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PERFORMANCE OF SUSTAINABLE URBAN INDICATORS: A CASE STUDY OF THRISSUR CITY IN KERALA, INDIA

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Abstract: Many cities in the world are facing acute challenges concerning growing dangers to the environment and ensuring quality of life for their inhabitants. In connection with cities achieving their individual goals of sustainable development, urban transport sustainability indicator frameworks are becoming the subjects of attention. Measuring progress towards sustainable or unsustainable urban development requires quantification with the help of suitable sustainability indicators. In this article the Performance of Sustainable Urban indicators were analyzed in the Thrissur city. Further the impact of existing land use in framing the transportation character along various nodes were also analyzed to find the relation between these land use and transportation character.

Index Terms **- Quality of life, Sustainable development, Urban transport, Sustainability Indicator**

1) INTRODUCTION

Cities and their development represent some of the biggest challenges of the 21st century. They have become the decisive motors of economic growth and are the centres of opportunity, prosperity, innovation, and social and cultural interaction (Ahvenniemi et al., 2017). Nowadays, 55% of the global population lives in urban areas, while the numbers and percentages of urban inhabitants are constantly growing. It is expected that due to urbanization and global population growth, the urban share of the population will reach 68% in 2050 (UNDESA 2018).

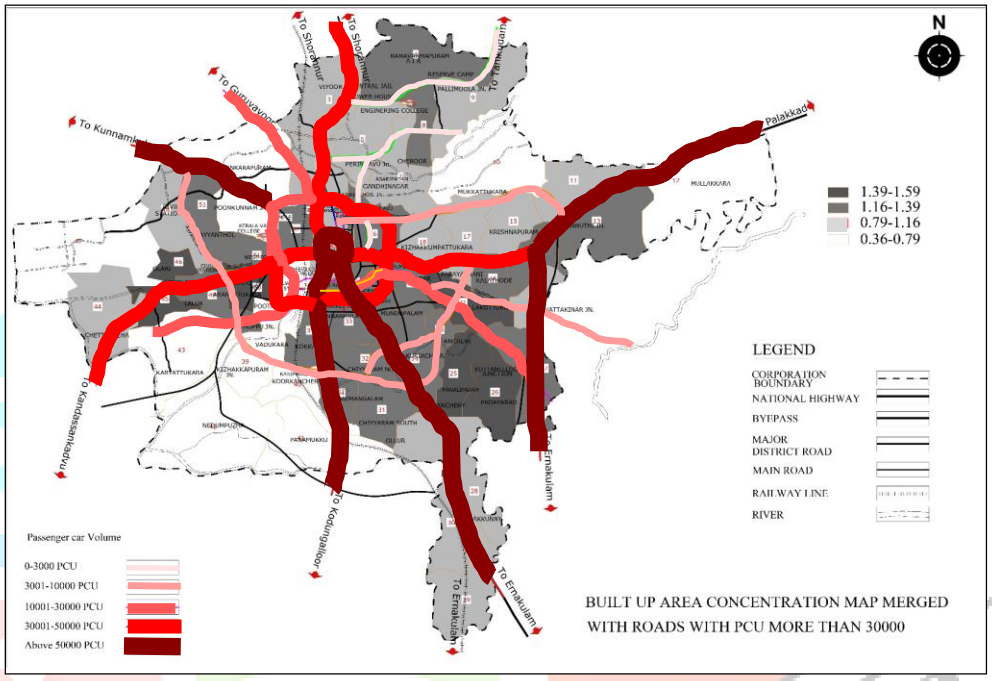
India, the second most populous country in the world, have 138 crores of population contributing about 17.6 % of the world population (World Population Prospects, 2019). Presently population of India is growing with a decadal growth rate of 15.1%. But during 1961-71, the decadal population growth rate was 24.8 %, the highest growth rate recorded ever in the history of India. Since then the population growth rate of India started declining. There are 7,933 urban centres in India, of which 4,041 are statutory towns, which are governed by the local self-governments (Census of India, 2011). The United Nations in 2019 estimated that, India will to surpass China as the world's most populous country by 2027. Also, India's urbanization is poised to accelerate in the coming decades. During 2011–36, urban growth will be responsible for 73% of the rise in total population (MoHFW, 2019). Earlier estimations indicate that about 416 million people will be added as urban dwellers in India between 2018 and 2050 (United Nations 2018); and that India will be 50% urban by 2050 (UN-Habitat, 2017).

As per Census of India, 2011 Kerala witnessed the highest level of urbanization i.e. 47.71% as against the National average of 31.16% during 2001-11, with a growth rate of 83.20% over the previous decade. The analysis shows that new urban jurisdictions of a hitherto rural area as urban, due to the shift in the occupational structure from agriculture to other categories of employment causes such a huge urbanization in the state.

Thrissur known as the 'Cultural Capital of Kerala' is located centrally in the Kerala State of India. Thrissur Municipality came into existence on 1st July 1949. Thrissur was one of the smallest municipalities with just 12.65 sq.km area and a population of about 74, 640 as per 1991 Census. The city was upgraded to the level of a Municipal Corporation on 2nd October 2000 by including five Panchayats -Ayyanthole, Ollur, Ollukkara, Koorkanchery, Vilvattom and a part of the Nadathara. Thrissur Municipal Corporation was formed as the 4th Municipal Corporation of Kerala State. The Municipal Corporation comprises two legislative assembly constituencies namely Thrissur and Ollur. The population of Thrissur Municipal Corporation is 3, 15,596 as per 2011 census in an area of 101.42 sq.km.

2)BUILT UP CONCENTRATION IN THRISSUR CITY

Built up concentration map of the wards were merged with roads with higher Passenger car unit i.e. PCU more than 30000 daily. From the figure it was noticed that in some of the roads with higher PCU were having only higher built density. Those roads are Thrissur –Palakkad road, Thrissur-Kodungalore road, Ring road, NH 544.Along the Shornur road and Kunnamkulam road with in the corporation limit the built density was comparatively lower than other areas. Details are shown in the map 1.1.



Map 1.1.: Map showing the Comparison of Ward wise Built up concentration and roads with PCU more than 30000

3)SUSTAINABLE URBAN INDICATORS

Urban sustainability indicators are ways to measure the conditions and status of an urban area with a variety of factors. They differ from most types of indicators because they are connected to each other, with aspects of economic, environmental, and equity dimensions impacting and connecting to one another. However, as with other types of indicators, urban sustainability indicators show strengths and weaknesses inherent in the system via the indicators (Phillips, R. 2014).Sustainability assessment methods of urban development including projects, indices, frameworks and tools, have become an active research field. Furthermore, the majority of these methods have focused on environmental aspects such as energy efficiency, renewable resourcesand the reduction of carbon emissions (Ameen et al., 2015).

Sustainable urban form is currently a widely discussed topic in the concept of urban sustainability. The physical built form of cities can be conceptualised as two interlocking planes. The first is the spatial distribution of activities and buildings. The second element is the pattern of streets, parks and the public realm. In the indicator selection process, we seek to use an action-learning approach to build working relationships among diverse stakeholders from the community, government, and industry and cultivate common understandings of the complexities in the planning choices that they face. Sustainable integration between these layers lead to a compatible built environment Mohamed Gamal Abdelmonem et al., 2014. Nations have developed indicators according to their local or national priorities (Shen et al., 2011). While urban sustainability performance is measured across the world, there is no single set of indicators that can be used for all the urban areas (Shen et al., 2011). Shen and Zhou (2014) identified five principal criteria for sustainability indicator selection, they are, the scope of sustainable development dimension, coherence for strategy, public participation, focus on sustainable development goals and consistency regarding meaning and dimensions of sustainable development indicators. A recent review of urban sustainability assessment tools is provided in Kaur and Garg (2019), which concludes that the main shortcomings of the existing, conventional approaches for monitoring urban sustainability is that these tools cover only limited or few specific aspects of sustainability. The Index of Sustainable Economic Welfare (ISEW) (Daly et al., 1994), and the Genuine Progress Indicator (GPI) (Progress, 1995) are two pioneering examples of economic indicators that extend traditional growth measures by adding costs associated with pollution and other unsustainable costs.

Accessibility, Connectivity, Compatibility, Diversity, Nodality, Density, Identity, and Adaptability are the eight indicators adopted for the study (Source: Abdelmonem et.al 2016).Accessibility is considered an essential indicator for achieving sustainable cities. Many scholars have noticeably described the relationship between accessibility and sustainable urban forms. Burton and Mitchell (2006), indicate the meaning of accessibility as urban efficiency, equity and sustainability as well as the extent to which people have the means to access places, services and facilities outside their local area. The organization of urban form and building pattern has an exclusive interrelationship with the movement network system. Hence, urban connectivity refers to how urban blocks and spaces are connected within the district and with adjacent neighbourhoods visually and physically (Masnavi, 2011).Urban compatibility refers to the capability of urban form to be homogenous and harmonic with the surrounding buildings and open spaces. Scheel 2011, also defines compatibility as maintaining harmony, balance, and unity of forms and patterns of buildings. Undoubtedly,

diversity is considered one of the significant indicators in achieving sustainable cities. Community stability is enhanced if the neighbourhood consists of a variety of house types, daily services and facilities, and a mix of tenures. The creation of accessible, social, and livable nodes and open spaces is one of the significant dimensions in achieving sustainable urban forms. The articulation of buildings and the surrounding spaces creates valuable nodes which should be strongly considered in the planning and design process. Density is another essential component and an important characteristic in definitions of sustainable urban form. There is a common agreement among scholars that high density and compactness of buildings lead to more sustainable cities (M. Jenks, et al., 1996). Many scholars indicate the role and importance of compactness, density, mass proximity, intensification, and contiguity in the latest sustainable urban strategy. The sustainable city is one that basically lasts through the ages, which has the ability to restore it-self. Therefore, one of the crucial definitions of sustainability is the equitable preservation of the built and natural environments, cultural heritages, and economic opportunities and encouragement to generate and protect the sense of place and identity of the city (D. Farr, 2008).For many communities, surviving in a polluted world along with social, economic and political issues will be an enormous challenge. The quest for adaptable population, management and urban strategies is one of the ultimate demands of sustainable cities (M. Jenks, and C. Jones, 2010).

4)MATERIALS AND METHODS

Accessibility, Connectivity, Compatibility, Diversity, Nodality, Density, Identity, and Adaptability are the eight indicators adopted for the study. The Whole study area was divided into 14 clusters based upon the similarities in the characteristics and the analysis was done to the clusters. The wards included in the Clusters are shown below in the Table 1.1 and Fig1.1.

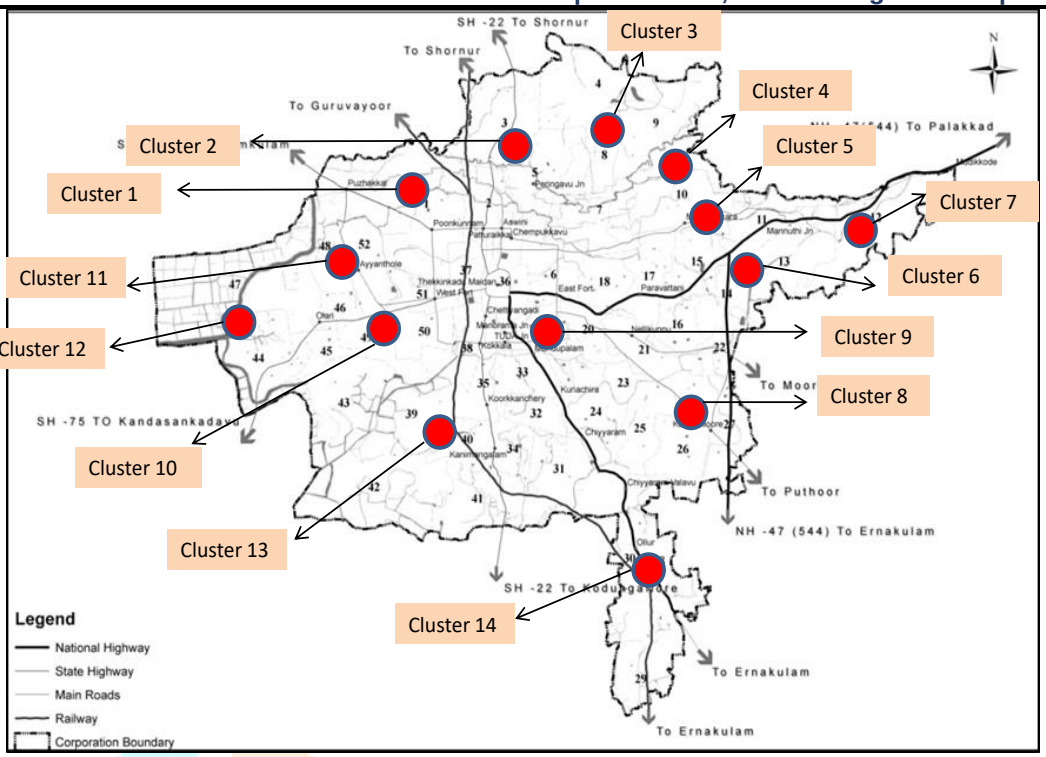


Fig 1.1: Location of the Clusters identified for analyzing the performance of Sustainable Urban Indicators.

Table 1.1: Clusters identified for analyzing the performance of indicators.

Cluster	Wards
1	1
2	2,3,5,7,36
3	4,8
4	9,10
5	11,15,17,18
6	13,14,16,22
7	12
8	21,25,26,27
9	6,19,20,23,24,31,32,33,34,35
10	37,45,46,49,50
11	48,51,52
12	44,47
13	38,39,40,41,42,43
14	28,29,30

5) RESULTS AND DISCUSSION

A questionnaire was prepared based upon the eight sustainable urban indicators and its sub-parameters a detail survey was conducted at the study area to analyze the performance on these indicators at the 14 clusters. Randomly selected few respondents in each clusters and draw the opinion about sustainable urban indicators parameters. Performance of this indicator was scaled as follows-Very good (5), Good (4), Moderate (3), Weak (2), Not available (0-1). The result obtained is shown in the Table 6.1. From the Table 6.2 it clearly shows that the overall score obtained was highest in the Cluster 9. It comprises of Ward No- 6, 19, 20, 23, 24, 31, 32, 33, 34 and 35 which is the CBD area of the city. Translation of these performance can be summarised as follows:

Accessibility: In the Cluster 9, the accessibility parameters like Local services, Public transportation and Public spaces are significantly in a better standard when comparing with the remaining clusters.

Connectivity: Even though the Cluster 9 there is better internal connectivity and also connectivity to the other parts the occurrences of traffic blocks and conjunctions is high which reduces the score for that indicator.

Compatibility: Cluster 9 is having better compatibility, the general theme; unity and architectural rhythm of the building have been arranged with satisfying harmony.

Diversity: There is inter-mixing of housing, shops, restaurants, workplaces, social centre, and other activities places many destinations close together, thus inviting more walking and bicycling.

Containment: There is a better safety and security and better designing and landscaping but as far as privacy is concern due to high building density was very less.

Density: In the Cluster 9 a concentrated residential and commercial areas with compact buildings about 3-4 storeys on average were noticed.

Identity: Cluster 9 is having a very good identity - Centrally located Lord Siva temple with Swaraj round which is the unique feature of even the Thrissur city.

Adaptability: The location, orientation, and district management are important futurity urban planning tools which is satisfactory this cluster.

The performance of Sustainable Urban Indicators of other clusters can be summarized similarly from the table 1.2. Radar chart showing the performance of the indicators in all the clusters are shown in the figure 1.2.

Table 1.2: Performance of Sustainable Urban Indicators cluster wise

Indicators		Cluster													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1-Accessibility															
PAR 1-1	Local Services	2	4	3	2	3	4	2	4	5	4	4	2	3	3
PAR 1-2	Public Transportation	3	4	3	2	3	5	2	4	5	5	4	2	4	3
PAR 1-3	Public Spaces	2	3	3	2	3	5	2	3	5	4	3	3	3	3
PAR 1-4	Buildings	2	4	3	2	3	5	2	3	5	4	3	2	4	4
2-Connectivity															
PAR 2-1	Internal connectivity	2	4	2	3	4	4	2	3	4	4	4	2	4	3
PAR 2-2	Block occurrence	3	3	4	4	4	4	5	3	1	1	2	3	2	3
PAR 2-3	With other parts	4	4	2	2	4	5	3	4	5	4	4	2	4	4
3-Compatiblity															
PAR 3-1	Unit	2	3	2	2	3	4	2	3	4	4	3	2	3	3
PAR 3-2	Fitness and Harmony	1	3	3	3	2	3	2	3	4	3	3	2	3	3
PAR 3-3	Richness and control	2	3	2	1	3	3	2	4	5	3	3	3	3	4
4-Diversity															
PAR 4-1	Mix of Uses	4	3	3	2	4	3	3	4	4	4	4	3	3	4
PAR 4-2	Vibrancy	3	4	2	2	3	3	2	4	4	3	3	3	3	3

5-Containment															
PAR 5-1	Privacy	5	2	4	5	3	2	5	2	1	2	3	4	2	2
PAR 5-2	Safety and Security	4	4	3	3	4	4	3	4	5	4	3	3	3	3
PAR 5-3	Design and Landscape	3	4	3	2	3	3	3	1	4	3	3	3	3	3
6-Density															
PAR 6-1	Building density	2	4	3	2	4	4	2	4	5	4	4	3	4	4
PAR 6-2	Population density	2	4	3	2	3	4	2	4	5	4	3	3	5	4
7-Identity															
PAR 7-1	Physical features	1	3	3	2	3	3	3	2	5	3	3	2	3	3
PAR 7-2	Dynamic Activities	2	3	2	3	3	3	2	3	2	3	3	2	3	2
8-Adaptability															
PAR 8-1	Robustness	2	3	2	3	3	3	2	3	4	3	3	3	4	3
PAR 8-2	Management	2	3	2	2	4	4	2	4	4	4	4	2	4	4
PAR 8-3	Public participation	3	2	3	4	3	3	4	3	3	2	3	3	3	3
Overall Score (Max-10)		**5**	**7**	**5**	**5**	**6**	**7**	**5**	**7**	**8**	**7**	**7**	**5**	**7**	**6**

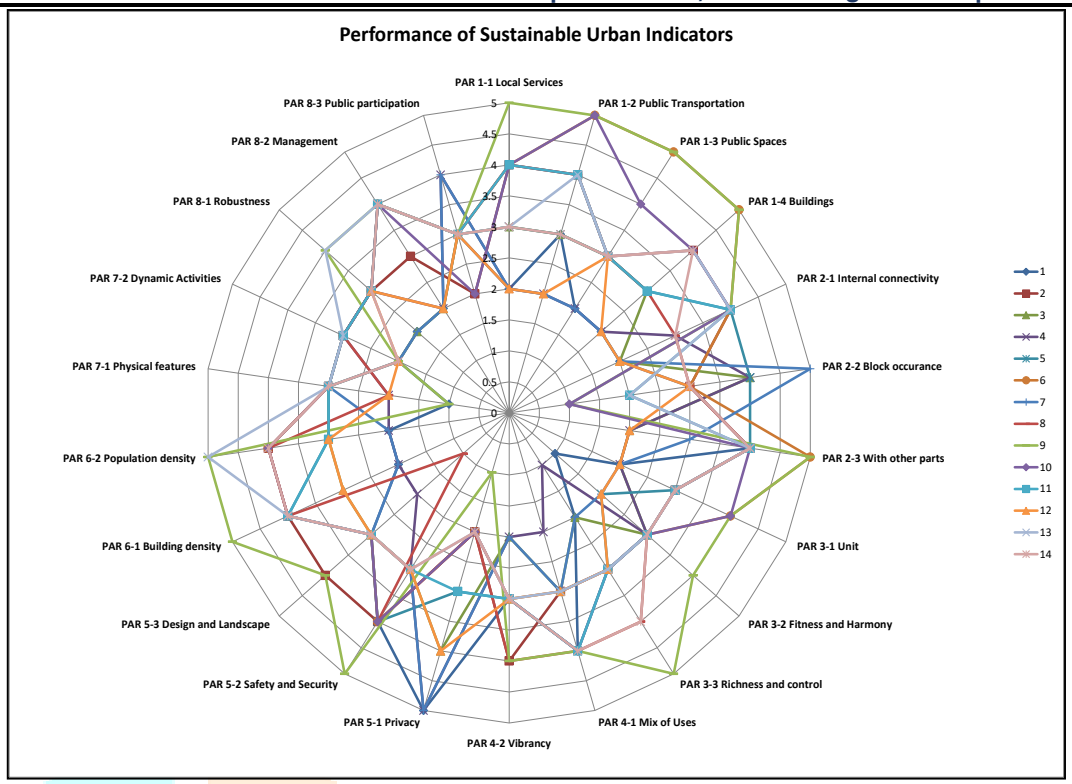


Fig 1.2: Radar Chart showing the performance of Sustainable Urban Indicators of Clusters in Thrissur city

Cluster wise suggestions for improving performance of Sustainable Urban Indicators

SUGGESTIONS FOR CLUSTER 1

Cluster 1 is comprised of ward 1.From the analysis it was noticed that improvement is required in the following sustainability indicator-Accessibility, Connectivity, Compatibility, Density and Identity. To improve the accessibility of local services need to be improved i.e. feeder vehicle services need to be started at various locations. Internal connectivity within the settlement need to be improved. To improve the densification as it is in the boundary of the city a new commercial growth node is suggested at Puzhakkal to shift some of the whole sale activities of the core area to outskirt.

SUGGESTIONS FOR CLUSTER 2

Cluster 2 comprises of wards 2,3,5,7 and 36. Overall score of sustainable urban indicators is 7 which is somewhat good. Improvement is required in development of Public spaces, for that vacant lands available can be taken by Municipal Corporation for the development of parks and open grounds, block occurrence need to be reduced by widening the existing arterial road towards the Shornur side and development of external ring road will reduce the through traffic, improvement of privacy at neighbourhood level by planting more trees and gardening and Public participations can be improved by the participation of resident associations in development activities in their concern areas.

SUGGESTIONS FOR CLUSTER 3

Cluster 3 comprises of wards 4 and 8. Improvement is required in the following sustainability indicator-Accessibility, connectivity, compatibility, diversity, density and adaptability. Internal connectivity improvement is required along with feeder service like paratransit needed to strengthen. To improve diversity mixed development need to be promoted.

SUGGESTIONS FOR CLUSTER 4

Cluster 4 comprises of wards 9 and 10. Improvement is required in the following sustainability indicator-Accessibility, connectivity with other parts, richness and control of compatibility, diversity and density. As far as accessibility factor is considered public transport system to this location need to be improved. Connectivity to other parts can be improved by developing good road network i.e. existing major road need to be widened and to become a part of outer ring road. For improving the richness and control of this area more agro based farms development and promotion fests need to be conducted which will revive the existing agro farms in this area.

SUGGESTIONS FOR CLUSTER 5

Cluster 5 comprises of wards 11, 15, 17 and 18. Improvement is required in the following sustainability indicators-Accessibility, connectivity with other parts, richness and control of compatibility, diversity and density. Local services and public transportation need to be improved as far as accessibility is considered. Connectivity with other parts need to be improved.

SUGGESTIONS FOR CLUSTER 6

Cluster 6 comprises of wards 13, 14, 16 and 22. Improvement is required in the following sustainability indicators- Compatibility, Containment and Adaptability. As far compatibility is considered building units needed to be Fit and Harmonious, in the containment factor privacy, safety and security needed to be improved.

SUGGESTIONS FOR CLUSTER 7

Cluster 7 consist of ward 12. Improvement is required in the following sustainability indicators-Accessibility, Connectivity, Compatibility, Diversity, Density and Adaptability. Local services like Paratransit, feeder bus etc. needed to improve the accessibility to far away areas from NH. Internal connectivity also needed to be improved. Dynamic activities related to industries can be promoted as nearness to NH provides better connectivity to other locations.

SUGGESTIONS FOR CLUSTER 8

Cluster 8 comprises of wards 21, 25, 26 and 27. Improvement is required in the following sustainability indicators- Design and Landscape aspect of Containment indicator, Physical features aspect of Identity indicator.

SUGGESTIONS FOR CLUSTER 9

Cluster 9 comprises of wards 6, 19, 20,23,24,31,32,33,34 and 35. This cluster is having highest overall score compared to other clusters. In this cluster traffic blocks and related issues need to be addressed along with to provide privacy green plantations can be promoted along road sides and open areas.

SUGGESTIONS FOR CLUSTER 10

Cluster 10 comprises of wards 37,45,46,49 and 50.Traffic blocks and related issues need to be addressed here also. In order to provide privacy green plantations can be promoted along road sides and open areas.

SUGGESTIONS FOR CLUSTER 11

Cluster 11 comprises of wards 48, 51 and 52. Traffic blocks and related issues needed to be addressed.

SUGGESTIONS FOR CLUSTER 12

Cluster 12 comprises of wards 44 and 47. Improvement is required in the following sustainability indicators-Accessibility, connectivity with other parts, richness and control of compatibility.

SUGGESTIONS FOR CLUSTER 13

Cluster 13 comprises of wards 38, 39, 40, 41, 42 and 43. Improvement is required in the following sustainability indicators-Accessibility by providing adequate public transportations and paratransit systems, better connectivity by reducing block occurrence and increase compatibility.

SUGGESTIONS FOR CLUSTER 14

Cluster 14 comprises of wards 28, 29 and 30. Improvement is required in the Privacy aspect of Containment indicator and Dynamic activities of Identity. Since this area is heavily concentrated with Industrial developments other activities are hindered. Multipurpose activities which are allied with industries can be also promoted here.

6) CONCLUSION

Composite indicators are increasingly recognized as useful tools in policy analysis and public communication to assess the performance of units, such as countries, regions and even cities, with respect to

a multidimensional phenomenon. The main advantage is that they can be used to illustrate complex and sometimes difficult to understand issues represented by a huge number of individual indicators. Based on the studies conducted on the Sustainable Urban Indicators performance of the study area it was understood that in the cluster 9 i.e. on the core area its performance is better in comparison with other clusters. It was understood that the land use character of an area were having an impact in the transportation needs of the particular location. It is noticed that particular land use is attracting vehicles with in the influencing area.

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