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Research paper

The evolution of studies in traffic management: a systematic literature review (2007-2018)

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Abstract

The purpose of this paper is to critically review the papers published in the area of traffic management system. The current Traffic conges-tion in our highway networks should be addressed with top most priority. And steps to identify the issues and challenges associ-ated with traffic congestion in our highway networks including National highway, state highways, fast-transit corridors, and traffic hubs shall be analyzed to understand the basic root causes of traffic congestion. The paper aims to critically evaluate the available evidence on the contri-bution of traffic management systems. Design methodology– structured literature review approach is adopted to analyze the previously pub-lished papers. Findings – The review concludes that there is a growing body of research that supports the assertion that integrated traffic management system is the solution for the current congestion of traffic situations in major metro cities. The findings also conclude that lim-ited amount of work has been carried out in the field of integrated traffic management system in India.

Keywords: *Traffic; Integrated Traffic Management System (ITMS); Congestion; Metro-Cities; India; Sustainability.*

1. Introduction

1.1. Economic costs of traffic congestion

The management and control of traffic are linked with the conges-tion of traffic on roads and the kind of infrastructure provided to manage the flow of traffic. The parameter to describe road traffic are such as speed, flow and density of vehicles moving on that particular section of road. While estimating the traffic congestion, different parameters were used. However, the models used to es-timate the traffic patterns sometimes fails to report the underline issues. In such cases, the real-time live traffic data shall be consid-ered for the traffic state, e.g. traffic counts and speed/travel time measurements [1]–[5].

Most of the problems faced by today's traffic networks are caused by the ever-increasing usage of the traffic system. Congestion in roads and highways is considered to be one of the prominent is-sues that should be analyzed and correction measure shall be taken to minimize the loss of extra money, time and to reduce the impact over the environmental (sustainability). Researcher's, academi-cians, and policymakers need to work together to manage the swift flow of traffic. The problem of traffic congestion shall be resolved by laying extra roads for the vehicles, or lanes to cope with the traffic demand, or either imposing extra taxes to limit the demand. Feasibility and applicability of both the cases are difficult, because for the laying extra roads need money and resources, and for rais-ing the taxes our political leadership feels vulnerability in that case. Now the last hope is to use the currently available infrastructure efficiently to manage the traffic flow and save our environment [6]–[9].

The other important part of the traffic system has enabled with intelligence gadgets such as onboard sensors, navigation tools, GPS enables, real-time traffic input, an alternate route option is also suggested on the basis of historical and live data patterns. And also used for gathering information such as their position and speed, and with many fast devices that process and present the obtained information in a meaningful and usable form [10]–[13].

1.2. Current situation and bottlenecks

The current Traffic congestion in our highway networks should be addressed with top most priority. And steps to identify the issues and challenges associated with traffic congestion in our highway networks including National highway, state highways, fast-transit corridors, and traffic hubs shall be analysed to understand the basic root causes of traffic congestion. And an integrated traffic management system (ITMS) shall be proposed for pilot study in Noida-Greater Noida region of Uttar Pradesh. Automation com-bined with the increasing market penetration of online communi-cation, navigation, and advanced driver assistance systems will ultimately result in ITMS that distribute intelligence between roadside infrastructure and vehicles and that in particular on the long term are one of the most promising solutions to the traffic congestion problem [4], [14]–[16].

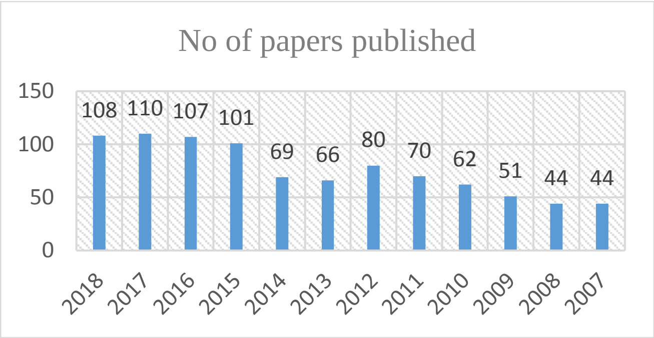

Fig. 1: Number of Papers Published Year Wise.

Table 1: Top 10 Affiliations

Affiliation	No of papers published
Delft University of Technology	28
Deutsches Zentrum fur Luft- Und Raumfahrt	16
NASA Ames Research Center	13
ETH Zürich	13
Massachusetts Institute of Technology	12
Beijing Jiaotong University	12
Nanyang Technological University	10
Chinese Academy of Sciences	10
Tsinghua University	10
Purdue University	9

Table 2: Top 10 Authors

Author	No of papers published
Corman, F.	11
Collotta, M.	9
Pau, G.	8
Abdelghany, K.	6
D'Ariano, A.	6
Hashemi, H.	6
Sastry, J.K.R.	6
Castelli, L.	5
De Schutter, B.	5
Gardi, A.	5

Table 1: Top 10 Countries

County	No of papers published
United States	231
China	107
United Kingdom	72
Italy	59
Germany	53
India	52
Netherlands	51
France	45
Spain	40
Australia	38

2. Methodology

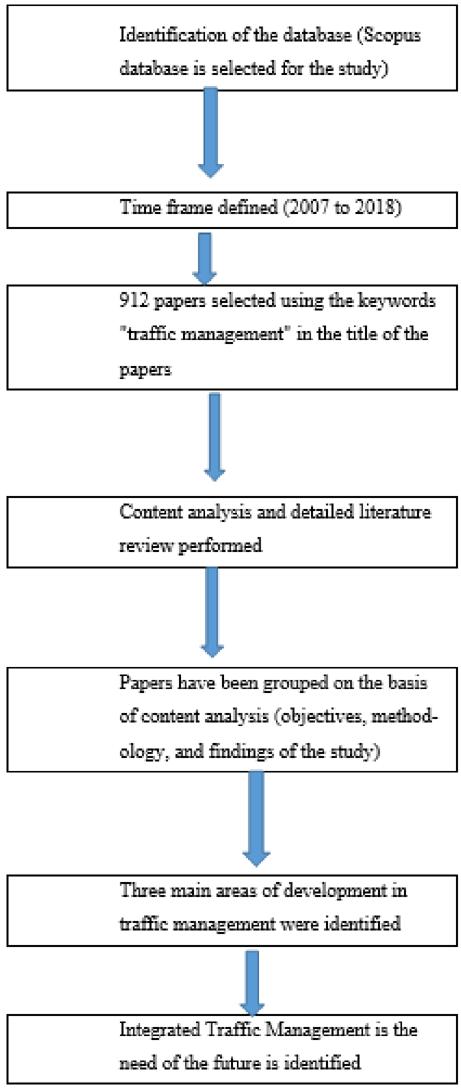

Fig. 2: Flow Chart of the Methodology Adopted.

3. Systematic literature review (SLR)

To fulfil the objective of the study, the author's adopt a Systematic literature review (SLR) focusing on the leading indexing bodies like Scopus. Cook et al., firstly used SLR and track its presence in the medical and healthcare fields as well. When we compare SLR with traditional and less systematic review approaches, SLR is generally considered better, as other researchers can easily verify the findings of the study. SLR enables the author's to cover the literature in a systematic and more comprehensive way[18]–[20]. It covers a specific time duration, in this paper from post-2007 literature from authentic sources. Only full text published articles with the terms traffic management in the title of the targeted Scopus database. A total of 912 papers were identified from the database.

In 2005 [21] has studies the role of York Council in the development of the UK's Urban Traffic Management and Control (UTMC) programme. There major focus on the establishment and functioning of a centralized and common database for sharing the information between information sources and applications. The new database adopted in York id the heart of the system, and it is used for storing the data and development and implementation of control algorithms and data processing.

[22] Studied the use of information technology in automation of traffic fine issue and management. This scheme is sponsored by the government for using RFID (Radio-Frequency Identification)

tag is an electronic label, known as an advanced form of barcodes. They concluded that the issuance and management of traffic are possible by implementing and utilizing the integrated traffic management systems.

In 2017 [23] summarize the traffic management strategies to improve the flow of traffic, improvement in air quality, and the effectiveness of traffic management strategies (TMS) for mitigating emissions, ambient concentrations, human exposure, and health effects of traffic-related air pollution in urban areas. The authors explain the strategies relevant to the local municipal and regional government plans. They have used a systematic literature review to analyse the impact of traffic management system on air quality, safety, number of incidents, the amount of emission and exposure. The findings of previous studies have been discussed and analysed.

In 2018 [24] studied the development and pattern of traffic congestion, deterioration, and traffic accidents of the environment because of fast growth in population, and the increase in level of urbanization (a major portion is because of the migration from rural to urban area for seeking high wages, and good opportunities of carrier growth) have become one of the significant issues in the Asia-pacific region. To resolve the issue of traffic congestion and to maintain a swift speed of traffic the intelligence system is the need of the hour. It uses information communication technologies to manage traffic flow and functioning. Majority of the Asian countries facing the issue of traffic congestion and the policymakers and administration is adopting the use of traffic management systems to manage the situation. The authors highlighted few problems while adopting the intelligent traffic management system such as lack of coordination between the stakeholders, lack of technical support, lack of a master plan and issues in its implementation because of political interferences, and financial constraints in its implementation. The authors suggest that in order to implement integrated traffic management effectively it is important to plan, execute, evaluate, and take corrective measures if needed according to the situation on the ground.

In 2018 [12] studied the fact that road transportation negatively affects the quality of the environment and deteriorates its bearing capacity has drawn a wide range of concerns among researchers. They explained that in order to know the exact situation and to propose realistic traffic data for the estimation purpose and to capture the demand in the master plan we need to have a centralized database management system to capture the data directly from sensor enables vehicle such as speed of vehicle in different – different times, congestion patterns, accident-prone area, and others. The authors also emphasis on the importance of environment and sustainability while planning for new infrastructures such as dedicated freight corridors, national highways and other schemes.

In 2018 [9] suggested that the rapid development in machine learning and in the emergence of new data sources help to examine and predict the issue and challenges of traffic management in smart cities. They concluded that this could optimize the design and management of transport services in a future automated city. The authors provide a detailed presentation of the predicted traffic patterns using intelligent traffic management system for the smart cities.

Table 2: Categorization of Traffic Management Strategies

Categorization of traffic management strategies		
Factors	Attributes	References
Operating restrictions & pricing	Road, congestion and cordon pricing: tolling, distance pricing, or pricing based on time-of-day or congestion levels	[7], [9], [31], [21], [23], [25]–[30]
	Low/zero emission zones and eco-zones: pricing or restrictions based on emissions status of vehicles	[11], [12], [25], [32]–[38]
	Vehicle operating and access restrictions: by zone, time-of-day, or route	[2], [14], [28], [37], [39]–[44]
	Parking management: supply and pricing strategies	[21], [23], [30], [45]–[49]
Lane management	High occupancy vehicle (HOV), High Occupancy Toll (HOT), and eco-lanes	[9], [12], [31], [50]–[52]
	Truck and/or bus lanes	[23][2], [25], [31]
	Lane capacity changes (road diets, peak shoulder running)	[23], [37], [40], [53]
Speed management	Lower speed limits	[2], [54], [55]
	Variable speed limits	[2], [54], [55]
	Speed control devices: traffic calming such as humps, chicanes, micro-roundabouts	[54]–[60]
	Speed enforcement devices & programs	[30], [40], [46]
	Eco-driving, eco-routing (not requiring significant new technology)	[8], [12], [35]
Traffic flow control	Ramp meters	[15], [53], [54], [56], [57]
	Electronic toll collection	[2], [23], [30], [61]
	Incident management systems	[38], [51], [53], [62], [63]
	Intersection control device: roundabout, signal, stop signs, etc.	[11], [64], [65]
	Traffic signal timing: signal coordination, adaptive signal systems, transit signal priority, etc.	[11], [40], [42], [60], [66]–[69]
Trip reduction strategies	Shared-ride programs: carpool/vanpool/rideshare programs, incentives, and services	[2], [27], [50]
	Employer programs for trip reduction: flextime, telework	[9], [46]
	Transit improvements: pricing, service quality, etc.	[2], [8], [23], [30], [31], [51]
	Pedestrian and bicycle facilities: roadway & trip-end facilities	[2], [9], [46], [70]
	Outreach & marketing (to reduce auto use)	[6], [14], [23], [71]

Table 3: Previous Studies

Field	References
Transportation	[10], [12], [52], [61], [67], [71]–[75], [29], [31], [35], [36], [41], [46], [47], [50]
Environmental Science	[12], [23], [76], [77], [37], [45], [46], [48]–[50], [61], [68]
Economics and public policy	[1], [2], [78], [9], [12], [22], [23], [45]–[47], [77] [1], [35], [70]
Health	[9], [12], [23], [29], [30], [41], [50]
Safety	[1], [6], [48], [50], [61], [63], [72], [77], [79], [80], [13], [15], [23], [29]–[31], [46], [47]
General	[6], [7], [71], [74], [81]–[85], [35], [39]–[41], [49], [52], [53], [55]
Advanced/Intelligent/Integrated traffic management systems	[5], [10], [57], [61], [64], [70], [75], [76], [82], [84], [86], [87], [11], [88], [89], [16], [28], [31], [41], [47], [54], [56]

4. Discussion and conclusion

In an Integrated traffic management system framework the new data sources are used for improving the performance of the system and provide an extra value to all the stakeholder's such as the policymakers, the administration bodies, the operational staff, the end users, the commonality and the other directly and indirectly associated to the traffic and surrounding environments. The proposed ITMS framework is enabled with different traffic models those shall suggest the possible routing mechanism on the basis of daily data, the speed of vehicles, and the current status of traffic. ITMS framework not only helps in predicting the traffic condition but also to use the available data and models to shape it. This can be done by evaluating control strategies, with respect to some system performance measurement, using a traffic model [54], [60], [80], [83], [122]–[125].

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