IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, March 2023

Planning and Evaluating Road Network Configuration in Urban Context: An Analytical Study

Vivek Raj[1] and Raushan Kumar[2]
Research Scholar, Department of Civil Engineering[1]
Assistant Professor, Department of Civil Engineering[2]
Eklavya University, Damoh M.P, India

Abstract: *It is essential to consider supply disparities in the urban road network when developing an equitable and sustainable urban growth model for cities. In order to lead the optimisation and correction of the urban road network, this research proposes to apply the notion of fractal analysis to an assessment of the layout and internal structure characteristics. This is significant because it encourages sustainable urban development, optimises the use of geographical space, and directs the use of urban land. The objective of this project is to establish evaluation standards for residential area road networks. To do this, a review of earlier studies on road network evaluation standards, neighbourhood road network designs, and urban plan paradigms is done.*

Keywords: Road Networks, Evaluation Criteria, Eco-Friendly Transportation Network, Residential Area

I. INTRODUCTION

One of the key social infrastructures that make up cities is the road network, which is crucial for allowing citizens to live comfortably and with mobility in residential neighbourhoods. But although the precise extent of this injury is still unknown, persons who live in residential areas close to roadways are in fact negatively impacted by these roads on both a direct and indirect level. There are numerous challenges in planning road networks from the viewpoint of the residents since road networks in current residential neighbourhoods are designed based on the arbitrary conceptions of planners. Numerous issues have resulted from this, including poorly planned residential road networks in terms of road comfort, safety, and efficiency. Road network plans have recently begun to incorporate user-oriented paradigms, such as plans for road networks that prioritise pedestrians or public transportation, as well as environmentally friendly designs. Nowadays, many see walking and bicycle as acceptable forms of transportation. According to TEA-21, "where appropriate, bicycle transportation facilities and pedestrian walkways shall be considered in conjunction with all new construction and reconstruction of transportation projects, with the exception of areas where bicycle and pedestrian use is prohibited" (Federal Highway Administration, 2003). Comfortable cities require road network designs that take into account the shifting paradigm of urban planning. Although research pertaining to the evaluation of urban road networks have taken into account the efficiency and mobility of motorways, pedestrian paths, and bicycle paths, no studies have carried out an integrated assessment of these three elements. As a result, an evaluation framework representing the opinions of residential area road network users, motor way evaluation indexes, environmentally friendly transportation networks such bicycle and pedestrian paths, and public transit networks were created for this study. Both the quantitative evaluation criteria mobility and efficiency and the qualitative evaluation criteria safety, comfort, and convenience that had been taken into account in earlier research were taken into account when formulating the evaluation criteria. This study's main ideas can be roughly categorized into four sections.

II. LITERATURE REVIEW

The main evaluation criteria to take into account while developing residential area road networks were derived, and road network plan aspects offered in various urban plan paradigms were analysed. Public transportation linkage, traffic safety, energy efficiency, air pollution, and noise are all major planning factors according to the Compact City Theory, an urban planning theory that focusses on the relationships between transportation and city densities (Michael, 1994; Peter and Harry, 1997; Haiyan et al., 2008). Smart Growth is a concept in urban development that tries to preserve a

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, March 2023

good environment and a high level of comfort. It is a combined strategy that uses areas in existing cities for public transportation amenities, pedestrians, residences, and commerce. Review of the road network plan elements found in various urban plan paradigms led to the derivation of the main assessment criteria for residential area road network planning. The Compact City Theory is an urban planning theory that focusses on the connections between transportation and city densities. It identifies noise, air pollution, public transportation connectivity, energy efficiency, and traffic safety as important planning considerations (Michael, 1994; Peter and Harry, 1997; Haiyan et al., 2008). In order to maintain a pleasant atmosphere and a high standard of comfort, smart growth is a combined plan that uses space in existing cities for pedestrians, residences, businesses, and public transportation services. It indicates that creating pedestrian-friendly neighbourhoods, enhancing walking, and making public transportation more accessible are crucial for achieving this goal (Steven et al., 2006). The ideology known as "New Urbanism" seeks to bring neighbourhoods back to the centre of cities with a humanistic focus. It prioritises the creation of environmentally friendly and effective pedestrian pathways as well as the preservation of connectivity between highways and walking areas as key components of road network designs (Larry, 1999). In order to address the issues raised by land use plans that prioritise automobiles, Transit-Oriented Development (TOD) proposed a number of key plan components, including reducing air pollution, building pedestrian-friendly street linkages, railroad plans, and passenger car moving distances. (Ronnie, 2006; Jennifer and Robert, 2008). A human-scale, walkable community with a mixed-use core and moderate to high residential density is called a Traditional Neighbourhood Development (TND). Because TNDs encourage and accommodate different modes of transportation, they have a stronger potential to generate modal splits than standard suburban development. Additionally, TNDs are more likely to record interior journeys, which lowers the number of miles driven by vehicles. There are a lot of connected roadways, pavements and pathways in TNDs. Bicycles, pedestrians, and cars all share the same streets and right-of-ways. According to David et al. (2000), the dense network of TND streets provides continuous pathways that improve non-vehicular travel in an interdependent manner. The project promotes bicycling and walking, expands the availability of transit services, and increases traffic safety by encouraging low speed, and cautions driving while fully accommodating the needs of pedestrians and bicyclists.

Sr no.	Author Name	Year	Results
1	Michael	1997	The Compact City Theory is an urban planning theory centered on the relationships between transportation and city densities, and presents public transportation linkage, traffic safety, energy efficiency, air pollution and noise as major plan factors
2	Peter and Harr	1997	The Compact City Theory is an urban planning theory centered on the relationships between transportation and city densities, and presents public transportation linkage, traffic safety, energy efficiency, air pollution and noise as major plan factors
3	Haiyan et al.,	2008	The Compact City Theory is an urban planning theory centered on the relationships between transportation and city densities, and presents public transportation linkage, traffic safety, energy efficiency, air pollution and noise as major plan factors
4	Larry	1999	it presents the formation of efficient and environment friendly pedestrian ways and the securing of connectivity between motor ways and walking spaces as major plan factors in road network plan
5	David et al.,	2000	The dense network of TND streets functions in an interdependent manner, providing continuous routes that enhance non-vehicular travel
6	James et al.	2003	divided a 10-mile section of road located in Chapel Hill, North Carolina into 31 segments to evaluate the pedestrian and bicycle ways adjacent to roads.
7	Campo	2009	defined the major criteria to be considered in planning bicycle way networks as accessibility, directness, continuity, route attractiveness and low conflic
8	Todd et al.	2009	presented guidelines that can be utilized when planning pedestrian, bicycle ways and criteria for evaluation methods

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, March 2023

9	FHWA	2008	uggested that safety, convenience and comfort should be secured in access systems between all starting points and all destinations in a community
10	Lindsey et al.	2008	suggested that an enhanced quality of life for residents is very closely related to livable streets, and presented traffic injuries, noise and air pollution, vehicle speeds and traffic speeds as items to be considered when designing these livable streets

III. CRITERIA FOR DEDUCTING ROAD NETWORK EVALUATION

(i) Deriving Road Network Evaluation Criteria- A five-step procedure was used to develop the evaluation criteria for the road network in residential areas.

Step 1: Analysing prior research to determine preliminary evaluation criteria
Step 2: Creating questionnaires with initial assessment standards
Step 3: Using the first expert questionnaire survey to determine evaluation criteria (One Sample t-test) Creating questions to determine the weighted values of the assessment criteria is the fourth step.
Step 5: Using the second expert questionnaire survey, determine the weighted values of the evaluation criteria (AHP analysis) 63 preliminary evaluation criteria that aligned with the current study's objectives and were thought to make it possible to measure and quantify road network evaluation criteria were chosen from the evaluation criteria established in earlier research.

(ii) Calculation of the Weighted Values of Evaluation Criteria- The residential area road network evaluation criteria's weighted values were determined using the Analytical Hierarchy Process (AHP). AHP is a technique for expressing quantitative aspects as values that can be applied in intricate scenarios involving numerous criteria and decision-making. Pairwise evaluations of the significance of numerous evaluation criteria for a consistent setting of priorities characterise this (Saaty, 1980). AHP questionnaires for the second expert questionnaire survey were created using the 42 evaluation criteria in order to determine the weighted values of the evaluation criteria. A survey of 40 experts 20 traffic planners and 20 urban planners was also carried out.

IV. METHODS FOR APPRAISAL OF CRITERIA

(i) Overview of the Method of Scoring the Evaluation Criteria- The 42 evaluation criteria were separated into quantitative and qualitative indicators in order to score the road network evaluation criteria.

Field surveys and simulations were used to gather data on qualitative indicators. The EMME/2 simulations yielded results for the efficiency indicators V/C and average traffic speeds, while actual field measurement surveys based on road installation criteria were used to determine the extent to which the design criteria was satisfied for the planning quality indicators.

(ii) Method Used to Score Residential Area Road Network Evaluation Criteria- Efficiency, environmental quality, planning quality, accessibility, convenience, and comfort, as well as the techniques for rating each feature, were the seven elements that make up the residential area road network evaluation criteria. After an earlier test of the appropriateness of evaluation criteria, 42 evaluation criteria were developed for assessing the road networks in residential areas.

(iii) Planning Quality- The design criteria and forms of motorways, bicycle and pedestrian paths that complement land use plans, illustrating the connections between land use and roads, conformance to design criteria, an evaluation criterion for the geometrical structures of roads, and the appropriateness of road hierarchies, or the connectivity of roads, are all part of the planning quality indicators. As of yet, no precise standards have been provided for the qualitative indicator of harmony with land use plans. Therefore, in this study, field questionnaires were used to rate the harmony between the use of the surrounding areas and the roadways using 5-point Likert scales.

(iv) Accessibility- The accessibility indicator, which consists of travel times to bus stops and subway stations, is meant to assess how accessible certain locations are for locals. In order to assess the assessment criteria for this indicator, a map was used to indicate the locations of subway stations and bus stops close to residential areas. The accessibility score was calculated by measuring the distances between the centre of the region and these sites. In order to calculate

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, March 2023

the assessment scores, the distances were divided into 100-meter intervals starting with a 500-meter reference distance, which typically represents the station regions' radius.

V. CONCLUSION

The paper's objective was to offer standards for evaluating residential road networks. The review of studies pertaining to urban plan paradigms, neighbourhood road network designs, and road network evaluation criteria resulted in the selection of 42 road network evaluation criteria through first and second expert questionnaire surveys, the computation of weighted values, and the establishment of procedures for scoring the resulting evaluation criteria. The road network evaluation criteria were divided into two categories: interregional and regional road networks. To develop the assessment criteria, the former were divided into public transit and motorways (major roads and auxiliary main roads), while the latter were divided into motorways (distributed roads, local roads), pedestrian ways, and bicycle ways. An AHP analysis of the weighted values of the assessment criteria revealed that eco-friendly transport networks, such as bicycle and pedestrian lanes, are more significant than other networks. Regional road networks are also more significant than interregional road networks. Road network evaluation criteria were divided into quantitative and qualitative indicators, and scoring methods were presented taking into account the distinctive characteristics of each assessment criterion.

REFERENCES

[1] LIU, X., WANG, J., LIU, T., XU, J. Forecasting spatiotemporal boundary of emergency-event-based traffic congestion in expressway network considering highway node acceptance capacity. Sustainability [online]. 2021, 13(21), 12195. eISSN 2071-1050. Available from: https://doi.org/10.3390/su132112195

[2] BECKMANN, M. J. Traffic congestion and what to do about it. Transportmetrica B: Transport Dynamics [online]. 2013, 1(1), p. 103-109. ISSN 2168-0566, eISSN 2168-0582. Available from: https://doi.org/10.1080/2168 0566.2013.780988

[3] MATHEW, T. V., BOMBAY, I. T. Automated traffic measurement. Transportatin System Engineering [online] [accessed 2021-09-11]. Lecture notes and presentations. Available from: https://www.civil.iitb.ac.in/tvm/1100_LnTse/ceTseLn/ceTseLn.html

[4] KIM, J., SARKAR, S., VENKATESH, S. S., RYERSON, M. S., STAROBINSKI, D. An epidemiological diffusion framework for vehicular messaging in general transportation networks. Transportation Research Part B: Methodological [online]. 2020, 131, p. 160-190. ISSN 0191-2615. Available from: https://doi.org/10.1016/j.trb.2019.11.004

[5] WANG, D. Z. W., XIE, D. F. Reliable transportation network design considering uncertain demand variability. Journal of Sustainable Transportation [online]. 2016, 10(8), p. 752-763. ISSN 1556-8318, eISSN 1556-8334. Available from: https://doi.org/10.1080/15568318.2016.1149644

[6] Traffic counting systems - General Directorate of Highways [online] [accessed 2022-03-21].
Available from: http://www.kgm.gov.tr/SiteCollection Documents /KGMdocuments/Istatistikler/ TrafikveUlasimBilgileri/17TrafikUlasimBilgileri.pdf

[7] KOC, E., CETINER, B., ROSE, A. SOIBELMAN, L., TACIROGLU, E., WEI, D. CRAFT: Comprehensive resilience assessment framework for transportation systems in urban areas. Advanced Engineering Informatics [online]. 2020, 46, 101159. ISSN 1474-0346. Available from: https://doi.org/10.1016/j.aei.2020.101159

[8] GAUTHIER, P., FURNO, A., EL FAOUZI, N. E. Road network resilience: how to identify critical links subject to day-to-day disruptions. Transportation Research Record [online]. 2018, 2672, p. 54-65. ISSN 0361-1981, eISSN 2169-4052. Available from: https://doi.org/10.1177/03611981187921

[9] WEN, H., SUN, J., ZENG, Q., ZHANG, X., YUAN, Q. The effects of traffic composition on freeway crash frequency by injury severity: a Bayesian multivariate spatial modeling approach. Journal of Advanced Transportation [online]. 2018, 2018, 6964828. ISSN 0197-6729, eISSN 2042-3195. Available from: https://doi.org/10.1155/2018/6964828

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, March 2023

[10] HADAS, Y., GNECCO, G., SANGUINETI, M. An approach to transportation network analysis via transferable utility games. Transportation Research Part B: Methodological [online]. 2017, 105, p. 120-143. ISSN 0191-2615. Available from: https://doi.org/10.1016/j.trb.2017.08.029

[11] ZHANG, X., ZHANG, H. M., LI, L. Analysis of user equilibrium traffic patterns on bottlenecks with time-varying capacities and their applications. International Journal of Sustainable Transportation [online]. 2010, 4(1), p. 56-74. ISSN 1556-8318, eISSN 1556-8334. Available from: https://doi.org/10.1080/15568310601060036

[12] FREEMAN, L. C. The development of social network analysis. Vancouver, BC Canada: Empirical Press, 2014. ISBN 1-59457-714-5.

[13] PRITCHARD, J. P., MOURA, F., ABREU E SILVA, J. Incorporating social network data in mobility studies: benefits and takeaways from an applied survey methodology. Case Studies on Transport Policy [online]. 2016, 4(4), p. 279-293. Available from: https://doi.org/10.1016/j.cstp.2016.09.002

[14] CHENG, Y. Y., LEE, R. K. W., LIM, E. P., ZHU, F. Measuring centralities for transportation networks beyond structures [online]. In: Applications of Social Media and Social Network Analysis. KAZIENKO, P., CHAWLA, N. (eds.). Lecture Notes in Social Networks. Cham: Springer, 2015. ISBN 978-3-319-19002-0, eISBN 978-3-319-19003-7, p. 23-39. Available from: https://doi.org/10.1007/978-3-319-19003-7_2

[15] COOPER, C. H. V. Predictive spatial network analysis for high-resolution transport modeling applied to cyclist flows, mode choice and targeting investment. International Journal of Sustainable Transportation [online],2018, 12(10), p. 714-724. ISSN 1556-8318, eISSN 1556-8334. Available from: https://doi.org/10.1080/15568318.2018.1432730

[16] WATTS, R., WITHAM, A. Social network analysis of sustainable transportation organizations [online].Available from: http://www.uvm.edu/~transctr/research/trc_reports/UVM-TRC-12008.pdf 2012