SPATIAL FACTORS AFFECTING PATTERNS OF EDIBLE LANDSCAPING IN URBAN LANES AND ALLEYS

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ABSTRACT

Edible landscaping presents a type of sustainable cultural landscape. Creating productive space in and around cities provides several purposes, including beautifying the environment, encouraging social interaction, securing fresh food provision, supporting ecosystems and, in general, developing sustainably. In high-density urban environments, linear greening can bring a physical connection to fragmented green spaces. Notably, alleys of inner urban areas in Taiwan play an important role among other public open spaces as they are where daily life, transportation and cultural activities take place. These alley greening and edible landscaping often lacking visual harmony require fundamental research to serve as a basis for establishing design principles. Thus, this article aims at understanding the relationship between the forms of alley greening and its alley space, as well as the spatial factors affecting pattern of edible landscaping. All alleys and lanes in the designated regeneration areas in Chiayi City were surveyed and documented, and the association between typology of their greening and spatial factors were analysed by SPSS. The results show that the existence of alley greening is mainly associated with the spatial pattern of alley itself, the type of buildings alongside and the activities in the alley space, but less associated with the land use alongside. Also, the number of species of edible crops is associated with spatial pattern and activities in the alley space. Edible plants occur in 77.9% of greened alleys and those alleys with car parking alongside are more likely to have edible plants than those without. Those alleys with pots placed on the ground are most likely to have edible plants than other types of greening. In conclusion, in order to practically manage alley greening, an edible alley greening principle should be developed according to the current spatial features of and activities in the alley.

Keywords: alleys, edible landscape, greening, lanes, productive landscape, Taiwan, urban agriculture.

1 INTRODUCTION

Edible landscaping has been considered as a sustainable strategy and an alternative to simply creating green space in urban development [1]–[3]. Edible landscape is a space greened by using edible plants and other landscape plants to create a multi-functional place [4], [5]. Just like other green spaces, it has the potential to offer ecosystem services [6], including mitigating heat island effects, reducing storm water runoff, providing recreational, social and scenic values, and leaving habitats for wildlife [7]. But one of the most distinct services is that it produces food for its neighbourhoods [5]. This can sustainable if the cultivation is environment-friendly [1]. During the production, organic wastes from the neighbourhoods can be composted and reused for fertilizing crops. The harvests can complement low-income families' food needs while generating part of their incomes [2]. Besides, other educational and social activities or events can be hold in this place to foster a sense of community [1]. In this regards, some inner urban areas with needs to regeneration have delivered the idea of edible landscaping or urban agriculture in its vacant lands or abandoned street blocks [1].

However, space availability for greening or landscaping has been found to be one of the key issues in many urban areas. Especially in those high-density and high-income cities, green spaces have to compete with other land uses having more spatial efficiency, such as high-rise buildings for commercial or residential use [8]. Through greening linear space, those high-density urban environments can have a green networks to compensate the loss of

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vegetation cover from building developments. Greening with trees in roads, streets and boulevards are the main focuses [8]–[10], but greening with edible plants in lanes and alleys has rarely been concerned in the former research. It is thus no substantial basis to support the creation of design principles for edible landscaping in urban lanes and alleys.

Also, edible landscaping is not necessarily a pleasant idea for all of its surrounding neighbours due to the odour, fire safety, appearance, territory or other conflicts and issues [11], [12]. Although a few cities have paid attention to establish planning and design principles for lanes and alleys greening [8], [13], [14], this issue remains less focused by urban policies in many countries. Other than that, greening and edible landscaping in alleys and lanes have not been fully explored in previous studies. Thus, this research focuses on examine those factors that affect the pattern of edible landscape in urban alleys and lanes (Fig. 1). The factors include surrounding density, land use types and its visual accessibility [9], [13]–[15].

2 METHODOLOGY

Based on the literature review and field observation, this study constructs a conceptual framework of factors that affect the greening patterns of edible landscape in alleys and lanes. The spatial factors affecting patterns of edible landscape include land use, density, and activities happened in the space. It first surveyed and documented the key characteristic of the greening and edible landscaping in all alleys and lanes in the designated regeneration areas in Chiayi City. It then analysed the association between typology of their greening and spatial factors by SPSS.

The research subject is alleys and lanes in the regeneration area of Chiaiy City. As found in the urban planning system, greening in alleys and lanes do not have clear regulations nor do they guided by any policy documents. By reviewing planes and regulation, there are only legal definitions in alley and lanes. Alleys are identified as “pass ways connecting boulevards, roads or streets no wider than 7 meters” while lanes are defined as “narrow pass ways connecting alleys and those roads and streets wider than 7 meters but shorter than 2 meters.” The research area is those designated as regeneration areas in the urban plan of the Chiayi City, namely the railway station and the surrounding area, downtown area, historical town area, old dormitory area, downtown industrial area, Houhu redevelopment area, Dashih settlement, and Beisewei settlement (Fig. 2). The survey conducted between September 2014 and October 2015. Six surveyors are responsible for one or two regeneration areas individually and investigated all alley and lanes in their own responsible areas. They used Google Map to guide their way to each alleys and lanes and verified the locations on field. Once the locations are clarified, they went into each alley and lane to record the features of the greening and space, namely shape of alley and lane space, real land use, building types, activities in the space, type of planting and name of the crops found.

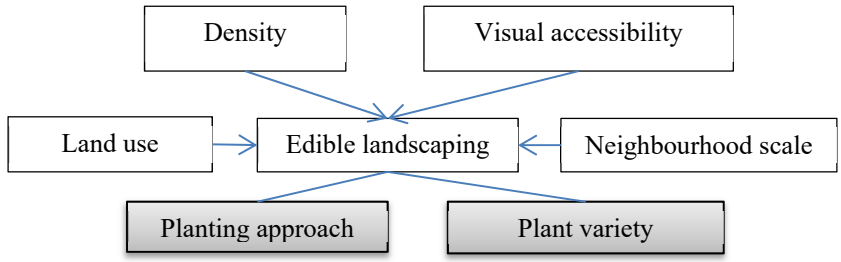

Figure 1: Theoretical framework of factors affecting edible landscaping in alleys and lanes.

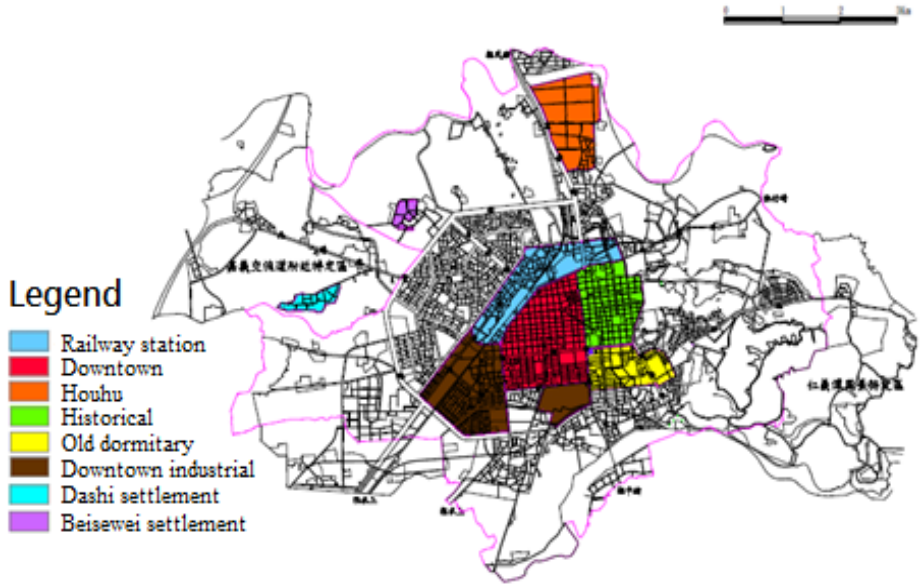

Figure 2: The designated regeneration areas in Chiayi City, Taiwan [16].

This study first uses Microsoft EXCEL to document property data of each alley and lane. It then maps the location of all the alleys and lanes by Google Map, and imports the KML files into QGIS to create a map. The EXEL files are also imported into SPSS to analyse the associations between the factors. The Levene test is used to examine if the varieties of edible plants in each regeneration area is significantly different. Also, the Chi square test is applied to examine whether those factors are associated with each other.

3 FINDINGS

There are 687 data in the eight designated regeneration areas: 235 data in the railway station and the surrounding area, 127 data in the downtown area, 189 data in the historical town area, 53 data in the old dormitory area, 99 data in downtown industrial area, 15 data in the Houhu redevelopment area, 16 data in the Dashih settlement, and 25 data in the Beisewei settlement (Table 1). The Levene test is that $p = 0.000 < 0.05$, thus the null hypothesis is rejected and means that those alleys and lanes in each regeneration areas has distinctive numbers of varieties in edible plants.

The edible landscaping ratios of alleys and lanes in most of the regeneration areas are higher than 70%. In particular, those in the Houhu area are fully greened, and for downtown industrial area (96.97%) and the railway station area (90.55%), the ratios are higher than 90%. The old dormitory area (88.68%), the Dashih settlement (75%), and the Beisewei settlement (72.00%) are higher than 70%. The lowest ratios are in the downtown area (68.51) and historical town area (58.12).

In each regeneration area, the household edible landscaping ratio is between 15 and 55%. Only Beisewei settlement (53.77%) and the historical town (51.74%) have more than 50% of households with edible landscaping in front of their properties. Downtown industrial area has the lowest ratio, 15.89% of households with edible landscaping.

Table 1: The descriptive statistics of edible landscaping in eight designated regeneration areas.

Designated regeneration area	Railway station	Downtown	Historical town	Old dormitory	Downtown industrial	Houhu redevelopment	Dashih settlement	Beisewei settlement	Total
Area of the regeneration area (ha)	158	216	170	92.2	128	14.9	14.3	128	921.4
Total no. of alleys and lanes	127	235	99	53	117	25	16	15	687
No. of edible alleys and lanes	115	161	96	47	68	18	12	15	532
% of total no. of alleys and lanes	90.55	68.51	96.97	88.68	58.12	72.00	75.00	100	77.44
No. household with edible landscape	517	779	713	252	171	80	61	107	2680
Total no. of households	2364	3267	1378	1203	1076	344	197	199	10028
% of total no. of households	21.87	23.84	51.74	20.95	15.89	23.26	30.96	53.77	26.73

The variety of edible plant is 127 species, and 2314 counts of the species number are found in all households. Regarding the variety number of edible plant species in each area, there are 101 in the downtown area, 90 in the downtown industrial area, 59 in the old dormitory area, 55 in railway station area, 45 in the Houhu area, 36 in the historical town area, and 23 in the Beisewei area. The five most frequently counted species are Aloe Vera (10.24%), Crossostephium chinense (6.44%), Carica papaya (5.19%), Ipomoea batatas (5.19%), and Ocimum basilicum (5.10%).

In the descriptive statistics of overall spatial variables, the form of an alley or lane is most likely to be the pass-through type (60%) while the cul-de-sac type (37.5%) ranks second (Table 2). Land use along the alleys or lanes are mostly residential (76.1%), otherwise is residential mixed with one other type of land use (14.5%), such as commercial, industrial or educational ones. The activities other than passing through happened in the alley or lane is mostly car parking (72.6%) and no activity ranks second (13.8%).

The Chi-square test is used to examine weather edible landscape existing or not in an urban alley or lane is associated with the four spatial variables of an alley or lane (Table 3). According to the Chi-square test result: $\chi 2 = 13.747$, df = 2 and $p = 0.001 < 0.05$, the association between the existence of edible landscape and the form of an alley or lane is significant. In particular, there is a higher chance to find edible landscape in pass-through type than other form of alleys or lanes. Also, the Chi-square test result ($\chi 2 = 32.314$, df = 3, and $p = .000 < .05$) reveals that the existence of edible landscape is significantly associated with the activities happened in an alley or lane. Especially those alleys and lanes with automobile parking alongside are more likely to have edible landscaping. Based on the Chi-square test result: $\chi 2 = 9.213$, df = 5 and $p = 0.101 > 0.05$, the association between the existence of edible landscape and the land use along an alley or lane is insignificant. Also, the Chi-square test result ($\chi 2 = 6.484$, df=5, and p=0.262>0.05) shows that the existence of edible landscape is significantly associated with the building types along an alley or lane.

Table 2: The descriptive statistics of the spatial variables of alleys and lanes in eight designated regeneration areas.

1. Form	*Counts*	*%*
Pass-through	410	60.0
Cul-de-sac	256	37.5
Mixed	17	2.5
2. Land use	*Counts*	*%*
Vacant	3	.4
Residential or with vacant	520	76.1
Residential with one others	99	14.5
Residential with two others	42	6.1
Residential with three others	7	1.0
Non-residential	12	1.8
3. Building type	*Counts*	*%*
Apartment	6	.9
Townhouse	529	77.5
Detached house	59	8.6
Apartment with one other	34	5.0
Detached house with townhouse	49	7.2
Three types or high-rise	6	.9
4. Activities	*Counts*	*%*
None	94	13.8
Car parking	496	72.6
Parking with one other	43	6.3
Non-parking	50	7.3

ANOVA is used to analyse the associations between the varieties of edible plants and the four spatial variables of an alley or lane (Table 4). For the first spatial variable, form of the alleys and lanes, the Levene's Test for Equality of Variances has $P = 0.001 < 0.05$; thus, the variances not equal can be assumed. The Dunnett's T3 and Games-Howell method are adopted for the Post-hoc examination. The result shows that at a 95% confidence level, the species numbers of edible plants in those alleys and lanes with a cue-de-sec form are significantly different from those with a mixed form of pass-through and cue-de-sec types. For the second spatial variable, land use along the alleys and lanes, the Levene's Test for Equality of Variances has $P = 0.000 < 0.05$; thus, the variances not equal can be assumed. The Dunnett's T3 and Games-Howell method are adopted for the Post-hoc examination. The result shows that at a 95% confidence level, the species numbers of edible plants in those alleys and lanes with different land use alongside are not significantly different. Only those alleys and lanes with residential use mixed with four other land uses at the same time have a significantly high mean number of edible plant varieties from other land use types of alleys and lanes. For the third spatial variable, building types along the alleys and lanes, the Levene's Test for Equality of Variances ($P = 0.164 > 0.05$) suggests that the variances equal can be assumed. At a 95% confidence level, F = 2.201, and $p = 0.53 > 0.05$, there are no

Table 3: The Chi-Square test of the alleys and lanes with edible landscape and those without edible landscape in four spatial factors: form, land use, building type and activity.

1. Form	*Edible*	*None*	*Total*	*χ2*	*p*
Pass-through	75	335	410	13.747	0.001
cul-de-sac	75	181	256		
mixed	1	16	17		
2. Land use	*Edible*	*None*	*Total*	*χ2*	*p*
Vacant	0	3	3	9.213	0.101
Residential or with vacant	126	394	520		
Residential with one others	18	81	99		
Residential with two others	7	35	42		
Residential with three others	0	7	7		
Non-residential	0	12	683		
3. Building type	*Edible*	*None*	*Total*	*χ2*	*p*
Apartment	2	4	6	6.484	.262
Townhouse	123	406	529		
Detached house	14	45	59		
Apartment with one other	5	29	34		
Detached house with townhouse	5	44	49		
Three types or high-rise					
4. Activities	*Edible*	*None*	*Total*	*χ2*	*p*
None	40	54	94	32.314	.000
Car parking	89	407	496		
Parking with one other	6	37	43		
Non-parking	16	34	50		
Total	**151**	**532**	**683**		

difference between the mean numbers of edible plant varieties in alleys and lanes with different types of buildings. For the final spatial variable, activities happened in the alley or lane, the Levene's Test for Equality of Variances has $P = 0.000 < 0.05$; thus, the variances not equal can be assumed. The result of the Dunnett's T3 and Games-Howell method are adopted for the Post Hoc examination shows that those alleys and lanes with car parking and other activities has a mean number of edible plant varieties (7.58) significantly higher than other types of alleys and lanes. In particular, the types of alleys and lanes with no activities other than traffic have the lowest mean number of edible plant species (2.44).

The Chi-square test is used to examine weather edible landscape existing or not in an urban alley or lane is associated with the greening approach of an alley or lane. According to the Chi-square test result: $\chi2 = 120.984$, df = 8 and $p = 0.000 < 0.05$, the association between the existence of edible landscape and the greening approach of an alley or lane is significant. In most of the greening approaches, their existence of edible landscape is higher than 50%, only vertical greening has a ratio of edible landscape lower than 50%. In particular, there is a higher chance to find edible plants in the alleys or lanes greened by movable or fixed planters on ground-level and two or three types on the ground level.

Table 4: The ANOVA test of the number of edible plant species in four spatial factors: form, land use, building type and activity.

1. Form	*No.*	*Mean*	*SD*	*SE*	*Min*	*Max*	*F*	*p*
Pass-through	410	4.43	5.081	.251	0	31	8.969	.000
Cul-de-sac	256	3.00	3.536	.221	0	20		
Mixed	17	5.59	4.317	1.047	0	14		
2. Land use	*No.*	*Mean*	*SD*	*SE*	*Min*	*Max*	*F*	*p*
Vacant	6	3.17	3.125	1.276	0	8	5.450	.000
Residential or residential with vacant	529	3.73	4.458	.194	0	31		
Residential with one other land use	59	4.27	5.346	.696	0	26		
Residential with two other land uses	34	3.76	4.112	.705	0	18		
Residential with three other land uses	49	5.92	5.346	.764	0	23		
Non-residential	6	3.00	3.347	1.366	0	8		
3. Building type	*No.*	*Mean*	*SD*	*SE*	*Min*	*Max*	*F*	*p*
Apartment	6	3.17	3.125	1.276	0	8	2.201	.053
Townhouse	529	3.73	4.458	.194	0	31		
Detached house	59	4.27	5.346	.696	0	26		
Apartment with one other	34	3.76	4.112	.705	0	18		
Detached house with townhouse	49	5.92	5.346	.764	0	23		
Three types or high-rise	6	3.00	3.347	1.366	0	8		
4. Activities	*No.*	*Mean*	*SD*	*SE*	*Min*	*Max*	*F*	*p*
None	94	2.44	3.928	.405	0	23	14.220	.000
Car parking	496	4.01	4.142	.186	0	26		
Parking with one other	43	7.58	8.353	1.274	0	31		
Non-parking	50	2.78	3.797	.537	0	21		
Total	**683**	**3.93**	**4.598**	**.176**	**0**	**31**		

4 CONCLUSIONS

This study aims at understanding if the existence and variety of edible landscape in an alley or lane has association with the spatial features of an alley or lane itself. The results show that the existence of alley greening is mainly associated with the spatial form of an alley itself, the type of buildings alongside and the activities in the alley space, but less associated with the land use alongside. Also, the number of species of edible crops is associated with spatial form and activities in the alley space. Edible plants occur in 77.9% of greened alleys and those alleys with car parking alongside are more likely to have edible plants than those without. Those alleys with pots placed on the ground are most likely to have edible plants than other types of greening. In conclusion, in order to practically manage alley greening, an edible alley greening principle should be developed according to the current spatial features of and activities in the alley.

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