

# Complete Street Planning and Design: A Framework to Develop Quantitative and Qualitative Evaluation Method



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**Abstract:** Many countries over last few decades have worked on complete street planning and designing. As per various researches and organizations, the complete streets are the streets that are context sensitive and designed to accommodate all types of users, considering safety, accessibility and mobility for all types of users. The type of user for every street may vary due to the function and context of the street. Streets are not only the linear linkages but should be treated as 3D spaces. To have a context sensitive street it is equally important that the built mass along the street should be evaluated and designed accordingly.

The proposed evaluation methodology will be done at overall level to study the street context, overall quality of services, detailed study for street design elements and measuring urban design qualities for pedestrians through which the study will go one step ahead and evaluated the importance of integrated approach for complete street planning and design. For the evaluation of the streets the selection of study area was on the basis of its context and function. The urban landuses identified are residential, commercial, intuitional and open spaces, which contributes about 85% of the land reservation in master plan. This paper aimed to present the quantitative and qualitative framework evolved to evaluate the street planning and design through identified streets to assess the completeness of the existing streets in Gurgaon.

The method of evaluation will help to check the completeness of streets in terms of context, quality of services, street design elements and urban design quality for pedestrians. Through street evaluation the shortfalls can be prioritized and streets can be improved accordingly to become the complete street. The method will help to check the completeness of streets in Gurgaon and other cities with some variations for better cities and better streets.

**Index Term:** Complete streets, Evaluation of Street, Quality of Services, Street Context, Street Design Elements, Urban design qualities.

## I. INTRODUCTION

With the rapid urbanization trend in India, the urban areas have given priorities to develop streets to accommodate more and more motor vehicles and compromising on the space given to the other street users. Streets provides linkages and also serves as big urban gathering areas.

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Hence the street should be seen as a link and a place. In last few decades the roads have been taken over by engineers and they worked towards meeting the level of services for roads, whereas the quality of services is equally important to have safe and accessible street for all types of users. Quality of services gives priority to other NMT users such as pedestrians, bicyclists, and other transit users. Multi modal choices increases the level of independence for all the street users. Private car users are also facing problems of congestions and jams, and it is increasing day by day.

To understand the type of user and the usage of streets it is important to have an efficient design, it can't be one fit to all street design, the street should respond to the surrounding landuses. The streets are 3 dimensional spaces and can't be designed in isolation. While designing the streets a team of engineers, architects, planners, economist and urban designers, etc. should work together to achieve an efficient design. Only through an integral approach towards street planning, a well-planned, well-connected, well-designed, context sensitive streets can be achieved. During last few decades the streets were designed primarily for vehicles and other modes of transportation are overlooked, such streets that doesn't accommodate all types of users and are not safe to walk and accessible by street users are termed as incomplete street. Many countries across the globe are now working towards complete street planning and design. Complete streets are the streets that safely, comfortably accommodates all types of users [1]. This paper aims to present a methodology to evaluate the completeness if identified streets in Gurgaon. The completeness of the streets can be evaluated through an extensive understanding of the complete streets, parameters to achieve complete streets, understanding of the existing land use and transportation context along the streets. Study of existing design elements on the streets and study of built environment along the street. While evaluating the completeness of the street and an incomplete picture of street planning and design starts emerging, which helps to understand the short comings and scope of improvement.

## II. REVIEW OF LITERATURE

Streets represent cities [2] and Cities are the reflection of the countries [3]. Streets are for two main functions i.e. movement and place [4]. Kelvin lynch in 1960, Said that the contents of city image can be classified under five types of elements i.e. nodes, paths, edges, landmarks, and districts.



Streets will be evaluated at two levels, overall level and detailed level. The context and the street design will be evaluated at macro/ spatial level in overall level. the streets are classified in two categories, one used for movement and distribution of traffic and other used for accessing the areas performing activities within the protected environment [5]. It considers that the streets are places for people and not for vehicles.

Cities are moving towards car centric approach and public transport and use of non-motorized vehicles are declining [1], [6], [7]. Car centric approach will not lead to sustainable transportation the approach should be people centric. Sustainable urban streets are defined as “multi modal right of way designed and operated to create benefits to movement, ecology and community”. It together support a broad sustainability agenda embracing the three E’s: environment, equity and economy and implementing sustainable urban streets can create more livable communities [8] [9]. In a city when no. of residents are approx. 1,00,000 or when city provides more than 30,000 jobs it is not feasible to have maximum trips by automobiles and the road is never sufficient for driving or parking and the results is increased congestion, pollution, infrastructure cost, fatalities and poor Imageability of city [10].

Since last decade many American and European cities have worked on streets to increase other modes of transportation to accommodate all types of users, and suggested guidelines for safe, mobility and accessible streets [11] [12] (Jones, Marshall and Boujenko, 2008). The street should be designed for the users, and to understand the use and user of street the surrounding land use should be well understood, which gives clear picture of need of place [13]. In India, cities vary in terms of culture, population, typography, economic activities, etc., hence land use and transportation should be planned together to achieve overall sustainability of the city [7]. The surrounding land uses have primary effect on street design [14]. Understanding of street character to design spaces is important. As per the character of street the pedestrian volume can be analyzed and the space on the street can be provided accordingly [15]. The authors says that there is a strong link between the built environment and mobility on street. Streets with high mobility contributes to the health of people too. Through inclusive planning approach we can achieve a good street design which contributes to the health and wellbeing of the elderly people [16]. [17] An Author said that when we have to design for volume then safety is important thing to be considered in an environmentally sustainable way. The policy describes all the zones across the cross section in detail and in each street type key design elements were identified and designed based on the surrounding context [1].

An active street contributes to human health by a large extent, it increases physical activities, reduces pollution, sense of community, and creating healthy and comfortable environment [18]. The street design elements considers the elements between the property line at one end to property line on the opposite end, including carriageway, travel ways and verges, hierarchy of road widths, traffic calming facilities and other elements [9]. Author said that the street are used by the public due to following reasons i.e. attraction on street, street proximity, congestion on the street, supportive facilities and

activities on the street [19]. Better understanding of Link and Place helps to understand minimum and maximum space requirement for the street users. Each street design element can be designed accordingly as per the requirement [5]. Urban greening is an important part while designing urban areas which includes, sidewalks, buffer zone along the streets, parks and recreational areas developed for city improvement, but it is also identified the only greening is not the solution, right greening should be there which can reduce pollution levels, reduce heat islands, decreases the storm water runoff, reduces the noise levels, etc. [20]. Planting of trees should be as per requirement as too many trees will also become barrier to wind.

When we measure the completeness of the street an incomplete street patterns appears which shows the short comings of the street. Measuring the completeness of street helps to set the priority for infrastructure investment and also helps to priorities the shortfall to achieve complete streets [21]. Streets are big urban spaces and proper design and planning will impart good urban design characteristics, enhancing the built environment along the street for better cities and better streets (Ewing, Handy, Brownson, Winston, & Clemente, 2005). Built environment has one of the major roles in contributing physical activity of the residents. Through proper planning and designing on neighborhoods. If the area is well connected, safe and accessible to the surrounding amenities, then people tend to walk (Jung, Lee, Kim, & Lee, 2017). (Ewing et al., 2005) for active living research, developed the measures for measuring urban design qualities related to walking. They have identified six physical characteristics of urban streets. (Ewing & Handy, 2009) developed a tool to measure the subjective qualities of urban street environment. Many cities in the world are heading towards the automobile free zone and promoting pedestrian and bicyclist users [22]

### III. IDENTIFICATION OF PARAMETERS

Safety and accessibility are the two priorities of street planning and design for all types of users. The study will be done at overall level, to understand the existing and future conditions. A Street may vary in land use from start to end, but it may not be possible to vary street section along one stretch at short spans, hence the border perspective will be considered. The landuses next to the streets should be integrated with street function to have relevant street elements required during existing or for future land uses [1]. Up till now engineers and planners have used level of services considering the function of the street, which takes in to consideration only motorists but it is more important to consider the other modes of transportation to accommodate all types of users, which will increase options for modal choices and make users independent. An approach that Streets are for people not for vehicles should be followed then only we can create well planned, well designed and context sensitive communities and cities.

To evaluate the completeness of the street the study will be performed as:



1. Street Context
2. Quality of Services (bicyclists, pedestrians, motorists, etc.)
3. Street design elements and
4. Urban design qualities

The street context and the quality of services will be studied at overall level, the street design elements will be a detailed level study and urban design qualities will be measured for pedestrians. In this paper, the methodology for evaluating the street completeness will be explained through above mentioned heads.

#### A. Street Context

Before designing the street it is important to first understand the existing and future conditions of context along the street. The street context will be studied for the land use along the stretch and the transportation in the identified stretch. Either Land use or transportation should never be developed in isolation [1], [23], [24].

Understanding the context of street gives the full understanding of the built environment and the street type, through which the function of the street can be decided and accordingly parameters can be selected to maintain the balance between land use and design [25].

##### Context Factor

#### 1. Land use Context

- Land use is well defined and as per master-plan.
- Façade of buildings are designed as per the guidelines and urban character is reflected along the street.
- Development norms have been strictly followed (Scale, setback, density are as per the byelaws.

#### 2. Transportation Context

- The street design is as per the function of the street.
- Street is designed for all types of users. Pedestrians, Bicyclists, differently abled, two wheelers, cars and transit users.
- All the Facilities are provided on the street.
- Operating speed and posted speed are same
- Street design can accommodate the current and projected traffic

#### B. Quality of services

Quality of services ensures the safety and accessibility of travel. The quality of services applies to the design elements along the street to the used by pedestrians, bicyclists, and transit users. The experience of using non-motorized transportation should be safe, comfortable, and easy to use. Facilities that ensures the quality of services for the NMT users are:-

##### 1. Pedestrian

- Sidewalks/ walkways
- Buffer area
- Pedestrian crossing
- Curb extension
- Multiuse path
- Signage
- Paved shoulders
- Physically challenged

- Other amenities like tree shades, sitting area, etc.
2. Bicyclists
    - Bicycle lanes
    - Marking shared lanes
    - Multi-use paths
    - Signage
    - Paved shoulders
    - Cycle parking
  3. Transit users
    - Type of transit, busses
    - Transit service: frequency of services
    - Bus shelter
    - Connectivity
    - Schedule and routes
    - Seating
    - Lighting
    - Signage
    - Transit design: bus bays

#### C. Street design elements

Streetscapes are the space form the built mass on one side of the street to the built mass on the other side of the street [26]. The elements of street design were identified on the basis extensive literature review form the reports, articles, best practices and books, etc. and the identified elements of street design are development zone, sidewalks, Landscape zone, transit zone, carriageway, and medians. The field survey was designed to study the existing street conditions through the street design elements. It will help to priorities the shortfalls in the design and gives better understanding of completeness of the street.

Parameters identified to evaluate street design elements

##### 1. Street type (context and street function)

- Surrounding land use along the street stretch
  - Street serves as collect street/ local street
- ##### 2. Land use along the street, street function, traffic speed, traffic volume, access density
- Land uses in urban areas are mainly residential, commercial, institutional or open space.
  - Traffic speed
  - Traffic volume
  - Traffic calming measures
- ##### 3. Street cross section (development zone, dead zone, multi-use zone (foot path, landscaping, sitting, bicycling), parking zone, Bicycle lane, vehicle zone and median.
- No. of lanes
  - Lanes are per users
  - No. of zones
  - Width of each zone
  - Facilities on street
  - Types of trees, shrubs and ground covers
  - Environmental parameters

**D. Urban design Qualities for pedestrians**

As per complete street definition the complete streets are context sensitive streets, hence the landuse along the street becomes and important and integral part while designing the street.

Streets are not only linear linkages within a city but also a 3 dimensional space. Urban design qualities are qualitative aspects of an area, but it can be measured under certain categories like Imageability, Human scale, enclosure, transparency (Livability & Linkage), and Complexity [27], [28]. Streets are all about accessibility. Pedestrians are the one who spend and live most of the time on street. They feel the space while sitting, walking, crossing, chatting, sleeping, etc. It is important to make them feel safe on street, feel connected to the space, and carry a good image along [6]. To make all possible we need to measure the urban design quality of space and understand its strengths and weaknesses for betterment. This will help designers, planners and engineers to deliver better quality of streets to the city and its residents.

Based on the literature review the following qualities were identified that is to be measure to understand the urban design quality for pedestrians.

**1. Imageability**

- Number of courtyards, plazas, and parks (both sides)
- Proportion of historic buildings—both sides of street
- Presence of outdoor dining—same side of street
- Number of buildings with non-rectangular silhouettes—both sides of street
- Noise level—same side of street
- Number of major landscape features—both sides of street
- Number of buildings with identifiers—both sides of street.

**2. Human Scale**

- Long sight lines (#)
- All street furniture and other street items (#)
- Proportion first floor with windows
- Building height—same side
- Small planters (#)
- Urban designer (y/n)

**3. Enclosure**

- Proportion street wall—same side
- Proportion street wall—opposite side
- Proportion sky across
- Long sight lines (#)
- Proportion sky ahead

**4. Transparency**

- Proportion first floor with windows
- Proportion active uses
- Proportion street wall—same side

**5. Complexity**

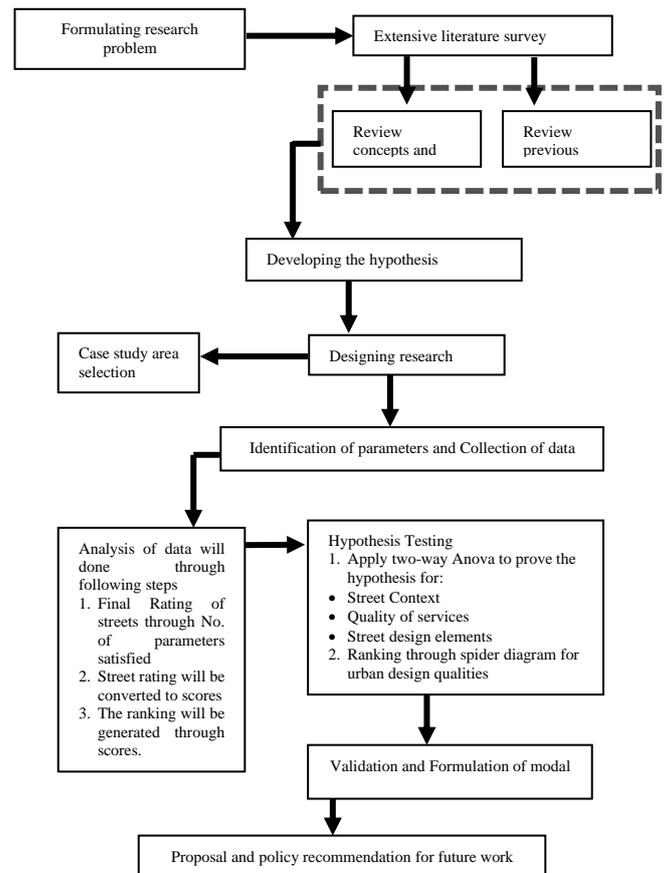
- People
- Buildings
- Dominant building colors

- Accent colors
- Outdoor dining (y/n)
- Public art

**IV. METHODOLOGY**

The proposed evaluation method is carried out at three levels and will go one step ahead and evaluate the importance of integrated approach to evaluate the complete street planning and designing. The method adopted to perform the research is as shown in the Fig. 1.

The streets selected for the study are serving as collector streets and all the 4 landuses (Residential, Commercial, Institutional and Open spaces) are taken in to consideration which lies along the street. Keeping the above method to selecting streets 10 streets of 30 mts width were identified in Gurugram. The street evaluation will be achieved through performing the analysis at varies stages. The evaluation of qualitative data will be done by converting it to quantitative data. The street will be rated on the basis of no. of parameters satisfied, there after the final rating will be converted to scores and through which the ranking will be given to each street. Once the ranking is awarded, Two-Way ANOVA will be used for as an statistical analysis tool for the hypothesis testing..



**Fig.1. Framework to evaluate completeness of the streets**



The methodology for grading of streets is as follows:

1. With the help of the checklist a comprehensive survey of the selected stretch of street is carried out.
2. Data is collected
3. Collected data is weighted against the identified parameters for overall characteristic of street context and designing as shown in table I.
4. Analysis of street context and designing is done with the help of checklist, to grade the selected streets. The grade at overall level is selected based on the highest no of parameters satisfied,
5. The data obtained should be rationalized as the variety of conditions i.e. the street quality of services is good, average or bad, it is rare that it will be either good or bad. Hence it is required to identify the ratings as per the highest no. of parameters satisfied.

**Table I: Table showing the street context rating based on parameters satisfied, data received**

Street Name	Badshapur road				
Parameters	Existing Land use and zoning	Built mass development and urban design character	Development regulations, existing and proposed	Street character and function	Street design features
Rating					
A	-	1	-	-	-
B	1	-	1	1	-
C	-	1	-	-	1
D	1	1	2	2	5
E	-	-	2	2	3
<b>Final Rating</b>	<b>D</b>	<b>D</b>	<b>E</b>	<b>E</b>	<b>D</b>

Source: Field Study 2019

6. The above mention method will be done for all the street stretches and the cumulative rating will give the existing street conditions in terms of context and quality of services provided for the street users.

**V. DATA COLLECTION AND DISCUSSION**

The data will be collected for identified streets through extensive field survey. The data obtained will be collected through secondary source, observation, photographs and video under following categories:

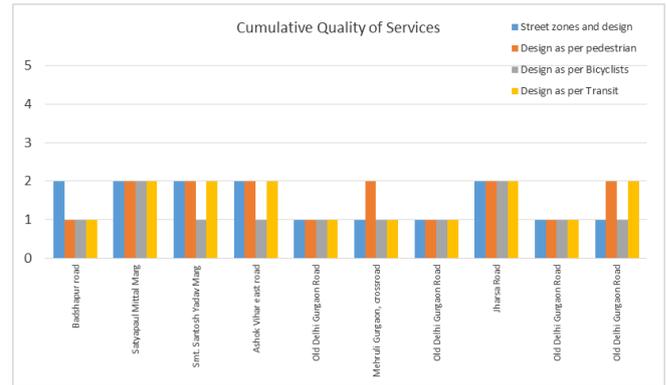
1. Street Context
2. Quality of services
3. Street Design elements
4. Measuring Urban design qualities

The data collected for context, quality of services and street design elements will be based on the parameters and it will be the quantitative data. The data obtained will be marked on the basis of parameters satisfied. The no of parameters obtained will be graded and the grading will help to do the final rating of the parameter of the selected street. The street will be rated from A to E, where A = 5 and E = 1 as shown in the table I. The rating will be based on the lowest grade scored by the parameter. The rating will show the worst case scenario and shows that the immediate intervention is required for the identified parameter.

Rating will identify that the street scoring highest i.e. 5 rating needs least attention and street scoring lowest i.e. 1 can be the worst case scenario or poor in built environment and quality of services as shown in fig. 2. The street getting highest rating should also be taken in to consideration for further up gradation and improvement.

Similarly the quality of services at overall level can be graded and the final grading can be obtained each street stretch.

The final grading of each stretch for identified parameters will be converted to the cumulative rating depending on the maximum rating achieved as shown in table II for all the identified heads. The graphically representation for the same is as shown in Fig. 2 for Quality of services.



**Fig. 2. Graphical representation of cumulative rating of all selected streets through field study**

**Table II: Cumulative evaluation of parameters awarded**

Street Planning and Design parameters	Street	Badshapur road	Satyapaul Mittal Marg	Smt. Santosh Yadav Marg	Ashok Vihar east road	Old Delhi Gurgaon Road	Mehruli Gurgaon, crossroad	Old Delhi Gurgaon Road	Jharsa Road	Old Delhi Gurgaon Road	Old Delhi Gurgaon Road
	Parameters										
Street Context	Existing Land use and zoning	D	B	C	C	D	D	D	D	D	D
	Built mass development and urban design character	D	C	B	D	E	E	E	D	E	D
	Development regulations, existing and proposed	E	B	C	D	E	E	E	D	D	D
	Street character and function	E	C	C	D	C	C	D	C	D	D
	Street design features	D	C	D	E	E	E	E	D	E	E
Quality of services	Street zones and design	D	D	D	D	E	E	E	D	E	E
	Design as per pedestrian	E	D	D	D	E	D	E	D	E	D
	Design as per Bicyclists	E	D	E	E	E	E	E	D	E	E
	Design as per Transit	E	D	D	D	E	E	E	D	E	D
Street Design Elements	Development Zone	C	C	C	D	E	D	D	D	D	E
	Side Walks	D	C	C	E	E	D	D	D	D	E
	Landscape	D	B	B	D	E	E	E	D	E	E
	Transit	D	C	C	E	E	E	E	D	E	E
	Vehicle lane	D	C	D	E	D	E	E	D	E	E
	Median	E	C	-	E	E	E	E	D	E	E

for complete street planning and designing through field survey



The street ratings are converted to scores considering A = 5 and E = 1 and used for graphical representation. The above statistical analysis helps to rank the planning and designing of the street. Table III shows that how rating received by each street will be converted to scores and ranking.

The score obtained will be converted to the street ranking as the highest score will be ranked 1 and rest will be done accordingly. The similar method will be followed for evaluating the all the identified categories.

Once the final ratings and cumulative rating for all the identified streets the ratings will be converted to scores and based on scores the rankings will be done, the mean ranking for each street will be further used for hypothesis testing.

**Table III: Street Ranking based on Rating awarded**

Sr. No.	Streets	Cumulative rating	Score	Ranking
1	Badshapur road	E	1	2
2	Satyapaul Mittal Marg	D	2	1
3	Smt. Santosh Yadav Marg	D	2	1
4	Ashok Vihar east road	D	2	1
5	Old Delhi Gurgaon Road	E	1	2
6	Mehruli Gurgaon, crossroad	E	1	2
7	Old Delhi Gurgaon Road	E	1	2
8	Jharsa Road	D	2	1
9	Old Delhi Gurgaon Road	E	1	2
10	Old Delhi Gurgaon Road	E	1	2

Source: Field Study 2019

The Two-way ANOVA will be used to analyze the relationship between the street planning and designing and Elements of street planning and designing.

On other hand the urban design qualities to be measured for the pedestrians will be performed as follows:

1. With the help of the checklist a comprehensive survey of the selected stretch of street is carried out.
2. Data is collected
3. Collected data is weighted against the identified parameters to measure the urban design qualities for pedestrians.
4. Calculation of parameters identifies will be done with the help of coefficients and P-values. The measured value of each urban design quality will depict the quality of urban environment.
5. The above mention method will be done for all the street stretches and the measure values for each street will be calculated, which gives the fair idea of urban environment of the street, and the worst street can be prioritized to start work from.

Number of physical or the measured value will be multiplies with the identified parameters to calculate the value of imeagibility, enclosure, human scale, transparency and complexity.

The evaluated values will be combined to get the cumulative measures for each physical characteristics, which will be ranked with the help of spider diagram.

## VI. CONCLUSION

It is evident from the above evolved method that the integrated approach towards street planning adopted will help to achieve the complete streets. The data collected and evaluated revealed detailed picture of the present street

conditions. The data collected under various heads will be used to get detailed analysis and correlation of built environment and street design elements to achieve complete streets as a whole through proper planning, and designing, using required elements of design be it a street or built environment.

The quantitative evaluation of the streets will help to have clear understanding of the each and every parameters that needs improvement or design intervention to achieve complete streets. The evaluated results will help in standardization of street designs ensuring the safety and accessibility of streets. It will increases the mobility choices among street users and will enhance the urban design qualities of along the street. This will provide the city to have well-planned, well-designed and well-connected transportation network for all types of users.

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## REFERENCES

1. (North Carolina Department of Transport) NCDOT, "Complete Streets Planning and Design Guidelines," North Carolina, 2012.
2. J. Jacobs, *The Death and Life of Great American Cities*. 1961.
3. R. A. Oppong, A. B. Marful, and E. S. Asare, "Improving urban visibility through fractal analysis of street edges: The case of John Evans Atta Mills High Street in Accra, Ghana," *Front. Archit. Res.*, vol. 6, no. 2, pp. 248–260, 2017.
4. M. Tandon and V. Sehgal, "Traditional Indian religious streets: A spatial study of the streets of Mathura," *Front. Archit. Res.*, vol. 6, no. 4, pp. 469–479, Dec. 2017.
5. P. Jones, S. Marshall, and N. Boujenko, "Creating more people-friendly urban streets through 'link and place' street planning and design," *IATSS Res.*, vol. 32, no. 1, pp. 14–25, 2008.
6. Christopher Kost, Matthias Nohn, H. Bhatt, P. Deshpande, P. Dixit, and A. J. (EPC), "Better Streets , Better Cities," no. December, p. 177, 2011.
7. M. NUTP, "National Urban Transport Policy. Government of India," 2014.
8. H. G. El-Shimy and R. A. Ragheb, "Sustainable Urban Street Design: Evaluation of El-Moaz Street in Cairo, Egypt," *Procedia Environ. Sci.*, vol. 37, pp. 689–698, Jan. 2017.
9. N. Mohareb and M. Felix, "Affordable and Common Modes of Transportation in Developing Cities and Their Effect on the Sustainability of Streets," *Procedia Environ. Sci.*, vol. 37, pp. 319–329, Jan. 2017.
10. I. Org and T. Litman, "Evaluating Complete Streets," 2015.
11. C. of Johannesburg, "City of Johannesburg Complete Streets Design Guideline," Public Roads. 2010.
12. P. and D. Alta, "Urban , Rural and Suburban Complete Streets Design Manual," 2017.
13. B. E. Saelens and S. L. Handy, "Built environment correlates of walking: A review," *Medicine and Science in Sports and Exercise*. 2008.
14. I. C. Abdullah, F. Yusof, S. M. Kamaruddin, and A. R. A. Rasam, "Travel Behaviour and Landuse Planning: The Planning of Mosque in Shah Alam, Selangor," *Procedia - Soc. Behav. Sci.*, vol. 105, pp. 723–733, Dec. 2013.
15. K. Nakamura, "The spatial relationship between pedestrian flows and street characteristics around multiple destinations," *IATSS Res.*, vol. 39, no. 2, pp. 156–163, Mar. 2016.
16. A. Curl, C. Ward Thompson, and P. Aspinall, "The effectiveness of 'shared space' residential street interventions on self-reported activity levels and quality of life for older people," *Landsc. Urban Plan.*, pp. 117–125, 2015.
17. F. Kehagia, "Transforming small towns by remedial street design," *Transp. Res. Procedia*, vol. 24, pp. 507–514, Jan. 2017.



- 18.H. Stefansdottir, P. Næss, and C. M. Ihlebaek, "Built environment, non-motorized travel and overall physical activity," *Travel Behav. Soc.*, Oct. 2018.
- 19.N. A. Rahman, S. Shamsuddin, and I. Ghani, "What Makes People Use the Street?: Towards a Liveable Urban Environment in Kuala Lumpur City Centre," *Procedia - Soc. Behav. Sci.*, vol. 170, pp. 624–632, 2015.
- 20.K. M. Shaneyfelt, A. R. Anderson, P. Kumar, and W. F. Hunt, "Air quality considerations for stormwater green street design," *Environ. Pollut.*, vol. 231, pp. 768–778, Dec. 2017.
- 21.N. Hui, S. Saxe, M. Roorda, P. Hess, and E. J. Miller, "Measuring the completeness of complete streets," *Transp. Rev.*, vol. 38, no. 1, pp. 73–95, 2018.
- 22.K. Shubenkova, A. Boyko, and P. Buyvol, "The technique of choosing a safe route as an element of smart mobility," *Transp. Res. Procedia*, vol. 36, pp. 718–724, Jan. 2018.
- 23.C. Hardwicke et al., "Complete Streets by Design," 2012.
- 24.T. Newsome and K. Cornett, "Complete Streets : Marrying Land Use and Transportation," 2014.
- 25.E. Prelovskaya and A. Levashev, "Modern Approach of Street Space Design," *Transp. Res. Procedia*, vol. 20, pp. 523–528, Jan. 2017.
- 26.C. Hardwicke et al., "Complete Streets by Design," *Toronto Cent. Act. Transp.*, 2012.
- 27.R. Ewing and S. Handy, "Measuring the unmeasurable: Urban design qualities related to walkability," *J. Urban Des.*, vol. 14, no. 1, pp. 65–84, 2009.
- 28.K. Park, R. Ewing, S. Sabouri, and J. Larsen, "Street life and the built environment in an auto-oriented US region," *Cities*, Nov. 2018.



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