



American Transactions on Engineering & Applied Sciences

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Natural Surveillance for Perceived Personal Security: The Role of Physical Environment

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ARTICLE INFO

Article history:
Received 11 April 2012
Received in revised form
25 June 2012
Accepted 16 July 2012
Available online 20 July 2012

Keywords:

Perceived Security;
Natural Surveillance;
Land Use;
Building Openings;
Lighting.

ABSTRACT

Natural surveillance by adjoining building occupants and public space users is one of the major strategies of crime prevention in public places. Lighting, vision through building openings and land uses around facilitate the surveillance by building occupants and public space users. This study inquires about the influence of mix of land uses and lighting of the area and the number of visible openings of adjoining buildings on the perceived personal security of people waiting at the bus stops during night hours. The detailed land use inventory, number of visible building openings and subjective assessment of lighting were recorded for the selected bus stops. The people waiting at the bus stops were interviewed to assess their perception of security. The results revealed that the perceived security is highest in bus stops from where more number of adjoining buildings openings are visible and located in areas with diverse mix of uses and good lighting. The land use mix of the area has a greater influence than lighting and visible openings on perceived security. This study demonstrates that the aspects of built environment contribute to perceived security and these aspects are to be considered in the location of bus stops.

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1. Introduction

Natural surveillance is one of the common principles recommended by various place based crime prevention theories such as defensible space, situational crime prevention and crime prevention through environmental design (CPTED) to alleviate incidence and fear of crime. Personal safety and security issues are prime concerns for people while waiting at the bus stops. Natural surveillance provided by adjoining building occupants and people on the streets enhances the perception of personal security of people waiting at the bus stops. Features of the physical environment play a major role in providing natural surveillance. Surveillance by adjoining building occupants depends on the number openings through which the people have direct view of the bus stop and also on the use of the interior spaces. The level of surveillance by people on the streets depends on the continuous presence of people which in turn depends on the level of mix of land uses of the area. At night time the surveillance is facilitated by provision of lighting so that the building occupants and people on the streets have clear visibility of bus stops. The previous studies have focused mainly on individual contribution of mix of land uses, lighting and unobstructed openings of surrounding buildings to surveillance and thus to perception of personal security, whereas the collective influence of these features were not dealt with. Hence this study is focused on (a) assessing the level of natural surveillance at bus stops offered by the mix of land uses, lighting and visible openings of surrounding buildings of the respective bus stop environments; (b) association between the level of natural surveillance and the rated perceived personal security at bus stops; and more importantly, (c) the influence of these features of bus stop environments on the perceived personal security of people waiting at the bus stops during night time.

2. Review of Literature

2.1 Natural Surveillance

Natural surveillance offered by features of the physical environment plays a significant role in alleviating the incidence of crime and enhancing the perceptions of personal security in public places. Jane Jacobs (1961), in 'The Death and Life of Great American cities' suggested that the eyes of those natural proprietors of the street must be scanning it all the time for a city street to be

successful. Oscar Newman's (1973) defensible space focused on natural surveillance in addition to territoriality, images and milieu. The basic principles of crime prevention through environmental design (CPTED) include natural surveillance together with image/ maintenance, natural access control and territorial reinforcement (Crowe, 2000). Natural surveillance consists of increased visibility of urban places directed at keeping intruders under observation and undesirable behaviour under control (Sorensen *et al.*, 2008). Natural surveillance of urban places is provided by occupants of the buildings around and the public on streets (Desyllas *et al.*, 2003). People feel more secure in areas with high surveillance due to the confidence that there are more chances for people to intervene or report crime if any. The offenders also look for desolated places since better surveillance make them feel more vulnerable as they may be identified or caught while committing a crime.

2.2 Natural Surveillance at Bus Stop Environments

Bus stops, being one of the important urban places, are expected to provide a safe and secure waiting environment for the people in addition to other needs such as visibility, easy access to the bus, and comfort and convenience of people. The concerns for personal security affect the travellers' decisions of what stops to use and their confidence in using those stops (Tucker, 2003). In bus stop settings also, natural surveillance provided by occupants of the building around and the public on the streets enhances the perceptions of personal security of people waiting at the bus stops along with other environmental design strategies. Research on bus stops revealed that low-crime bus stops offered better surveillance opportunities from surrounding establishments (Loukaitou-Sideris, 1999); and general lack of people and activity contribute to anxiety and fear that no one will be there to help if a crime occurs in transportation settings (Loukaitou- Sideris and Camille Fink, 2008).

2.3 Natural Surveillance and Physical Environment

Natural surveillance refers to the arrangement of physical design features involved with the activities and the people in order to maximise the opportunities for surveillance (Cozens, 2002). Desyllas, *et al.*, (2003) mentioned that the occupants of surrounding buildings provide surveillance by seeing public space from windows and building entrances. It may be assumed that the

surveillance from surrounding buildings depends on the number of unobstructed openings visible from the bus stops, in addition to the presence of people in the surrounding buildings. The buildings that are occupied by uses or activities that are functioning till late night hours ensure continuous presence of people in the buildings and thus provide a continuous surveillance. Vogel and Pettinari (2002) argued that the street level commercial activity and upper level residential activity provide round the clock activity and eyes on the street, whereas public buildings such as post office, fire station etc., fall short of providing activity and eyes on the street after working hours.

To provide natural surveillance of urban places, there need to be continuous presence of people on streets. Jacobs (1961) advocated diverse land use streets so that there is a continuous flow of people enhancing natural surveillance on city streets. Angel (1968) asserted that with higher levels of activity, crime falls because there are enough people to assure informal surveillance of the site (Robinson, 1999). Diverse mix of land uses ensures some or other activities being carried out for most part of the day, which in turn increase the continuous presence of people on streets all the time. Areas with poor mix of land use or single use areas become deserted during certain hours of the day creating a suitable environment for the criminal activities. Thus the mix of land uses in surrounding buildings of bus stops contributes to both surveillance provided by the occupants of surrounding buildings and people on streets.

Atkins *et al.*, (1991) noted that lighting will encourage noticing suspicious activities and increasing opportunities for surveillance. During night hours good lighting improves the visibility and also reduces the fear of general darkness which, in turn, encourages increased street usage by the people. Both enhanced visibility and increased street usage may enhance possibilities for natural surveillance (Welsh and Farrington, 2009). It is understood that the features of the physical environment - mix of land uses, unobstructed openings and lighting independently influence the level of natural surveillance offered by that environment and thus impact the perceptions of personal security of people waiting at the bus stops. However the collective influence of these features of the physical environment on the level of natural surveillance and perceptions of personal security of people need to be investigated.

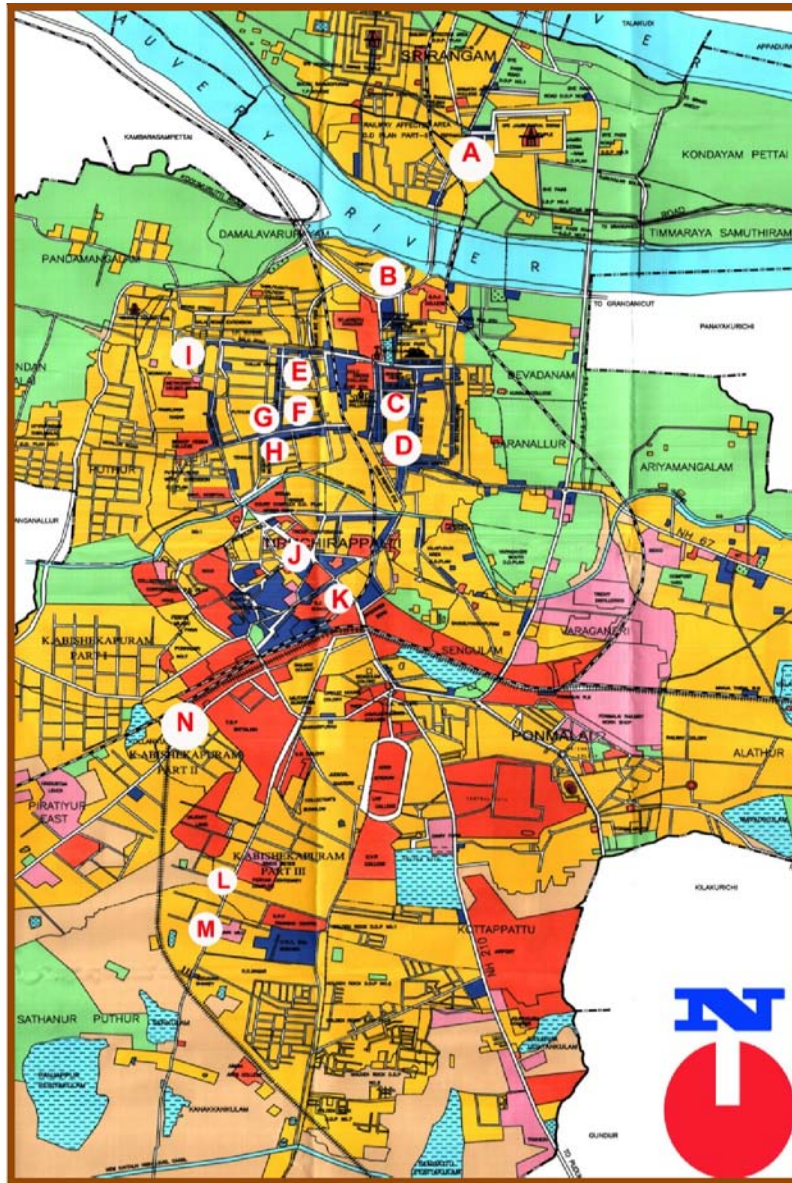


Figure1: Map of Tiruchirappalli showing the bus stops locations.

3. Method

3.1 Selection of Bus Stops

The bus stops in Tiruchirappalli, the fourth largest city in Tamil Nadu state India with an approximate population of 1 million in the year 2010, were selected for the present study. Based on the study of night time photographs of all bus stops within Tiruchirappalli city corporation limits,

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14 bus stops were selected. Bus stops with varying levels of mix of land uses, area lighting levels and visible openings of the surrounding buildings were considered for the selection. The selected bus stops are labelled from A to N in Figure 1.

3.2 Features of Physical Environment

In this study three physical environmental measures i.e. mix of use, street lighting and visible openings of the surrounding buildings were considered for determining the level of surveillance in the bus stops. Features of physical environment of bus stops were rated by five trained under-graduate students of Architecture by visiting the bus stops between 6pm and 9pm.

3.2.1 Mix of Land Uses

A detailed inventory of uses, within an area measuring approximately 45m radius around the bus stops were undertaken, by counting the number of establishments in a particular land use classification and in the case of commercial activities the type of business and the size (small, medium, and large) of the establishments were also recorded. Three Architect- Planners independently rated the bus stops taking into consideration the mix of different land uses, scale and types of commercial activities in the surrounding area, and the number of people present in the vicinity of bus stops environments. Thus the bus stops were categorized in to three groups, namely bus stops with good, medium and poor mix of land uses as stated below:

Bus stops with good land use mix: B, F, G and H

Bus stops with medium land use mix: A, C, D, E, I, J, K and N

Bus stops with poor land use mix: L and M.

3.2.2 Lighting

A subjective assessment of lighting at bus stops and their immediate environment was carried out by recording the uniformity of lighting (absence of dark spots) on a five point scale ranging from very good (5) to very poor (1). Based on the analysis of uniformity of lighting, the bus stops were classified into two groups as stated below:

Bus stops with good lighting: A, B, E, F, G, H, I and N

Bus stops with poor lighting: C, D, J, K, L and M

3.2.3 Openings of Surrounding Buildings

Building wise number of open, glazed (fully transparent) and lit openings of surrounding buildings within 15m radius that were clearly visible from the bus stops (not obstructed by physical features) were independently counted by the students. Types of openings include open or transparent shop fronts, doors and windows of other establishments. The bus stops were dichotomised into two groups about the mean value of number of visible openings of buildings. The bus stops were grouped as stated below:

Bus stops with more openings: B, E, F, G, H, I and N

Bus stops with less openings: A, C, D, J, K, L and M.

3.3 Features of Physical Environment

Based on levels of mix of land use, lighting and number of visible openings of surrounding buildings, the bus stops were categorised in to five groups (refer Table 1). Following assumptions were made on level of surveillance at bus stops: very good in bus stops B, F, G and H; good in bus stops E, I and N; medium in bus stop A; poor in bus stops C, D, J and K; and very poor in bus stops L and M. Based on the level of surveillance it was expected that the people would rate B, F, G and H as very safe; E, I and N as safe; A as neutral; C, D, J and K as unsafe and L and M as very unsafe bus stops.

Table 1: Classification of bus stops based on elements of physical environment.

Land Use	Good Lighting		Poor Lighting	
	More Openings	Less Openings	More Openings	Less Openings
Good Mix	B, F, G and H	-	-	-
Medium Mix	E, I and N	A	-	C, D, J and K
Poor Mix	-	-	-	L and M

3.4 Participants and measure of Perceived Personal Security

The perceived personal security was measured by asking the people waiting at the selected bus stops to report their concerns about personal security against crime and nuisance behaviour during night hours. The respondents were asked to rate their concerns about personal security on 5-point

scale ranging from very high (1) to not at all (5). The respondents were also asked about their opinion about the contribution of land use mix around bus stops, area lighting and the visible openings of the surrounding buildings for the personal security of people waiting at the bus stops on a 3- point scale ranging from contribute to safety (3) to problem for safety (1). The survey was carried out after dark between 6 p.m. and 9.30 p.m. The total sample consisted of 453 people and the number of people surveyed in each bus stop varied from 26 to 42. The sample consisted of 205 male and 248 female; and 34 people above 50 years of age, 213 people in the range of 31-50 years of age, and 206 people below 30 years of age.

4. Findings and Discussion

4.1 Grouping of Bus Stops based on Perceived Security

The mean perceived personal security levels at the bus stops are given in Table 2. Simple Analysis of Variance (ANOVA) revealed significant differences [F (13,439) =6.098, p<.001] in the reported perceived security levels of people among the bus stops. Based on the post-hoc analysis of bus stops level perceived security of people, the bus stops were categorised into five groups as described below: B and F as very safe; G and H as safe; C, E, I and N as neutral; A, D, J and L as unsafe; and K and M as very unsafe bus stops.

Table 2: Perceived personal security levels at bus stops.

Bus stop	A	B	C	D	E	F	G
Perceived Personal Security	3.59 _{bc}	4.34 _a	3.75 _{abc}	3.55 _{bc}	3.84 _{abc}	4.34 _a	4.13 _{ab}
Bus stop	H	I	J	K	L	M	N
Perceived Personal Security	3.94 _{ab}	3.73 _{abc}	3.63 _{bc}	3.47 _c	3.56 _{bc}	3.24 _c	3.86 _{abc}

Note: Means with same subscript did not differ significantly from each other, whereas means with different subscript differ significantly from each other.

4.2 Comparison of Surveillance and Perceived Security of People at Bus Stops

The individual bus stops with their rated safety level and the mean perceived security levels of bus stops groups based on the level of surveillance are given in Table 3. Simple Analysis of Variance (ANOVA) carried out revealed that there was a significant difference [F (4,448) =16.475, p<.001] in the perceived security level of people between the bus stops groups. Post-hoc analysis

revealed that the mean perceived security level of people in bus stops group with very good surveillance was significantly higher than that of other groups, whereas the mean perceived security level of people in bus stops group with very poor surveillance was significantly lower than that of bus stops groups with very good and good surveillance.

On comparison of level of perceived security of people at individual bus stops with the respective level of surveillance the following were noticed:

- a) Out of the four bus stops with very good surveillance (good mix of uses, good lighting and more openings), bus stops B and F were rated as very safe; and G and H were rated as safe bus stops.
- b) Bus stops E, I and N with good surveillance (medium mix of uses, good lighting and more openings) were rated as neutral bus stops.
- c) Bus stop A with medium surveillance (medium mix of uses, good lighting and less openings) was rated as unsafe bus stop.
- d) Out of the four bus stops with poor surveillance (medium mix of uses, poor lighting and less openings), bus stop C was rated as neutral, bus stops D and J were rated as unsafe and K was rated as very unsafe bus stops.
- e) Bus stops L and M with very poor surveillance (poor mix of uses, poor lighting and less openings) were rated as unsafe and very unsafe bus stops respectively.

Table 3: Mean perceived personal security of bus stops groups based on surveillance.

Surveillance	Bus Stops	Rated Safety Level	Mean Perceived Security
Very Good	B and F	Very Safe	4.18 _a
	G and H	Safe	
Good	E, I and N	Neutral	3.81 _b
Medium	A	Unsafe	3.59 _{bc}
Poor	C	Neutral	3.59 _{bc}
	D and J	Unsafe	
	K	Very Unsafe	
Very Poor	L	Unsafe	3.40 _c
	M	Very Unsafe	

Note: Means with same subscript did not differ significantly from each other, whereas means with different subscript differ significantly from each other.

These findings largely confirm the assumptions except in the case bus stop A with medium surveillance was rated as unsafe whereas the bus stop C with poor surveillance was rated as neutral bus stop. It was also noticed that the mean perceived security of people did not vary significantly among bus stops groups with very medium, poor and very poor surveillance. On comparison of individual features and perceived personal security level at bus stops, the following were observed:

- a) Bus stops located in areas with good mix of uses were rated as very safe and safe bus stops, the bus stops located in areas with medium mix of uses were rated as neutral, unsafe and very unsafe bus stops and bus tops located in poor mix of uses were rated as unsafe and very unsafe bus stops.
- b) Bus stops with good area lighting were rated as very safe, safe, neutral and unsafe bus stops; and bus stops with poor area lighting were rated as neutral, unsafe and very unsafe bus stops.
- c) Bus stops with more number of visible openings of surrounding buildings were rated as very safe, safe and neutral bus stops; and bus stops with less number of visible openings of surrounding buildings were rated as neutral, unsafe and very unsafe bus stops.

From these observations it may be assumed all the three features of bus stop environments had more or less similar affect on the perceived security of people at bus stops.

4.3 Peoples' Opinion about the Contribution of Features of Physical Environment for the Personal Security

The respondents' opinion about the contribution of features of physical environment for the personal security was analysed at the bus stops group level of each of the features independently. In case of land use the chi-square test revealed a significant association [$\chi^2(4) = 41.683, p < .001$] between the level of mix of land uses and the peoples' perception about the contribution of surrounding land uses to the personal security. The percentage of people expressed that the surrounding uses contribute to the personal security was 69.5% in bus stops group with good mix of uses; 40.5% in the group with average mix of uses; and 32.5% in the group with poor mix of uses. In case of lighting the chi-square test revealed a significant association [$\chi^2(2) = 93.115, p < .001$] between the quality of lighting and the peoples' perception about the contribution of lighting to the personal security. The percentage of people expressed that lighting contribute to personal security was 27.2% in bus stops group with good lighting and only 1.5% in the bus stops group

with poor lighting. In both bus stops groups majority of people expressed neutral about the contribution of lighting to personal security. In case of openings the chi-square test revealed a significant association [$\chi^2(2) = 49.650, p < .001$] between the number of visible openings and the peoples' perception about the contribution of openings to the personal security. In bus stops group with more number of visible openings 31.8% of the people expressed that the openings contribute to personal security; and in the group with less number of openings 47.5% of the people expressed that the lack of openings were problem for personal security. Therefore it may be concluded that there was clear association between the level of physical features and peoples' opinion about the contribution of these elements to their personal security while waiting at the bus stops.

To establish the relative importance of these physical features in predicting the perceived security of people at bus stops multiple regression analysis was conducted taking the respondents' opinion about contribution of land use, lighting and visible openings of buildings to personal security as independent variables. Land use yielded the highest beta weight of all the independent variables (0.370), followed by lighting, (0.211) and openings (0.147). The adjusted R^2 was 0.288, suggesting that twenty nine percent of the variance in perceived personal security was explained by the independent variables in this model (refer Table 4). The R^2 value 0.288 shows low linear relationships between the independent variables and the dependent variable. However, the model is statistically significant at the .001 level and such low R^2 value was noticed in similar studies.

Table 4: Regression analyses.

Variables	B	Std Error	Beta
Constant	2.056	.131	
Land Use	0.416	.047	.370*
Lighting	0.248	.051	.211*
Openings	0.164	.048	.147*

N=453; Adjusted $R^2 = 0.288$; F = 62.047; $p < .001$

* $p < .001$

5. Conclusion

This study established that the features of the physical environment- mix of land uses, lighting and unobstructed openings of surrounding buildings provide natural surveillance and thus enhance

the perceptions of personal security of people waiting at the bus stops during night time. Though the findings largely confirm the assumptions, the minor variation in the association between the levels of natural surveillance and perceived personal security could be mainly because the perception of personal security is not solely dependent on surveillance and also on the interactive effect of various other environment cues. The perceptions of personal security also seem to have significant relationship with each of the features of the environment. The peoples' opinion about the contribution of these individual features to the personal security of people waiting at the bus stops was significantly related to the level of the individual features. Though all three features seem to clearly predict the perceived security during night time, land use mix seems to be the most influential, followed by lighting and visible openings of surrounding buildings. Each environmental feature contributes to more than one environmental design strategies that influence the perceptions of personal security. For example lighting contributes to natural surveillance and also helps to reduce concealment spots. Larger study on this subject is required as the perceptions of personal security are influenced simultaneously by various aspects of environmental design. Hence this study can be expanded to investigate the impact of land use mix and various other environmental features on peoples' perceptions of personal security in bus stop settings with an objective to formulate guidelines for location and design of bus stops.

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Peer Review: This article has been internationally peer-reviewed and accepted for publication according to the guidelines given at the journal's website. Note: This article was accepted and presented at the 2nd International Conference-Workshop on Sustainable Architecture and Urban Design (ICWSAUD) organized by School of Housing, Building & Planning, Universiti Sains Malaysia, Penang, Malaysia from March 3rd -5th, 2012.