

# Verification of Connection Between Legibility and Conviviality of Public Open Spaces- A Case of New Market, Bhopal

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## ABSTRACT

Conviviality refers to happy and friendly coexistence. Public open spaces bring people together. They are considered as convivial when people feel joyful and lively while visiting them. Several studies suggest that physical qualities of a public open space can influence their conviviality. Legibility is considered as one of the most important physical qualities of urban spaces. Due to better legibility a space becomes more visible and accessible. Therefore, legibility increases the value of a public open space as a gathering place. To understand the role of legibility in bringing conviviality to a public open space, a perception survey is carried out at eight public open spaces in New Market, Bhopal. The data gathered from the perception survey is analysed with ANOVA and correlation tests on SPSS to determine the variance and correlation between perception of people regarding ease of locating a selected open space and overall conviviality of a public open space. To measure the physical dimension of legibility of the public open space, a space syntax tool known as visibility graph analysis in depthmap X software is used. The approach adopted in this study helps to understand public perception about legibility and conviviality of public open spaces and outcome is analysed with the help of space syntax tool.

*Key words* : Conviviality, Legibility

## Introduction

Conviviality of a place is determined by the lively engagement of people at a place. Legibility of a public space helps people to easily locate and reach to a place. Therefore, legibility increases chance of engagement between people at a place. There are studies which discuss the importance of legibility in urban spaces but do not address its empirical impact on conviviality (Banerjee, 2001; Shaftoe, 2008). The objective of this study is to empirically verify whether legibility of the public open spaces can affect the conviviality of the place.

This study is a part of a larger work which examines the impact of physical qualities of public open

spaces on conviviality. As a part of methodology of the study of relationship of conviviality and legibility, a perception survey was carried out to gather information regarding public perception about eight public open spaces at cognitive, affective, and interpretative stages. In this paper, the discussion is focused on results related to ease of locating a public open space and overall conviviality of the place. To objectively examine legibility at a selected public open space, a space syntax tool- visibility graph analysis developed by the depthmap X software is used.

In urban design legibility and conviviality are vast and complex topics to discuss. Therefore, with the help of literature the idea and context of both the

topics are presented. The discussion is followed by methodology adopted for the study and introduction of case study. The perception survey responses are analysed using ANOVA and correlation test. The results of visibility graph analysis are discussed with perception survey results.

### Conviviality

A convivial society appreciates the presence of others. In the company of others, people find satisfaction and happiness for their participation and representation which they could not experience and gather in isolation (Abspoel, 2017). Conviviality could be part of several domains such as workplace, home, social places. At public open spaces conviviality represents health of society (Shaftoe, 2008). Public places that induce anxiety or fear among people are unhealthy. Behaviour like just catching up with friends, passing by, staying for a while, having some food or drinks or could be just watching people is healthy, lively and convivial (Whyte, 1980). The convivial atmosphere geared up with activities like festivities, street performances, and street vendors selling goods at a place (Gehl, 2010). It is often seen that few public open spaces gather the character of conviviality whereas some spaces become dull and uninteresting. This phenomenon creates an interest to understand whether location or other physical qualities can make a place convivial or not. If yes, then does legibility of a public open space contribute to increasing conviviality of a place? To answer this question, first we will discuss the term legibility in the next section.

### Legibility

Legibility is defined as the ease with which the mind can organize an environment within an imageable and coherent pattern. It helps in cognition while orienting oneself in an environment by following easily recognizable elements of the built environment. Lynch (1960), in his iconic study of how people perceive image of the city found that people save mental images of spaces and divide their imagination into districts, paths, nodes, landmarks, and edges as elements of the built environment (Lynch, 1960). The simple, coherent, understandable, and perceivable environment is considered as the legible environment (Tibbalds, 2001). Statues, historical characters, distinct trees, etc. identify with local culture and historical background, also act as landmarks which eventually increase legibility of the place (Behnush,

2017). However, well-designed and managed a public space is, but if it is in an isolated, under populated or difficult-to-access location it may not thrive due to lack of legibility (Shaftoe, 2008). Visual connection helps to increase legibility of a public open space. Town centres or popular nodes usually become convivial as they are visually more well integrated in the network of streets.

To objectively understand the role of legibility, some researchers have discussed the evaluation methods of measuring legibility (Nothegger *et al.*, 2004; Raubal and Winter, 2002). The measurement of legibility can be done with 2d (two dimensional) and 3d (three dimensional) features. Saliency of Landmarks in Public open space act as 3d aspect of legibility whereas visibility due to space integration in layout planning or due to layout complexity act as 2d aspect of legibility (Koseoglu and Onder, 2011). In this paper the legibility of public open space is addressed through 2d aspect. Space syntax is a popular tool which produces results based on convexity of nodes in layout (Nes, 2014). Space syntax helps to analyse a 2d layout whose results can quantify how much a public open space is visible. Space syntax applies the concept of configuration in urban spaces to discover social patterns and structures. Space syntax software depthmapX therefore provides such opportunity to evaluate visual connectivity through spatial layout in visual graph analysis.

### Method

This study compares the results of perception survey and results of space syntax analysis: an objective measurement to examine relationship between ease of locating and conviviality of a public open space. A space which is likely to be visible due to its location in street network creates its own viable landmarks. In this study the measure of legibility is evaluated with a method which calculates its visibility in street network. Therefore, legibility is measured with the help of visibility graph analysis.

### Perception survey for conviviality of public open spaces

Perception survey helps to understand the public opinion related to a concern. As conviviality is a subjective topic and its evaluation depends on user's individual experience, social background, personality etc. In this case a perception survey has helped to gather the subjective responses that can state whether a public open space is convivial or not. This

study utilized a part of data collected in the perception survey which is designed to gather responses on cognitive, affective, and interpretative stages of perception of conviviality at a public open space. The perception survey was carried out with the people belonging to different /locations of the city. Respondents were included from all sections of age, gender, locality, and occupation. The survey was administered with the help of google forms. Respondents were asked to respond questions based on their memory and experiences of the selected public open spaces from New Market, Bhopal.

The main survey covers public responses on several physical built environment qualities of public open spaces. In this study the ease of locating a destination and overall convivial perception are two dependent variables, concerning eight selected public open spaces for the independent variable-built environment. The question and responses related to legibility and overall conviviality are mentioned in table 1. The responses were sought on a Likert scale from 1-5 as given in Table 1. The research explores whether variations in the perception of conviviality of public open spaces are associated with differences in ease of locating public open spaces.

To investigate these two dependent variables, ANOVA- analysis of variance and Correlation tests were applied on 544 opinions where each public open space act as a group of 68 responses. ANOVA

will help to establish whether there is a significant variation in ease of locating or overall conviviality due to change in the location of public open spaces. If the hypothesis, whether a particular location has significant impact on ease of locating and overall conviviality is true, then there is a strong possibility of a higher degree correlation between these two factors. Further the results are discussed with objective measurement of legibility by visibility graph analysis.

**Visibility graph analysis**

Visibility Graph Analysis (VGA) is a space syntax method for quantifying socio-spatial properties of the built environment by mapping the floor plan into a grid. DepthmapX is a program designed to perform visibility graph analysis of spatial environments. DepthmapX allows a user to import a 2D layout in drawing exchange format (DXF), and to fill the open spaces of this layout with a grid of points. The user may then use the program to make a visibility graph representing the visible connections between those point locations. The program attempts to find all the visible locations from each grid location in the layout one by one and uses a simple point visibility test radiating from the current location to achieve this. In the algorithm, graph set notation:  $V(G)$  is the set of all locations or vertices that exist, and  $v_i$  an individual location or vertex in the

**Table 1.** Questions and response scale

Q no.	Question	Responses on Likert scale
Q1	How convenient it is to locate the following Public open spaces?	Very difficult-1, difficult-2, convenient-3, easy-4, very easy-4
Q2	Kindly indicate the overall friendliness and welcoming quality of following Public open spaces?	Not at all-1, low-2, moderate-3, high-4, very high-5

**Table 2.** Mean and standard deviation

Public open space	No. of responders (N)	Means		Standard deviation	
		Ease of locating	Overall conviviality	Ease of locating	Overall conviviality
TNT	68	3.7500	3.1324	1.1113	1.220
SBI	68	3.5735	2.5735	.9668	1.225
SC	68	3.1618	2.3235	1.04539	1.274
GTB	68	3.3382	2.5588	.94015	1.137
Street1	68	3.4412	3.1618	1.11144	1.114
Street2	68	3.3088	3.0588	1.14940	1.104
Street3	68	3.4118	2.7941	1.06834	1.228
Street4	68	3.2500	2.8676	1.07029	1.232
Total	544	3.4044	2.8088	1.06772	1.219

graph. Each vertex  $v_i$  will have a set of vertices connected to it, which will label the set  $V(\tilde{A}_i)$ , otherwise known as the vertex's neighbourhood. The number of vertices in the neighbourhood is easily calculable, and depthmapX records these neighbourhood sizes as it makes the graph. In graph theory, the neighbourhood size for a vertex is commonly written  $k_i$  and may be expressed as in equation 1.

$$k_i = |V(\tilde{A}_i)| = |v_j : \{v_i, v_j\} \in E(G)| \dots(1)$$

where  $E(G)$  is the set of all edges (i.e., visibility connections) in the graph (Turner, 2001).

Analysis of the graph is split into two types: global measures (which are constructed using information from all the vertices in the graph) and local measures (which are constructed using information from the immediate neighbourhood of each vertex in the graph). In this study we have adopted global measures. The street network for 2d layout is obtained from open source i.e. Open Street Map.com. The street network was digitised in the Auto CAD version 2013 to be used for a depthmapX software.

**Case study**

The main study is focused on experience of those public open spaces which are used every day. Thus,



Fig. 1. Location of Bhopal city in India



Fig. 2. Location of new market in Bhopal city.

a marketplace was chosen, as case study. Market places are accessed by common man of the city and host everyone from the society irrespective of religion, gender, or age group. They represent the true democratic contemporary social fabric of Indian cities. People visit market places mostly for necessary purposes but it also give opportunity of optional and convivial activities (Gehl, 2010).



Fig. 3. Location of selected eight public open space in Bhopal

Bhopal is capital of state of Madhya Pradesh located in central region of India (see Fig 1). The case study considered eight public open spaces in new market in Bhopal (see Fig 2 and 3). New market is a popular, centrally located market of Bhopal city, established around 1970's. It caters to the new and regular visitors from across the city. It is a destination for all sorts of necessary, occasional, and social activities apart from being a major shopping zone. Therefore, public open spaces in new market represent contemporary day to day public spaces (see Figs. 4-11).

**DATA Analysis**

Data analysis is carried out at descriptive level using graphical presentation, mean and standard deviation. Then use of ANOVA and correlation coefficient is applied. The statistical explanation is further discussed with results of visibility graph analysis.

**Graphical representation**

The graphs in Fig 12 and Fig 13 represent the results of a perception survey carried out with 68 sample sizes for eight public open spaces. Graphs suggest that maximum participants have judged the eight public open spaces as convenient or easy to locate,





Fig. 4. Public open space 1 - TNT



Fig. 8. Public open space 5 - Street 1



Fig. 5. Public open space 2 - SBI



Fig. 9. Public open space 6 - Street 2



Fig. 6. Public open space 3 - SC



Fig. 10. Public open space 7 - Street 3



Fig. 7. Public open space 4 - GTB



Fig. 11. Public open space 8 - Street 4

whereas the conviviality judgment for same places is moderate.

**Mean and standard deviation**

The mean value of response in selected eight public open spaces is mentioned in Table 2 which suggests that value of ease of locating is higher than overall conviviality in Likert scale for all the cases. TNT plaza has received the highest mean value for overall conviviality and ease of locating response. The standard deviation suggests the spread of responses among responders which appears almost similar in overall conviviality and ease of locating responses. This data suggests that the relationship between ease of locating response and conviviality judgment still needs more clarity, for which the variance between responses is judged using ANOVA to explain whether change in location of public open spaces can affect response related to legibility and conviviality.

**Anova- Analysis of variance**

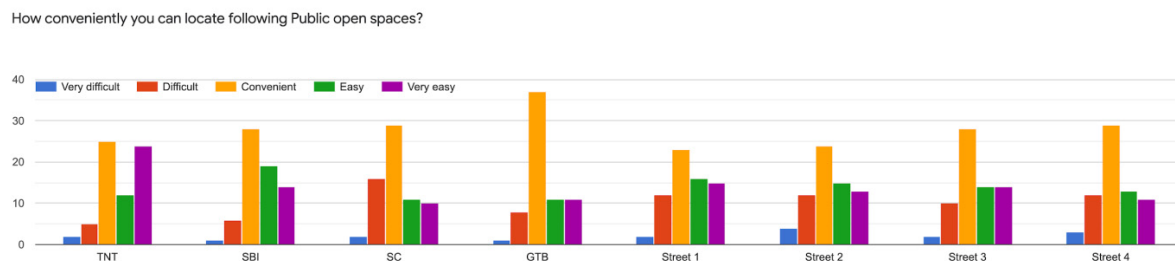
ANOVA is preferred in perception-based studies such as marketing, product performance and likewise urban design. One-way ANOVA helps to investigate the impact of one independent factor on dependent factors. In this case ANOVA tries to in-

vestigate whether changing location of public open spaces causes any impact on response related to ease of locating and overall conviviality of the selected public open spaces. The null hypothesis is that the change in independent variable (in this case location of public open spaces) will have responses equal or almost the same for both the dependent variables (i.e. ease of locating and conviviality judgement). ANOVA is analysed using the SPSS tool.

Table 3 and 4 shows the output of the ANOVA analysis. If the null hypothesis is true, it is expected F to have a value less than 1.0. A large F ratio more than 1 means that the variation among groups means more.

Table 3 shows ANOVA analysis for ease of locating responses, the significance value is 0.04 (i.e.,  $p = 0.04$ ), which is below 0.05. and, therefore, there is statistically significant difference in the means of ease of locating response. Also, the F value is greater than 1 which signifies that an alternative hypothesis should be accepted in this case. Therefore, there are significant differences in ease of locating the selected eight public open spaces.

Table 4, shows ANOVA analysis for conviviality judgement, the significance value is 0.00 (i.e.,  $p = .00$ ), which is below 0.05. and, therefore, there is statistically significant difference in the means of con-



**Fig. 12.** Response on ease of locating for selected public open spaces

**Table 3.** ANOVA analysis for ease of locating

	Sum of squares	df	Mean Square	F	Sig.
Between groups	16.706	7	2.387	2.124	.040
Within groups	602.324	536	1.124		
Total	619.029	543			

**Table 4.** ANOVA analysis for Overall conviviality

	Sum of squares	df	Mean Square	F	Sig.
Between groups	44.118	7	6.303	4.422	.000
Within groups	764.00	536	1.425		
Total	808.118	543			

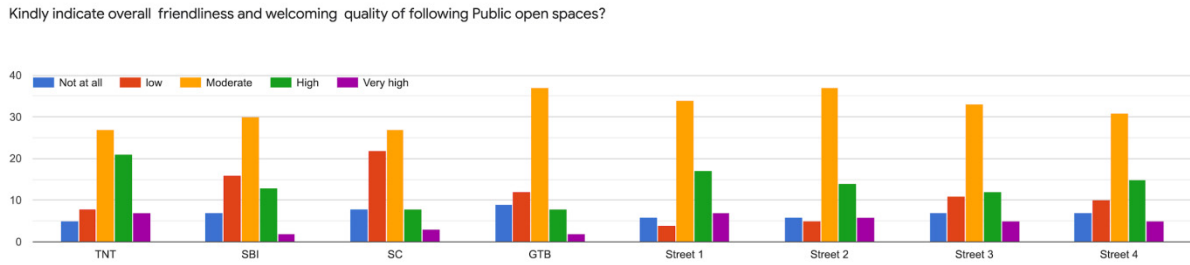


Fig. 13. Responses on overall conviviality for selected public open spaces

viviality judgment. Also, the F value is higher and more than 1 which signifies that the alternative hypothesis should be accepted in this case also. Therefore, there is significant variation in responses in conviviality judgement of selected public open spaces. These significant variations in responses of both the dependent variables results in suggesting strong relation between them is examined through correlation tests.

**Correlation**

Pearson’s correlations between ease of locating and conviviality judgement are detailed in Table 5. Pearson’s correlation coefficient measures the strength and direction of the relationship between two variables. A correlation of -1.0 shows a perfect negative correlation, while a correlation of 1.0 shows a perfect positive correlation. The coefficients among the two variables ease of locating and conviviality judgement is around .259 which is below 0.5 but greater than 0 and can therefore be considered to have mild correlation.

This analysis is furthered with physical examination of the legibility of selected public open spaces using visibility graph analysis techniques in depthmapX software in the following section of this paper.

**Objective measurement**

Fig 14. shows the visibility graph analysis map of New market, Bhopal. It explains the visible connectivity of eight public open spaces selected in this study. The grid spacing adopted for this study was default value as 7. Few blocks in the layout had boundary walls therefore they are enclosed within polygon to avoid their inclusion at eye level visibility. The places in red are highly visible and towards blue are less visible to the floating population of the market.

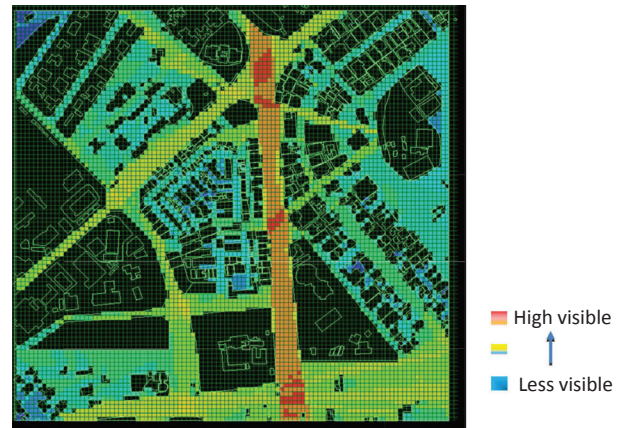


Fig. 14. Visibility graph analysis using depth map X software.

Table 5. Correlation between ease of locating and conviviality response

		Ease of locating	Conviviality response
Ease of locating	Pearson Correlation	1	.259**
	Sig.(2-tailed)		.00
	N	544	544
Conviviality response	Pearson Correlation	.259**	1
	Sig.(2-tailed)	.000	
	N	544	544

\*\* Correlation is significant at the 0.01 level (2-tailed)



## Result and Discussion

In the perception survey analysis, the mean values of ease of locating are higher than overall conviviality. It implies that the maximum people consider locating selected public open space convenient, easy, or very easy. On other hand overall conviviality appears higher than moderate only in three cases - TNT plaza, street 1 and 2. The results of ANOVA suggest that change in location of public open spaces implies change in ease of locating them as the F value is above 1 to accept hypotheses of significant variation. But the variance in overall conviviality is higher than ease of locating which suggests that the conviviality of each space varies more significantly. It was expected that correlation between ease of locating and overall conviviality should be strong. But due to familiarity of the responders with the market place, it was mostly easy for them to locate these places despite lack of visual connection. Their response does not reflect the implication of visible connectivity on considering a place to be legible. To decipher whether these places are easily visible, visibility graph analysis is performed from space syntax tool i.e. depthmapX which suggest that TNT plaza is more visible contrary to other public open spaces (see Fig 14). This study explains that familiarity with the spaces reduces their judgment regarding legibility of the place. But the perception of conviviality of a space reflects the importance of visible connectivity. As the most legible or visibly integrated spaces shown in visibility graph analysis are also accepted as more convivial spaces (refer Table 2). The visual graph analysis shows that very well integrated spaces in a network increase their visibility, also spaces closer to the main road becomes more legible for a large number of audience.

## Conclusion

The study helps to verify the role of legibility of a public open space in their performance as convivial public open spaces. The perception survey results establish that people consider most convivial spaces easier to locate. The visible connectivity of these spaces on visibility graph analysis explains firmly that more the visibility of public open spaces, more it is perceived as convivial. The perception based survey helped to quantify perception of legibility

(ease of locating) and conviviality. The use of visibility graph analysis helped to empirically evaluate legibility of different public open spaces. This study covers the perceptual as well as objective measurement of locating a space to understand its relationship with perception of conviviality. However, the correlation between ease of locating these spaces is not found to be very strong with perception of overall conviviality. Therefore, the use of objective measure to evaluate legibility through visibility graph analysis becomes useful tool to verify the importance of legibility in perception of conviviality.

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