Spatial configuration and vulnerability of residential burglary:

A case study of a city in Taiwan

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Abstract
Most research on space and crime focuses on factors related to target hardening, such as good quality locks, use of double glazed windows, CCTV, etc, however, very few take the spatial layout patterns against crime into account. Through case studies in one well-off town in northern Taiwan, this research tries to detect whether there exists a significant influence of the spatial configuration on the distribution of residential burglary.

This research focuses on two factors, namely social and spatial ones, which will be carefully cross-examined with regard to their effects on burglary distribution patterns. The research analysis is composed of two parts, i.e. area and detailed studies. First, in the area study, the correlation between spatial configuration and burglary distribution patterns will be examined when the social variable is controlled. In the detailed study, three major elements are considered: the road types, the degree of road accessibility (i.e. the integration measure), and the immediate surroundings of each dwelling.

Our findings show that segregated areas, allowing fewer passers by to enter the areas, turn out to be more vulnerable than integrated ones. This is particularly pronounced in the middle and low-income areas. The road types, the dwellings' front door to front door visibility and the degrees of road accessibility all have a highly measurable influence on burglary distribution. The road accessibility is the most interesting and important feature, which thus confirms that more strangers or passers by in highly accessible areas can be beneficial as crime prevention mechanisms.

Keywords
residential burglary, income level, spatial configuration, space syntax

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1. Intention and Focus

This research, though not the first space-crime study in the Taiwan context[1], is in fact the first study on the influence of spatial layout on burglary patterns in Taiwan and it builds on and follows up earlier research on spatial layout and burglary in the British context (Shu, 2000, Hillier and Shu, 2000, Hillier and Shu, 1999). These earlier researches cast doubt on the defensible space theory proposed by Oscar Newman. Hence, a further study in a different context, i.e. in Taiwan, was proposed to see if similar results would be obtained which could provide further proof that the defensible space model needs to be reconsidered. A further purpose of this research is to see whether the spatial configuration has a significant influence on residential burglary patterns, other things being equal.

The causes of crime in urban space, particularly on housing estates, are also related to social factors and not only to spatial ones. Therefore, in space-crime analysis, it is necessary to control the social variable in order to detect the independent influence of space on patterns of crime. Only if, after examining estates with different social classes within the city, one finds that certain kinds of spatial patterns that commonly appear in all those estates have a relatively higher proportion of crime can one be sure that certain kinds of spatial properties do play an independent role for determining the clustering pattern of crime (burglary in this research).

Case studies are based on an affluent town in northern Taiwan. The town has been selected for study due to the availability of local police crime data for this research. Because of the confidential nature of the crime data this selected town has to remain anonymous and will therefore be called Town X in this paper. The crime data for Town X covers 8 months during 2001-2002. During that period a total number of 241 residential burglaries were registered with the police.

2. Analytical methodology

The analysis in this research project falls into two main parts: the area, and the detailed study. For the area study, three administrative districts are identified in the selected up-market town mentioned above. Our assumption is that area crime rates may relate to the numbers of passers by, which may become a deterrent to the offenders during their target selecting process. Since the space syntax method allows us to simulate the distribution patterns of pedestrians in areas, it is possible to carry out space crime studies by areas provided the social variable is controlled. As to the detailed study, by employing the space syntax method for configurational analysis of spatial layouts and by cross-examining spatial type and spatial syntactic variables and their relationships with burglary rates according to the exact location and most importantly the point of access (POA) off public space to the targeted dwellings, this research yields empirical evidence to clarify the correlation between the spatial features of housing layouts and the burglary distribution patterns. For detailed analysis three major elements are considered: the road types, the degree of road accessibility, which in turn may influence their pedestrian and vehicle flow, and the immediate surroundings of each dwelling. These three factors will be correlated to the corresponding crime rates and the joint effects of combined factors on crime distribution patterns (i.e. the situational crime rates) will be studied further at a thorough detailed level. From these research findings, several recommendations on spatial layout (such as street layout, dwelling layout, etc.) can be provided for crime prevention purposes.

3. Area study

Town X is divided into three administrative districts, called A, B and C respectively (Figure 1). District A, located in the northeast of Town X, has the lowest density of the three areas under consideration (1205 persons per square km) and is characterized as a farming area. District B, located in the south of Town X, is the historical centre of the town and is now its main commercial and administrative centre, i.e. houses the local government. District B's density (8237 persons per square km) falls in between that of Districts A and C. District C, located in the west of Town X, is mainly a residential area and has the highest population and density of the three districts (10395 persons per square km). At the periphery of District C one finds a recreation area, an amusement park, and educational facilities (university campuses).

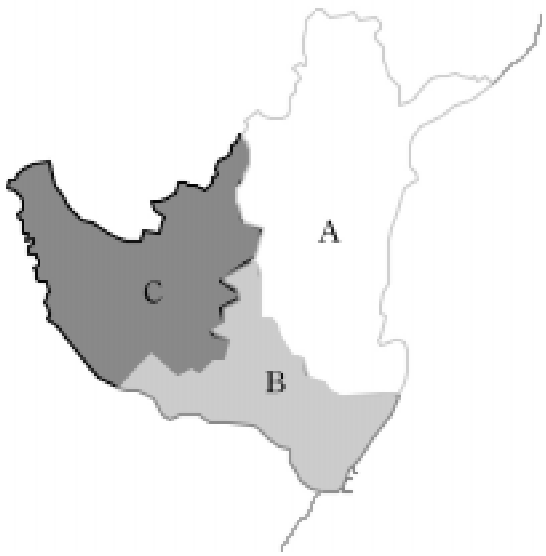

Figure 1: Three districts of Town X in northern Taiwan
(source: author)

The configurational analysis of Town X for the syntactic property of global integration of each line (Rn) is shown in Figure 2 below. Each line in the axial map shows the global integration value of the axial line with dark colours representing high integration values and thus high pedestrian flows whereas light grey colours represent low global integration values and low pedestrian flows. Local integration analysis (R5) for Town X is presented in Figure 3 below. Again dark colours represent high local integration values and lighter grey tones represent low local integration values.

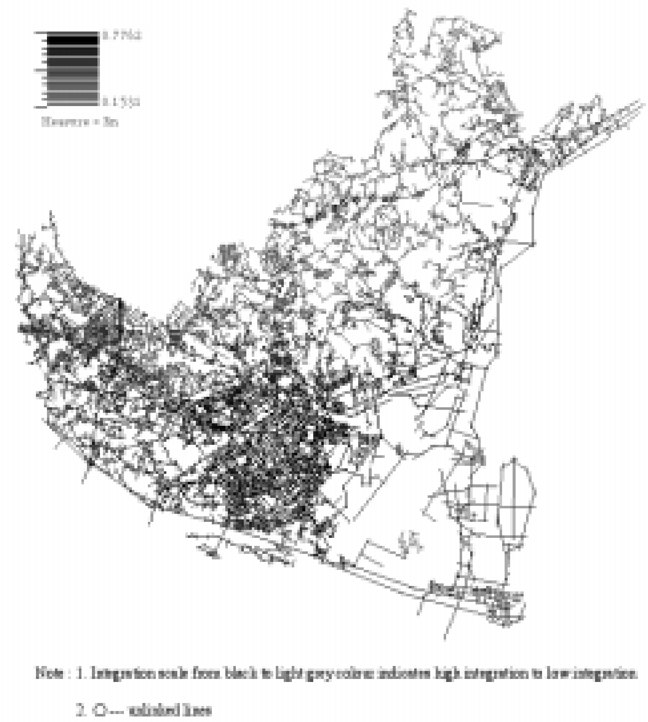

Figure 2: Global integration axial map of Town X in northern Taiwan
(source: author)

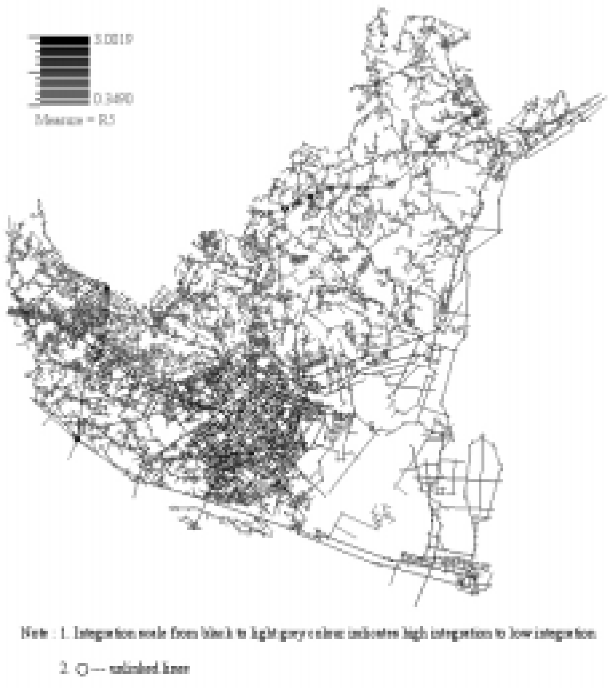

Figure 3: Local integration axial map of Town X in northern Taiwan
(source: author)

The area research is based on the neighbourhood concept because the Central Government of Taiwan gathers social data (such as index of income level) according to the neighbourhood system. Within the administrative districts there are a total of 121 neighbourhoods (District A 24, District B 44, District C 53) that have been classified according to income level. Town X has the second highest income level of all cities in Taiwan as it is one of the major centres for high tech industries. For this research project we have classified all neighbourhoods in Town X into three major groups according to their relative income level, i.e. low, middle and high. The neighbourhoods within each major income level group are further subdivided into four groups. There are thus twelve levels of income for neighbourhoods within Town X. The neighbourhoods have also been subdivided into twelve groups according to their mean global integration value Rn and into a further twelve groups according to their mean local integration value R5. The three scales (income, Rn and R5) operate on the same principle with level 1 representing a low value and level 12 being the highest value.

The area study falls into three parts. First we study the influence of the social variable, i.e. the correlation between the neighbourhood burglary rate and neighbourhood income level. In a second step we look at the syntactic values in relation to burglary rates, i.e. the correlation between the neighbourhood burglary rate against the neighbourhood mean Rn level and the correlation between the neighbourhood burglary rate and the neighbourhood mean R5 level. In the third stage, the most interesting one, we control the social variable and look at the correlation between the burglary rate and the global and local integration values for each of the three major income groups (Figures 4-5 for low income group, Figures 6-7 for middle income group and Figures 8-9 for high income group).

In this research the correlation between neighbourhood burglary rate and neighbourhood income level in Town X is very weak, i.e. R-squared: 0.009. This is different from the research carried out in Britain where high-income areas had low crime rates (Shu 2000a, chapter 3). This discrepancy between the Taiwan and Britain cases might be due to the fact that the Taiwan research project only uses one town and not three different ones as in Britain. Furthermore, it could also be that the twelve income levels within Town X are not sufficiently differentiated for results to be significant as Town X is generally an affluent town whereas in the British case income levels were much more differentiated.

In the second stage of the area study we consider the influence of the syntactic variables mean Rn and mean R5 for all neighbourhood groups. The correlation between mean Rn and neighbourhood burglary rates is not very strong, i.e. R-squared is 0.19, yet the correlation is much stronger than that for income level. For local integration mean R5 the correlation is R-squared: 0.178. Again a weak correlation can be observed. It seems that more integrated neighbourhoods, either locally or globally, that are more well connected to the system are slightly less vulnerable than those that are less integrated.

In the third stage of the area study we look at the different income groups. For the low-income group the mean Rn against burglary rate gives an R-squared value of 0.17 (see Figure 4). There is a correlation and the p-value (0.008) indicates it is significant. The local integration measure mean R5 versus burglary rate produces R-squared: 0.043, a weak correlation value that is not significant, p-value: 0.198 (see Figure 5). Therefore, for low-income group areas global integration is beneficial, i.e. more globally integrated low-income group areas are safer than more segregated ones.

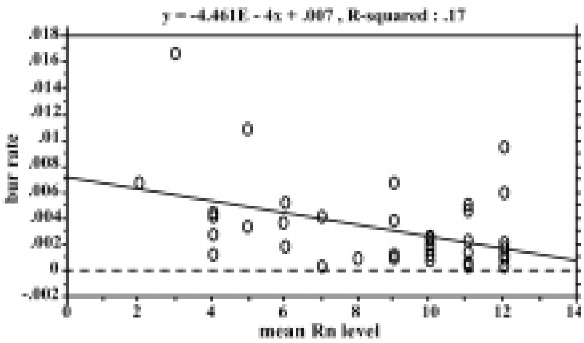

Figure 4: Scattergram of mean Rn against burglary rate in low-income group

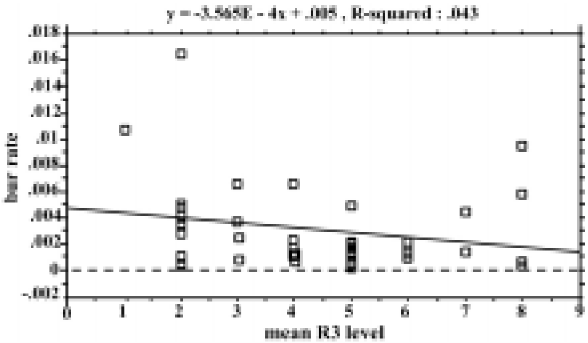

Figure 5: Scattergram of mean R5 against burglary rate in low-income group

For the middle-income group results are more pronounced. The middle-income group mean Rn against burglary rate results in an R-squared value of 0.192 and a p-value at 0.053 indicating a stronger and more significant relationship than is the case for the low-income group (see Figure 6). For the local integration measure mean R5 versus burglary rate for middle-income groups the results are R-squared 0.256 and p-value 0.023 indicating an even stronger and more significant relationship than for global integration (see Figure 7). For middle-income groups both global and local integration exhibit a more marked beneficial influence on burglary rates. More global and more local integration help make middle-income neighbourhoods safer.

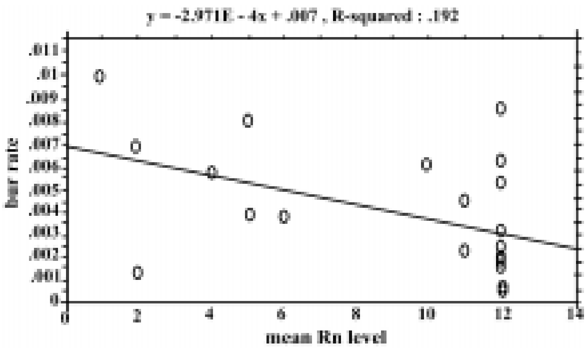

Figure 6: Scattergram of mean Rn against burglary rate in middle-income group

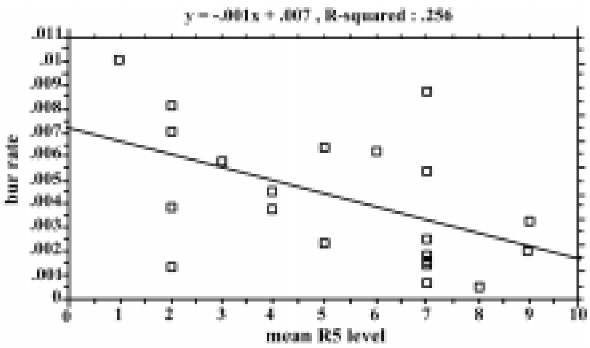

Figure 7: Scattergram of mean R5 against burglary rate in middle-income group

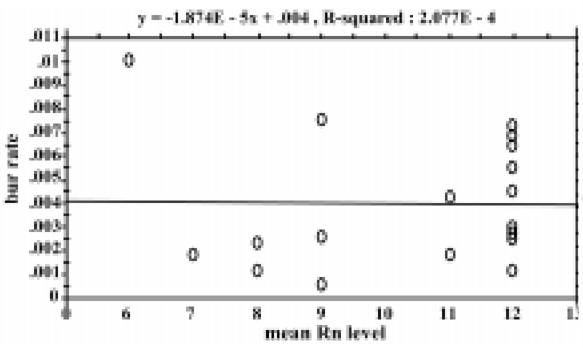

Figure 8: Scattergram of mean Rn against burglary rate in high-income group

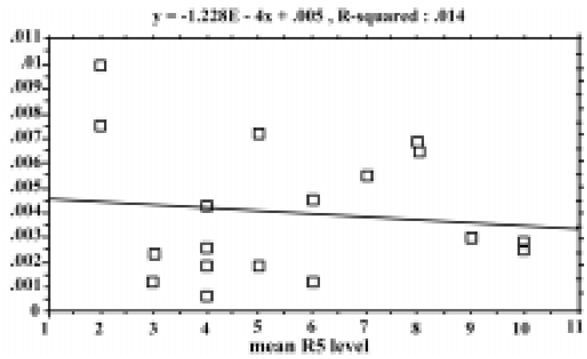

Figure 9: Scattergram of mean R5 against burglary rate in high-income group

Finally, the situation for the high-income neighbourhoods shows hardly any correlation between mean Rn and burglary rates: R-squared is 0.0002 and p-value is 0.955 (see Figure 8). For local integration mean R5 against burglary rate the result is similar, i.e. R-squared is 0.014 and p-value is 0.638 (see Figure 9). This result indicates that neither global nor local integration protect high-income neighbourhoods from burglary.

Global integration is beneficial for low-income and especially for middle-income areas, but not significant for high-income areas. Local integration is especially beneficial for the middle-income neighbourhoods. The reason why integration may not be beneficial for high-income areas could be related to other features, such as target-hardening, guards, CCTV and electronic alarm systems, which are more prevalent in the high-income areas of Town X. On the other hand, low- and middle-income group neighbourhoods in Town X do not have a large amount of these target-hardening features. It seems that the higher pedestrian flow in the more globally and locally integrated areas for low- and middle-income group neighbourhoods helps to protect them more since these neighbourhoods are safer when they are situated in more globally and locally integrated areas.

4. Detailed study

In the detailed study we focus our analysis on District C within Town X. The main reason for this choice is that it is the most densely populated area that also has the highest number of burglaries of the three districts in Town X. District C has a residential core in the southeast. In the west of District C you find the North-South freeway, which is surrounded on both sides by high-tech industrial zones. The northeast of District C is occupied by mountainous terrain.

In Figure 10 below one can observe the residential burglary distribution pattern for District C. Each dot on the map represents a burglary instance and was put on the map to the nearest axial line which provides the point of access (POA) off public space to the burgled dwelling.

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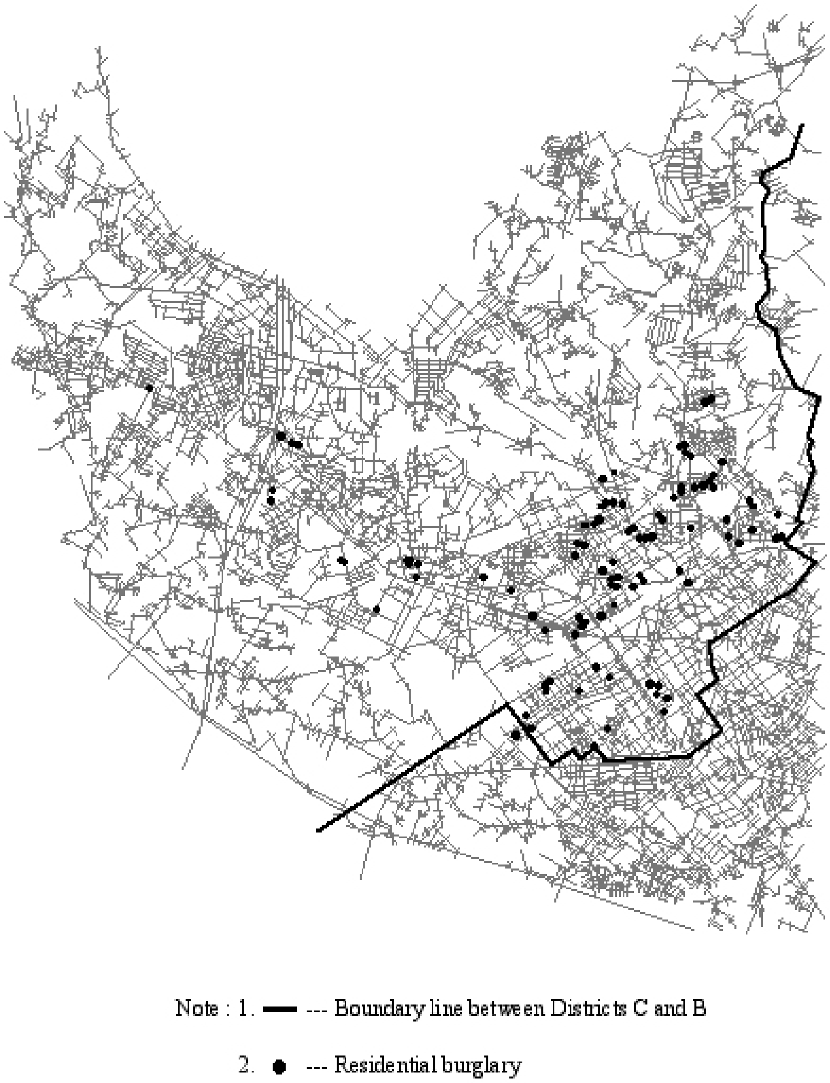

Figure 10: Residential burglary distribution map of District C in Town X

We have further distinguished 4 spatial types and 3 attributes within the study area. The spatial types are:

1. Through road: city main street of 8 metres wide or above wide allowing both pedestrian and vehicular movement
2. Through alley: city road of 4 to 8 metres wide which allows both vehicular and pedestrian access, the difference with the previous type is that this kind of road is more of a local road than a main road and has less traffic
3. Through footpath: road which is less than 4 metres wide, which only allows pedestrian access and which prohibits vehicular access in the Taiwan context
4. Cul-de-sac: private use road which in this particular case study is 6 to 8 metres wide and does not allow through access for vehicles.

The three attributes considered in this research are the spatial variable "constitutedness" and the syntactic variables "global integration" and "local integration":

1. Constitutedness (Con): This is defined as more than 50% of adjacent dwellings on one axial line having front door to front door visibility with no bushes, walls or other features obstructing the view between houses on both sides of the road.
2. Global integration (Rn): Global integration measures the accessibility of one axial line, i.e. the degree to which the line is linked to all other lines in the whole system. In the analysis below a distinction is made between high and low global integration with the mean set at 50%. High integration means that the line is highly accessible in the system.
3. Local integration (R5): Local integration measures the degree to which one axial line is linked to the other lines in the local system, i.e. R5 represents the degree of local accessibility of a line which only involves five steps from each line within the local system. A distinction is made between low and high local integration with the mean at 50%. High local integration means that a line is highly accessible on the local level.

The crime rate in this research has not been calculated as crime per line because this would provide us with an artificial result, since long lines with many dwellings would have lower crime rates than short lines with fewer dwellings. Instead the method used to calculate the crime rate is based on the total number of points of access for a particular type of line with specific attributes divided by the number of burglaries that occur on that type of line with those attributes. In this way the crime rate is represented by a fraction of one burglary against the number of points of access that have been violated[2] for lines of the same spatial type with the same attributes, i.e. the number of burglaries which occurred in the same situation or the situational crime rate. For example, the total number of lines of one specific road type with particular features is 160 and there are 2560 points of access and 12 burglaries on these 160 lines. The crime rate is then calculated as 12/2560 or 1/213, which means that on this type of road with those particular features one out of 213 points of access is burgled.

In the following space-crime detailed analysis we will first consider the effect of single attributes (Con/Rn/R5) on the crime rates for the spatial types discussed above. In a further step we will then consider the effect of combined attributes on the crime rates for the spatial types, both the effect of two combined attributes (such as Con+high Rn or high Rn+low R5 etc.) and the effect of three combined attributes (such as Con+high Rn+high R5 etc.). It is believed that the study of the combined effects of spatial types and attributes is the most detailed way for situational crime study.

4.1 Effect of single attributes.

The crime rates for the effect of single attributes are shown in Table 1 below. The overall crime rate for District C is 1/83. The first thing we consider is the road type (spatial type) on its own without any specific attributes. The safest spatial type is a through road with a rate of 1/153. The second safest is a through footpath (1/119), followed by a through alley (1/70). The most vulnerable spatial type is the cul-de-sac with a rate of 1/42. Through roads are more than three times safer than strictly cul-de-sacs. The cul-de-sacs in the study area are generally non-distributed ones with few connecting through footpaths. Hence, in general distributed roads or footpaths in Town X are better than the non-distributed ones (i.e. cul-de-sacs) as was the case in my previous study on British towns (Shu, 2000). The reason why the result of the through footpath category is so positive here might be related to the fact that there are relatively few through footpaths (21 axial lines on a total of 372) in the area of study and that they usually provide connections between through roads.

In the next step we look at each attribute separately for all spatial types considered together. Constituted spatial types (1/121) are twice as safe as unconstituted ones (1/59). Highly globally integrated spatial types (1/101) are almost twice as safe than more globally segregated spatial types (1/58). The same is true for highly locally integrated spatial types (1/92) which do better than less locally integrated ones (1/59). The influence of constitutedness, high global integration, and high local integration on burglary rates is positive. These results are similar to my previous study on three towns in Britain (Shu, 2000).

When we look at each spatial type separately and consider the influence of the single spatial attributes then the general result is reproduced, i.e. constitutedness, high global integration and high local integration make spatial types safer. The only exception is the influence of local integration on cul-de-sacs where highly locally integrated cul-de-sacs (1/29) are less safe then less locally integrated ones (1/48). This result is tentative and will be considered in the discussion of the combined effects of variables.

Table 1. Effect of single attributes on burglary in District C of Town X

Attributes	**Constitutedness**		**Rn**		**R5**		**Total**
Road Types	**con**	**uncon**	**High Rn**	**Low Rn**	**High R5**	**Low R5**	
Through Road	1/183	1/126	1/175	1/70	1/155	1/122	1/153
Through Alley	1/100	1/53	1/71	1/67	1/70	1/70	1/70
Through Footpath	0/177	1/30	0/161	1/38	0/49	1/94	1/119
Cul-de-sac	1/73	1/26	1/57	1/38	1/29	1/48	1/42
All Types	1/121	1/59	1/101	1/58	1/92	1/59	1/83

4.2 Effect of two combined attributes.

For two combined attributes we will only look at all spatial types together because the number of points of access for some subcategories are too small to provide meaningful results. It will be possible to look at results in more detail when more data is collected in other Taiwan cities in future further case studies.

First we consider the combined effect of constitutedness and global integration (see Table 2 below). All constituted spatial types are safer with high global integration (1/156) than with low global integration (1/79). This means that high global integration is beneficial to constituted spaces. When constitutedness and high global integration are combined for all spatial types the result (1/156) is better than for constituted spatial types (1/121) or for highly globally integrated spatial types (1/101) considered separately. Spatial types with strong door-to-door intervisibility (i.e. constitutedness) and which are highly integrated in the system are safer than others, i.e. they mutually reinforce each other.

Attributes	con+High Rn	con+Low Rn	Total
All Road Types	1/156	1/79	1/83

Table 2. Effect of combined attributes (constitutedness + global integration) on burglary in District C of Town X

When we combine constitutedness with local integration (see Table 3 below) then we get a similar result as for the combination constitutedness with global integration. All constituted spatial types that are also highly locally integrated (1/145) are much safer than constituted spatial types that are less locally integrated (1/91). High local integration is thus also beneficial to constituted spaces. When constitutedness and high local integration are combined for all spatial types the result (1/145) is better than for constituted spatial types (1/121) or for highly globally integrated spatial types (1/92) considered separately. Thus, constitutedness and local integration mutually reinforce each other.

Attributes	Con + High R5	Con + Low R5	Total
All Road Types	1/145	1/91	1/83

Table 3. Effect of combined attributes (constitutedness + local integration) on burglary in District C of Town X

In the next step we combine global and local integration to see how they influence each other (see Table 4 below). For all spatial types we see that when local integration is low, high global integration is helpful compared to low global integration (1/85 versus 1/59). When local integration is high, again high global integration has a beneficial influence compared to low global integration (1/104 versus 1/56). High global integration is thus not only beneficial to constituted spaces, but also to locally integrated spaces.

When global integration is high, high local integration is more helpful than low local integration (1/104 versus 1/85). However, when global integration is low, local integration does not provide any benefits as the burglary rate for highly locally integrated spaces (1/56) is nearly the same as for less locally integrated spaces (1/59). We conclude that global integration has a stronger beneficial influence than local integration.

Attributes	High Rn + High R5	High Rn + Low R5	Low Rn + High R5	Low Rn + Low R5	Total
All Road Types	1/104	1/85	1/56	1/59	1/83

Table 4. Effect of combined attributes (global + local integration) on burglary in District C of Town X.

4.3 Effect of three combined attributes.

Finally we look at the effect of three combined attributes (see Table 5 below). We add the attribute of constitutedness to the selections of the previous table (Table 4) and look at its influence. We note that when constitutedness is added all results improve. When constitutedness is added to high global integration and high local integration the burglary rate decreases from 1/104 to 1/162. When constitutedness is added to high global integration and low local integration the rate changes from 1/85 to 1/129. When we add constitutedness to low global integration and high local integration the rate decreases, from 1/56 to 1/79 and the same is true for constitutedness in relation to low global integration and low local integration, a change from 1/59 to 1/79. We can see that constitutedness is an attribute with a strong beneficial influence on reducing burglary rates, just like high global integration.

Attributes		**Con + Rn + R5**			**Total**
Road Types	Con + High Rn + High R5	Con + High Rn + Low R5	Con + LowRn + High R5	Con + LowRn + Low R5	
Through Road	1/177	0/0	0/55	0/0	1/153
Through Alley	1/158	1/115	1/61	1/73	1/70
Through Footpath	0/0	0/122	0/15	0/40	1/119
Cul-de-sac	1/56	1/50	0/0	1/87	1/42
All Types	1/162	1/129	1/79	1/79	1/83

Table 5. Effect of combined attributes (constitutedness + global integration + local integration) on burglary in District C of Town X.

5. Discussion

The results of the social variable influence on residential burglary for the area study are not very similar to the studies carried out in Britain (Shu, 2000a) and this might be related to the different social characteristic of the Taiwan society and the limitation of the study to one affluent town only. Further studies on different towns in Taiwan might shed a light on this issue.

The results for the detailed study show a remarkable resemblance with those from previous studies in Britain (Shu, 2000a). The fact that the findings of the space type influence on burglary rates is close to the British ones (i.e. through roads are much safer and cul-de-sac types are unsafe in the Taiwan context as in the British one) shows that the influence of the spatial types is important.

Furthermore, the influence of the three attributes (constitutedness, global integration and local integration) is also very similar and shows that constitutedness and global integration especially have a strong positive influence on the reduction of burglary rates. Well-connected through streets to the overall system are important in helping to protect dwellings from burglary. Door-to-door intervisibility between houses on both sides of roads is an important beneficial factor as well.

However, we should remember that the study of one district in one Taiwanese town is obviously not enough to provide us with clear-cut answers. More case studies in Taiwan need to be carried out to see whether this result is replicated and to provide even more in-depth analysis.

Notes

[1] Space-crime studies in Taiwan mostly focus on target hardening.

[2] For more details on the calculation of this crime rate see Shu 2000a and Shu 2000b.

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