede, determine and follow the decision process for the acquisition of need-satisfying products, ideas or services". Consumer decision-making has long been of great interest to researchers. Early decision-making studies concentrated on the purchase action. It was only after the 1950's those modern concepts of marketing were incorporated into studies of consumer decision-making, including a wider range of activities [4]. The contemporary research indicates that more activities are involved than the purchase itself. Many other factors influence the consumer decision-making than the final outcome. Vast numbers of studies have investigated this issue and many models have been developed accordingly. Models aim to depict the purchase decision-making process and its influential factors.

Factors that influence for the consumer in decision-making process are categorized into psychological and personal factors. The primary Psychological factors that influences on consumer behavior: 1). Personality and self-concept, 2). Motivation, 3) Learning, 4) Perception, and 5) the impact of attitudes. While the personal factors include demographic and situational variables such as sex, ages, race, origin, income, family life cycle, and occupation. Situational variables as external conditions like the amount of time for the consumer to make a decision [5].

The concept of vertical farming as the way for the citizen to do farming activity in an urban area especially in their neighborhood is a sustainable solution for the rapid growth in Malang city with the high demand of settlements and no adequate land. Vertical farming as a component of urban agriculture is the practice of producing food in vertically-stacked layers, vertically-inclined surfaces and/or integrated into other structures. Vertical farming is not a new idea. In 1915, Bailey coined the term "vertical farming". Since then, architects and scientists, especially towards the end of the twentieth century, have repeatedly looked into the idea of producing food in urban environments because of constant human population growth and the pressures exerted on resources for food production. Denmark was the first country to attempt to implement the concept of agricultural integration in a built environment in a house in the 1950s; they tried to grow watercress (*Nasturtium officinale*) on a large scale. Today a more evolved urban agriculture, where the product is grown in a totally controlled urban environment, in closed vertical structures, is attracting more attention in several countries. In the past two decades, scientists in the United States, Europe, and several Asian countries have been conducting research and development to bring this concept into reality [1].

Asia countries such as South Korea, Japan, China, Singapore, and Europe such as Italy, Holland United Kingdom, also Middle East areas such as Jordan, Saudi Arabia, United Arab Emirates and Canada, are moving ahead in the development of vertical farming projects. Vertical farming technology has been seen as a solution to the problems of limited land area suitable for agriculture, as well as a more rational use of water resources, thus providing better opportunities for a sustainable food supply in both developed and developing countries. Because of advances in hydroponic and aeroponic technology, lighting through LEDs and energy provided using solar cells, it is now possible to have agriculture in cities and possibly even in individual households to create centers of production and consumption integrated with urban and suburban communities. One can grow crops inside multi-story city buildings, using the very little land to produce food that would not need to be shipped far to the end of a consumer. Moreover, the vertical farming technology could contribute to a reduction in some of the following social, economic and environmental issues faced in the country [1].

3. Typology of vertical greenery

There are two typologies of vertical greenery that we can modify and adopt the construction to be implemented in the *verticulture* model for the vertical urban farming in settlements such as Green facade and living wall like in the table below:

Table 1. Vertical greenery classification.

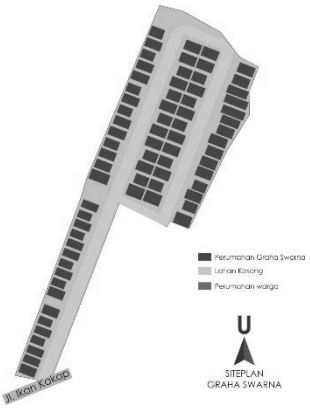
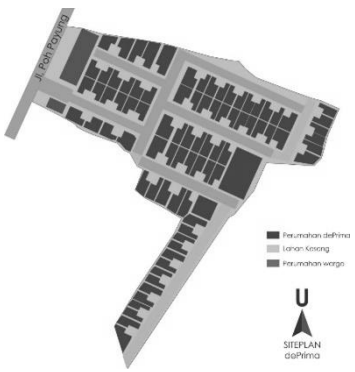
Classification	Construction on the building facade	Vertical greenery type	
Green façade	Direct	*Traditional wall climbers*	
	Not direct	*Modular trellis panel*	
		Mesh structure	
		Wire structure	
		Perimeter flower pots	
Living wall	Not direct	*Modular living wall*	
		Vegetated mat wall	

4. Research methodology

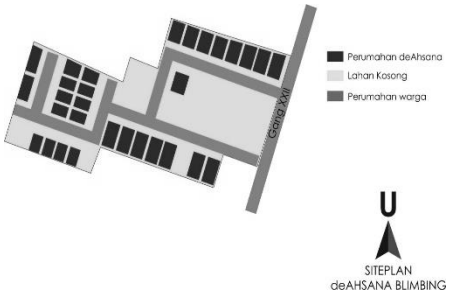
4.1. Study area

The study area consists of 5 settlements in Malang City. Several case study was used to determine how the respondent/public evaluate *verticulture* model and how they perceive them. The settlements that become case studies are Swarna Housing, Saxophone Housing, de Prima Housing, d Ahsana Regency and Dapenza Housing that located in Malang Region Table 2).

Table 2. Settlements characteristic.

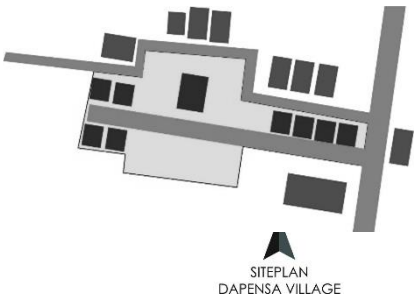
1. Housing I-Swarna	
	Housing Swarna is located in the Lowokwaru district in Malang City, the total occupancy in this housing is 55 units. It consists of types 45 and 36.  
2. Housing II-Saxophone	
	Saxophone Housing located in the Lowokwaru district of Ketawanggede Malang City, the total occupancy of this housing is 65 units. It consists of types 45 and 36.  
3. Housing III-de Prima	
	Housing de Prima is located in Lowokwaru district of Malang City, the total occupancy in this housing is 60 units. It consist of type 45 and 36.  

4. Housing IV-d'Ahsana regency



Ahsana housing is located in Pandanwangi district of Malang City, the total occupancy in this housing is 44 units. It consists of type 45 as many as 14 units as the focus of research. While other units of type 65 and 75 are not used as a research focus.

5. Housing V-Dapenza



Dapenza Housing located in Batu City, the total occupancy in this housing is 60 units. It consists of types 45 and 36.

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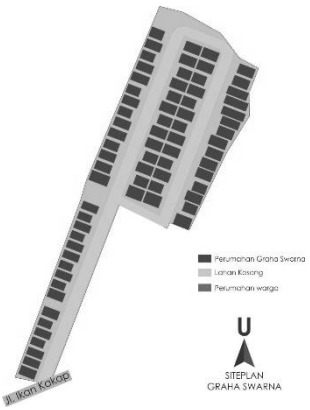

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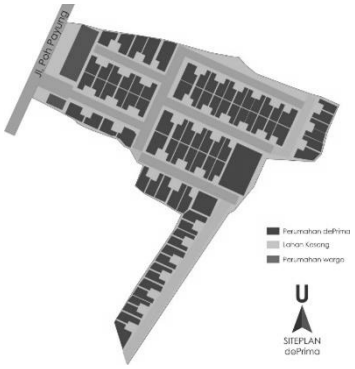
Saxophone Housing located in the Lowokwaru district of Ketawanggede Malang City, the total occupancy of this housing is 65 units. It consists of types 45 and 36.

3. Housing III-de Prima



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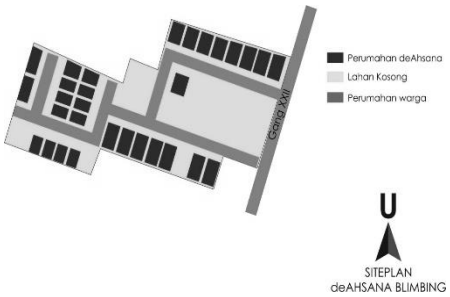

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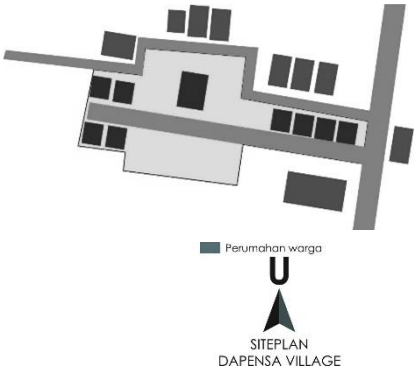

Dapenza Housing located in Batu City, the total occupancy in this housing is 60 units. It consists of types 45 and 36.

4.2. Data collection and research variable

This research using quantitative approach. The population of the research is small housing type settlement in Malang Region. The data collection procedure using field survey and questionnaire in order to get clear description of the research focus and public preference toward the vertical urban farming. In this research, 5 experimental groups were selected from 5 settlements. The respondent limited to productive ages people (17-50 years old) of house's owner and settlement manager. The number of sample determined from Gay and Diehl, that is depending upon the type of research. The experimental research has a minimum sample which is 15 subjects per one group [12].

The questionnaire survey using a Likert scale to measure people perception and preference. The variable that becomes research guideline in this paper are described in Table 3.

Table 3. Research variables.

Vertical agriculture and greenery			
1	Vertical greenery model	a	Green facades-GF
			• Traditional green facade (creeping and hanging)-GF1
			• Double skin green facades with trellises, wires and nets-GF2
			• Green facade with Perimeter flower pot-GF3
		b	Living Wall-LW
			• Living wall with landscape wall-LW1
			• Living wall with vegetated mat wall-LW2
			• Modular living wall-LW3
2	Vertical agriculture application	a	Growing media-GM
			• Recycle/used materials-MT1
			• PVC Pipe-MT2
			• New materials-MT3
			• Perimeter Flower Pot-MT4
			• Vegetated mat wall-MT5
			• Modular living wall-MT6
		b	Types of plants-JT
			• Fruits-JT1
			• Vegetables-JT2
			• Fruits and vegetables-JT3
		c	Plants watering-P
			• Watering plants manually-P1
			• Watering plants automatically-P2
		d	Target of harvesting-TP
			• Depending on the type of plant and planting period-TP1
			• Not targeted-TP2
		e	Space efficiency-EF
		h	Planting media should facilitate maintenance-MTMP
		i	Crop support structures must be sturdy and durable, resistant to rain, heat and cold-SP
3	Farming benefit for the community	a	Social value-NS
			• Increase public awareness of the importance of greening-NS1
			• Increase public awareness that greening can also meet the needs of micro foods crops-NS2
		b	Ecology value-NE
			• The benefit to improve urban green public space-NE1
			• The benefit to reduce the pollution in urban-NE2
			• Improve air quality around the dwelling area-NE3
		c	Aesthetic value-NES
			• Improve building and settlements uniqueness-NES1
			• Increase the interesting view around the dwelling-NES2

4.3. Method of analysis

This study explores factor analysis to get people preference and decision-making process. The analysis consists of several steps including descriptive analysis and to test the hypothesis using Factor Analysis (Bartlett's test of Sphericity (BTS), Kaiser-Meyer-Olkin (KMO), Principal Component Analysis (PCA) and the determination of the number of factors by extraction.

5. The result of the analysis

5.1. Respondent

Table 4. Characteristic of research respondent.

Demography		Swarna	Saxophone	De prima	Ahsana	Dapena
		n	n	n	n	n
Gender	Woman	15	4	1	1	1
	Man	13	6	6	5	6
Domicile	Malang					
	The other city					
Occupation	College student	10	3	2	1	1
	Stay at home mother	8	1			
	Company Employee	5		1	6	6
	Civil servant	3	1			
	others		5	2		1

5.2. People preference on the vertical urban farming

5.2.1. Normality test

According to normality test table, the significance of one sample Kolmogorov-Smirnov test us 0.089, that is bigger than 0.05. It indicates that the distribution of the data is normal.

Table 5. Kolmogorov-Smirnov test result.

One-Sample Kolmogorov-Smirnov Test

		Unstandardized Residual
N		58
Normal Parameters[a]	Mean	.0000000
	Std. Deviation	.86184232
Most Extreme Differences	Absolute	.164
	Positive	.078
	Negative	-.164
Kolmogorov-Smirnov Z		1.246
Asymp. Sig. (2-tailed)		.089

a. Test distribution is Normal.

5.2.2. Descriptive statistic

1. Bartlett Test and KMO

Bartlett test and KMO was conducted to know the appropriateness of all the indicator to analyzed using factor analysis. The Validity using factor analysis is the same principle with correlation analysis. It means if one indicator valid to measure one *latent variable*, that indicator must be correlated significantly and strongly with another *latent variable*. The significance of correlation can be seen in Bartlett's of Sperchity's Sig value. The strength of the correlation is in KMO value (Kaiser-Meyer-Olkin Measure of Sampling Adequacy). In this research, the Bartlett sig value is 0, that is smaller than 0.05 which means there is a correlation between indicators. All Indicator is indicated valid that can be seen from KMO score 0.836 which bigger than 0.05, so the correlation is strong.

Table 6. KMO and Barlett's test result.

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
GF1	3.5345	1.12726	58
GF2	3.6897	1.17289	58
GF3	4.1207	.97473	58
LW1	3.9310	.98874	58
LW2	3.7241	1.12067	58
LW3	3.6897	1.07942	58
MT1	3.3793	1.34852	58
MT2	4.1034	1.11905	58
MT3	3.8276	1.02833	58
MT4	3.8966	1.08724	58
MT5	3.5345	1.11159	58
MT6	3.7414	1.06886	58
JT1	3.3966	1.43807	58
JT2	3.5345	1.41688	58
JT3	4.2586	1.08515	58
P1	3.3793	1.42444	58
P2	3.9828	1.33102	58
TP1	3.8793	1.29882	58
TP2	3.3793	1.37430	58
EF	3.0345	1.99090	58
MTMP	4.2931	1.09238	58
SP	4.3276	1.11431	58
NS1	4.2931	1.07620	58
NS2	4.2414	1.11309	58
NE1	4.2414	1.08110	58
NE2	4.3103	1.09556	58
NE3	4.4138	1.07662	58
NES1	4.1379	.96333	58
NES2	4.3793	1.07324	58

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.836
Bartlett's Test of Sphericity	Approx. Chi-Square	1.639E3
	df	406
	Sig.	.000

2. Anti-Image Matrice

On the MSA scores result, the part which written as 'a' and has shaped a diagonal line indicated MSA score of each variable. The score characterized bigger than 0.5. It showed that the variables have been predicted to be processed appropriately in the future analysis. The MSA scores for indicator GF1 in variable Green Wall is 0.757. It means GF1 have a strong correlation with another indicator. The MSA scores divided into three parts of the result. The first part described the *anti-image correlation result* of several variables including variables such as Double skin green facade (GF2), Perimeter flower pot (GF3), living wall with landscape wall (LW1), living wall with vegetated mat wall (LW2), modular living wall (LW3), Recycle/used materials (MT1), PVC Pipe (MT2), New materials (MT3), Perimeter Flower Pot (MT4).

Table 7. MSA result part 1.

Anti-image Matrices

		GF1	GF2	GF3	LW1	LW2	LW3	MT1	MT2	MT3	MT4
Anti-image Correlation	GF1	.757a	-0.292	-0.034	-0.163	-0.333	0.287	-0.330	0.205	-0.052	0.011
	GF2	-0.292	.772a	-0.335	0.187	0.160	-0.141	-0.248	-0.584	-0.078	-0.075
	GF3	-0.034	-0.335	.871a	-0.392	-0.109	0.225	0.225	0.111	-0.058	-0.224
	LW1	-0.163	0.187	-0.392	.875a	-0.163	-0.167	0.047	-0.099	0.087	-0.386
	LW2	-0.333	0.160	-0.109	-0.163	.839a	-0.155	0.117	-0.274	0.114	0.392
	LW3	0.287	-0.141	0.225	-0.167	-0.155	.885a	0.059	-0.114	-0.005	-0.197
	MT1	-0.330	-0.248	0.225	0.047	0.117	0.059	.715a	-0.051	0.230	-0.047
	MT2	0.205	-0.584	0.111	-0.099	-0.274	-0.114	-0.051	.847a	-0.138	-0.023
	MT3	-0.052	-0.078	-0.058	0.087	0.114	-0.005	0.230	-0.138	.871a	-0.213
	MT4	0.011	-0.075	-0.224	-0.386	0.392	-0.197	-0.047	-0.023	-0.213	.857a
	MT5	0.401	-0.161	-0.131	0.158	-0.449	0.180	-0.146	0.001	-0.016	-0.234
	MT6	-0.150	-0.205	0.338	-0.230	-0.162	-0.127	-0.123	0.323	-0.127	-0.242
	JT1	-0.316	-0.017	0.182	-0.067	0.068	-0.093	0.385	0.008	0.363	-0.054
	JT2	0.385	-0.107	-0.078	-0.021	-0.103	0.011	-0.240	-0.020	-0.263	0.102
	JT3	0.002	0.053	-0.162	-0.116	0.194	-0.372	-0.050	-0.045	-0.323	0.352
	P1	0.042	0.102	0.145	0.072	-0.132	0.214	-0.352	-0.007	-0.248	-0.251
	P2	-0.222	0.243	-0.100	0.098	-0.195	-0.018	-0.129	0.005	-0.083	-0.235
	TP1	0.049	0.152	-0.084	-0.071	-0.102	-0.013	-0.089	-0.121	0.226	0.070
	TP2	-0.128	0.271	-0.485	0.101	0.138	-0.187	-0.128	-0.040	0.100	0.250
	EF	0.199	-0.117	-0.113	-0.171	-0.017	0.088	-0.174	0.127	0.111	0.172
	MTMP	-0.032	0.016	-0.187	-0.097	0.260	0.075	0.182	-0.098	0.063	0.079
	SP	-0.051	0.047	0.114	0.127	-0.115	-0.146	-0.247	0.067	-0.220	-0.014
	NS1	-0.065	0.147	-0.204	0.340	-0.039	0.123	0.104	-0.125	0.120	-0.153
	NS2	-0.085	-0.248	0.266	-0.151	-0.007	-0.044	0.340	0.033	0.255	0.023
	NE1	-0.313	-0.294	0.189	-0.212	0.208	-0.310	0.147	0.364	-0.181	0.137
	NE2	0.191	0.310	-0.323	0.311	-0.033	0.224	-0.161	-0.341	0.169	-0.065
	NE3	0.366	-0.121	0.002	-0.142	-0.166	0.224	0.094	-0.082	0.004	0.056
	NES1	0.111	-0.173	0.027	-0.230	-0.260	-0.243	-0.135	0.303	-0.363	0.230
	NES2	-0.233	0.380	0.058	0.104	0.041	-0.011	-0.272	-0.177	0.038	-0.309

a. Measures of Sampling Adequacy(MSA)

The second part described the *anti-image correlation result* of several variables including variables such as Vegetated mat wall (MT5), Modular living wall (MT6), Fruits (JT1), Vegetables (JT2), Fruits and vegetables (JT3), Watering plants P1 manually, watering plants automatically P2, depending on the type of plant and planting period (TP1), Not targeted (TP2), space efficiency (EF).

Table 8. MSA result part 2.

		MT5	MT6	JT1	JT2	JT3	P1	P2	TP1	TP2	EF
Anti-image Correlation	GF1	0.401	-0.150	-0.316	0.385	0.002	0.042	-0.222	0.049	-0.128	0.199
	GF2	-0.161	-0.205	-0.017	-0.107	0.053	0.102	0.243	0.152	0.271	-0.117
	GF3	-0.131	0.338	0.182	-0.078	-0.162	0.145	-0.100	-0.084	-0.485	-0.113
	LW1	0.158	-0.230	-0.067	-0.021	-0.116	0.072	0.098	-0.071	0.101	-0.171
	LW2	-0.449	-0.162	0.068	-0.103	0.194	-0.132	-0.195	-0.102	0.138	-0.017
	LW3	0.180	-0.127	-0.093	0.011	-0.372	0.214	-0.018	-0.013	-0.187	0.088
	MT1	-0.146	-0.123	0.385	-0.240	-0.050	-0.352	-0.129	-0.089	-0.128	-0.174
	MT2	0.001	0.323	0.008	-0.020	-0.045	-0.007	0.005	-0.121	-0.040	0.127
	MT3	-0.016	-0.127	0.363	-0.263	-0.323	-0.248	-0.083	0.226	0.100	0.111
	MT4	-0.234	-0.242	-0.054	0.102	0.352	-0.251	-0.235	0.070	0.250	0.172
	MT5	.826a	-0.269	-0.250	0.381	-0.132	0.093	-0.095	-0.182	-0.179	0.127
	MT6	-0.269	.827a	0.162	-0.162	-0.081	0.085	0.195	-0.103	-0.269	-0.112
	JT1	-0.250	0.162	.611a	-0.748	-0.368	-0.334	-0.057	-0.006	0.030	0.055
	JT2	0.381	-0.162	-0.748	.589a	0.374	0.070	-0.188	-0.120	-0.357	-0.064
	JT3	-0.132	-0.081	-0.368	0.374	.860a	-0.022	-0.257	-0.092	0.006	-0.071
	P1	0.093	0.085	-0.334	0.070	-0.022	.586a	0.377	-0.292	-0.249	-0.104
	P2	-0.095	0.195	-0.057	-0.188	-0.257	0.377	.895a	-0.086	0.085	-0.141
	TP1	-0.182	-0.103	-0.006	-0.120	-0.092	-0.292	-0.086	.852a	0.415	-0.040
	TP2	-0.179	-0.269	0.030	-0.357	0.006	-0.249	0.085	0.415	.734a	0.175
	EF	0.127	-0.112	0.055	-0.064	-0.071	-0.104	-0.141	-0.040	0.175	.710a
	MTMP	0.020	-0.170	0.009	0.001	0.047	-0.035	0.040	-0.173	0.012	0.142
	SP	-0.113	0.171	-0.037	-0.052	-0.027	0.095	-0.041	0.024	0.045	-0.188
	NS1	-0.034	-0.361	0.087	-0.267	-0.337	-0.049	0.168	0.186	0.239	0.118
	NS2	-0.327	0.275	0.336	-0.206	-0.035	-0.275	-0.005	0.136	-0.059	-0.132
	NE1	-0.253	0.468	0.197	-0.233	0.153	-0.086	-0.037	-0.161	-0.063	-0.059
	NE2	0.253	-0.533	-0.123	0.129	-0.198	0.096	-0.048	0.028	0.187	0.186
	NE3	0.343	-0.263	-0.186	0.411	0.116	0.055	-0.205	-0.007	-0.146	0.040
	NES1	-0.140	0.254	-0.157	0.138	0.422	-0.137	-0.006	0.076	-0.030	-0.037
	NES2	0.160	0.161	-0.030	0.017	-0.181	0.216	0.172	-0.085	-0.240	-0.203

a. Measures of Sampling Adequacy(MSA)

The third part described the *anti-image correlation result* of several variables including planting media should facilitate maintenance (MTMP), Crop support structures must be sturdy and durable belongs to(SP), resistant to rain (NS1), heat and cold (NS2), Increase public awareness of the important of greenery (NE1), Increase public awareness that greening can also meet the needs of micro foods crops (NE2), Benefit for improving urban green public space (NE3), Benefit for reducing pollution, Improving air quality around the dwelling area, Improving building and settlements uniqueness (NES1), Increase the interesting view around the dwelling (NES2).

Table 9. MSA result part 3.

		MTMP	SP	NS1	NS2	NE1	NE2	NE3	NES1	NES2
Anti-image Correlation	GF1	-0.032	-0.051	-0.065	-0.085	-0.313	0.191	0.366	0.111	-0.233
	GF2	0.016	0.047	0.147	-0.248	-0.294	0.310	-0.121	-0.173	0.380
	GF3	-0.187	0.114	-0.204	0.266	0.189	-0.323	0.002	0.027	0.058
	LW1	-0.097	0.127	0.340	-0.151	-0.212	0.311	-0.142	-0.230	0.104
	LW2	0.260	-0.115	-0.039	-0.007	0.208	-0.033	-0.166	-0.260	0.041
	LW3	0.075	-0.146	0.123	-0.044	-0.310	0.224	0.224	-0.243	-0.011
	MT1	0.182	-0.247	0.104	0.340	0.147	-0.161	0.094	-0.135	-0.272
	MT2	-0.098	0.067	-0.125	0.033	0.364	-0.341	-0.082	0.303	-0.177
	MT3	0.063	-0.220	0.120	0.255	-0.181	0.169	0.004	-0.363	0.038
	MT4	0.079	-0.014	-0.153	0.023	0.137	-0.065	0.056	0.230	-0.309
	MT5	0.020	-0.113	-0.034	-0.327	-0.253	0.253	0.343	-0.140	0.160
	MT6	-0.170	0.171	-0.361	0.275	0.468	-0.533	-0.263	0.254	0.161
	JT1	0.009	-0.037	0.087	0.336	0.197	-0.123	-0.186	-0.157	-0.030
	JT2	0.001	-0.052	-0.267	-0.206	-0.233	0.129	0.411	0.138	0.017
	JT3	0.047	-0.027	-0.337	-0.035	0.153	-0.198	0.116	0.422	-0.181
	P1	-0.035	0.095	-0.049	-0.275	-0.086	0.096	0.055	-0.137	0.216
	P2	0.040	-0.041	0.168	-0.005	-0.037	-0.048	-0.205	-0.006	0.172
	TP1	-0.173	0.024	0.186	0.136	-0.161	0.028	-0.007	0.076	-0.085
	TP2	0.012	0.045	0.239	-0.059	-0.063	0.187	-0.146	-0.030	-0.240
	EF	0.142	-0.188	0.118	-0.132	-0.059	0.186	0.040	-0.037	-0.203
	MTMP	.857a	-0.894	0.191	-0.004	0.065	-0.005	0.141	-0.258	-0.230
	SP	-0.894	.855a	-0.134	-0.123	0.026	0.013	-0.279	0.267	0.208
	NS1	0.191	-0.134	.891a	-0.250	-0.253	0.245	-0.339	-0.229	-0.070
	NS2	-0.004	-0.123	-0.250	.886a	0.106	-0.278	-0.039	0.090	-0.338
	NE1	0.065	0.026	-0.253	0.106	.825a	-0.785	-0.304	0.167	-0.017
	NE2	-0.005	0.013	0.245	-0.278	-0.785	.819a	0.123	-0.391	-0.034
	NE3	0.141	-0.279	-0.339	-0.039	-0.304	0.123	.888a	-0.132	-0.311
	NES1	-0.258	0.267	-0.229	0.090	0.167	-0.391	-0.132	.864a	-0.218
	NES2	-0.230	0.208	-0.070	-0.338	-0.017	-0.034	-0.311	-0.218	.891a

a. Measures of Sampling Adequacy(MSA)

5.2.3. Extraction

1. Communalities

The extraction number of the traditional green facade (GF) 1 is 0.742. It means 74.2% variance from GF1 variable can be explained by the factor that has been shaped. The extraction number of double skin green facades (GF 2) is 0.795, GF3 0.792, LW1 0.752, LW2 0.870, and LW3 0.715. The smaller the value of communalities means the weaker the relationship with the factors formed.

Table 10. Communalities score.

Communalities

	Initial	Extraction
GF1	1.000	.742
GF2	1.000	.795
GF3	1.000	.792
LW1	1.000	.752
LW2	1.000	.870
LW3	1.000	.715
MT1	1.000	.805
MT2	1.000	.739
MT3	1.000	.763
MT4	1.000	.758
MT5	1.000	.804
MT6	1.000	.729
JT1	1.000	.888
JT2	1.000	.865
JT3	1.000	.732
P1	1.000	.795
P2	1.000	.782
TP1	1.000	.755
TP2	1.000	.779
EF	1.000	.562
MTMP	1.000	.862
SP	1.000	.894
NS1	1.000	.901
NS2	1.000	.870
NE1	1.000	.873
NE2	1.000	.905
NE3	1.000	.928
NES1	1.000	.825
NES2	1.000	.918

Extraction Method: Principal Component Analysis.

2. The total variance explained

The total variance explained table show that there are 7 new factors have been shaped. The eigenvalue must be >1. According to the table of total variance explained, Factor1 eigenvalue: 13.5 with variance 46.927%, factor2 eigenvalue 2.767 with variance 9.54%, factor 3 eigenvalue 2.136 with variance 7.366%, factor 4 eigenvalue 1.541 with variance 5.314%, factor 5 eigenvalue 1.318 with variance 4.545%, factor6 eigenvalue 1.047 with variance 3.609%, factor 7 eigenvalue 1.010 with variance 3.484%. The total variance of all factors is 80.784.

Table 11. Total variances score.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	13.580	46.827	46.827	13.580	46.827	46.827	7.514	25.910	25.910
2	2.767	9.540	56.368	2.767	9.540	56.368	5.292	18.250	44.159
3	2.136	7.366	63.734	2.136	7.366	63.734	2.804	9.668	53.827
4	1.541	5.314	69.047	1.541	5.314	69.047	2.794	9.634	63.461
5	1.318	4.545	73.593	1.318	4.545	73.593	1.834	6.325	69.786
6	1.047	3.609	77.202	1.047	3.609	77.202	1.605	5.534	75.320
7	1.010	3.484	80.686	1.010	3.484	80.686	1.556	5.366	80.686
8	.727	2.508	83.194						
9	.627	2.164	85.357						
10	.558	1.924	87.281						
11	.514	1.774	89.055						
12	.443	1.526	90.581						
13	.392	1.352	91.933						
14	.378	1.304	93.237						
15	.331	1.140	94.377						
16	.293	1.009	95.386						
17	.279	.961	96.346						
18	.187	.646	96.993						
19	.149	.516	97.508						
20	.140	.484	97.992						
21	.126	.436	98.427						
22	.116	.401	98.828						
23	.092	.317	99.145						
24	.073	.252	99.396						
25	.055	.190	99.586						
26	.049	.170	99.756						
27	.032	.112	99.868						
28	.021	.074	99.941						
29	.017	.059	100.000						

Extraction Method: Principal Component Analysis.

3. Rotation component matrix

The value of loading factor are calculated by correlation between factors and variable. From line one in the table of Rotated component matrix, traditional green facade (GF) with loading factor 1 is 0.339, loading factor 2 is 0.129. Traditional green facade with loading factor 3 is 0.194, traditional green facade with loading factor 4 is 0.122, traditional green facade with loading factor 5 is 0.727, traditional green facade with loading factor 6 is 0.069, traditional green facade with loading factor 7 is 0.160. According to the correlation score requirements, strong correlation must be 1 or -1. In this indicator, the biggest one is 0.727, so traditional green facade indicator belongs to factor 5.

Double skin green facade (GF2) belongs to factor 2, Perimeter flower pot belongs to factor 1 (GF3), living wall with landscape wall (LW1) belongs to factor 5, living wall with vegetated mat wall LW2 belongs to factor 6, modular living wall (LW3) belongs to factor 2, recycle/used materials (MT1) belongs to factor 7, PVC Pipe (MT2) belongs to factor 2, new materials (MT3) belongs to factor 2, perimeter flower pot (MT4) belongs to factor 2, vegetated mat wall (MT5) belongs to factor 2, modular living wall (MT6) belongs to factor 2, fruits (JT1) belongs to factor 4, vegetables (JT2) belongs to factor 2, fruits and vegetables (JT3) belongs to factor 7, watering plants P1 manually belongs to factor 7, watering plants automatically P2 belongs to factor 3, depending on the type of plant and planting period belongs to factor 3 (TP1), not targeted (TP2) belongs to factor 4, space efficiency (EF) belongs to factor 3, planting media should facilitate maintenance (MTMP) belongs to factor 3, crop support structures must be sturdy and durable belongs to factor 3 SP, resistant to rain belongs to factor 1 (NS1), heat and cold (NS2) belongs to factor 1, increase public awareness of the important of greenery (NE1) belongs to factor 1, increase public awareness that greening can also meet the needs of micro foods crops (NE2) belongs to factor 1, benefit for improving urban green public space (NE3) belongs to factor 1, benefit for reducing pollution belongs to factor 1, improving air quality around the dwelling area belongs to factor 1, improving building and settlements uniqueness (NES1) belongs to factor 1, increase the interesting view around the dwelling (NES2) belongs to factor 1.

Table 12. Rotated component matrix.

Rotated Component Matrix[a]

	Component						
	1	2	3	4	5	6	7
GF1	.339	.129	.194	.122	.727	.069	.160
GF2	.128	.829	.032	-.014	.096	.175	.223
GF3	.471	.559	.091	.158	.403	.146	-.203
LW1	.293	.485	.195	.210	.513	.229	-.182
LW2	.384	.257	.111	.140	.171	.771	.037
LW3	.322	.602	.176	.371	.046	.123	-.251
MT1	.107	.204	.391	.128	.413	.035	.641
MT2	.293	.719	.220	.024	-.136	.260	.043
MT3	.365	.760	.083	.109	.109	-.140	-.055
MT4	.324	.718	.073	.023	.363	.007	.002
MT5	.259	.646	.184	.064	.024	.528	.052
MT6	.478	.547	.079	.125	.317	.250	.128
JT1	-.004	.059	.220	.891	.046	.195	-.033
JT2	.023	.136	.147	.894	.042	.009	.154
JT3	.480	.461	.369	.182	.098	.129	-.306
P1	.071	.021	.076	.522	-.020	.103	.707
P2	.322	.281	.454	.169	.326	.264	-.435
TP1	.067	.195	.710	.166	.013	.424	.017
TP2	.394	.063	-.149	.668	.326	-.104	.184
EF	.047	-.058	.699	.039	.174	.030	.186
MTMP	.439	.451	.643	.171	.053	-.124	-.063
SP	.438	.478	.663	.153	.007	-.083	-.054
NS1	.864	.349	.048	.086	.067	.138	.019
NS2	.860	.268	.200	.040	-.011	.104	.077
NE1	.875	.251	.078	.079	.159	.078	-.036
NE2	.893	.235	.097	.019	.149	.135	-.036
NE3	.898	.269	.141	-.015	.117	.103	-.067
NES1	.816	.228	.021	.144	.185	.208	.097
NES2	.887	.123	.236	.105	.218	-.031	.033

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

4. Component transformation matrix

Component transformation Matrix shows Varimax rotation result. All variables have been distributed to each factor that has been shaped. Factor I named Benefit of Vertical Agriculture including Green facade with perimeter flower pot (GF3), Fruits and vegetables (JT3), Increase public awareness of the important of greening (NS1), Increase public awareness that greening can also meet the needs of micro foods crops (NS2), Benefit for improving urban green public space (NE1), Benefit for reducing pollution (NE2), Improving air quality around the dwelling area (NE3), Improving building and settlements uniqueness (NES1), Increase the interesting view around the dwelling (NES2). Factor 2 named Modular Vertical Agriculture including Double skin green facades with trellises, wires and nets (GF2), Modular living wall (LW3), PVC Pipe (MT2), New materials (MT3), Perimeter Flower Pot (MT4), Vegetated mat wall (MT5), Modular living wall (MT6). Factor 3 named Technology for Vertical agriculture including watering plants automatically (P2), Depending on the type of plant and planting period (TP1), Space efficiency (EF), Planting media should facilitate maintenance (MTMP), Crop support structures must be sturdy and durable, resistant to rain, heat and cold (SP). Factor 4 named Vertical agriculture plants including Fruits (JT1), Vegetables (JT2), Not targeted harvesting (TP2). Factor 5 named Traditional

Alternative for greenery type. Traditional green facade/creeping and hanging (GF1), the living wall with landscape wall (LW1). Factor 6 named Alternative for living wall including living wall with vegetated mat wall (LW2). Factor 7 named environmentally friendly Vertical agriculture including Recycle/used materials (MT1) Watering plants manually (P1).

Table 13. Component score coefficient matrix.

Component Score Coefficient Matrix

	Component						
	1	2	3	4	5	6	7
GF1	-.042	-.093	.020	-.068	.549	-.020	.049
GF2	-.106	.321	-.100	-.085	-.040	.003	.200
GF3	-.029	.086	-.086	.019	.229	-.009	-.152
LW1	-.093	.043	-.031	.020	.346	.069	-.163
LW2	.011	-.108	-.072	-.018	.021	.609	.012
LW3	-.031	.147	-.037	.158	-.097	-.037	-.181
MT1	-.065	.018	.155	-.110	.241	-.067	.411
MT2	-.023	.221	.011	-.041	-.264	.083	.090
MT3	-.030	.280	-.062	.018	-.037	-.284	-.004
MT4	-.076	.225	-.079	-.062	.201	-.148	.019
MT5	-.055	.136	-.035	-.047	-.120	.332	.068
MT6	-.006	.092	-.090	-.033	.123	.088	.089
JT1	-.046	-.067	.009	.394	-.073	.100	-.136
JT2	-.034	.015	-.024	.386	-.095	-.076	.001
JT3	.020	.034	.095	.052	-.046	-.021	-.202
P1	.026	.000	-.016	.149	-.157	.046	.432
P2	-.043	-.084	.145	.031	.203	.123	-.326
TP1	-.059	-.083	.316	-.021	-.091	.274	.005
TP2	.060	-.039	-.180	.276	.152	-.151	.029
EF	-.030	-.125	.378	-.092	.093	-.033	.113
MTMP	.022	.067	.277	.008	-.109	-.268	-.024
SP	.022	.076	.286	-.002	-.154	-.236	-.010
NS1	.174	-.013	-.074	-.002	-.122	.021	.040
NS2	.195	-.048	.033	-.034	-.193	-.003	.090
NE1	.178	-.064	-.046	-.005	-.026	-.021	-.010
NE2	.185	-.083	-.033	-.037	-.033	.035	-.003
NE3	.185	-.065	-.005	-.050	-.061	-.001	-.014
NES1	.162	-.078	-.090	.007	-.012	.101	.067
NES2	.191	-.125	.060	-.013	.023	-.114	.024

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Component Scores.

6. Conclusion

The result indicated that people tend to choose the simple and smart system of the vertical urban farming model as a vertical garden in private residence. Based on factor analysis, the public preference of the vertical urban farming model can be classified in 7 important factor: 1. Factor 1 (Benefit of vertical agriculture), 2. Factor 2 (Modular vertical agriculture), 3. Factor 3 (Technology for vertical agriculture), 4. Factor 4 (Vertical agriculture plants), 5. Factor 5 named (Traditional alternative for greenery type), 6. Factor 6 (Alternative for living wall) including living wall, 7. Factor 7 (Environmentally friendly vertical agriculture).

However, this research has a limitation, the respondent could not in minimum amount in one group. It was suggested that the sample should be 15 in one group for the minimum; however, some of the samples was lower than 15 dues to the different occupancies of the house. The other issue is not all housing owner could fulfill the questionnaire. However, due to time constraints and the normality test which indicated normal, this research is finished. Future research can pinpoint this problem and thus could facilitate the improvement of research methodology.

Giving recommendation of the vertical urban farming model based on people preference, hopefully this study can be implemented in a small housing-type settlement in Malang City in order to be self-sufficient in food supply. It is hoped that the evaluation model that we established can serve as a constructive reference for professionals in the design of sign systems and for academicians regarding their further studies. On the other hand, the evaluation model in the research can be used for long-term follow-ups concerning user requirements, and for implementation when the vertical urban farming in a small housing type settlement are designed.

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