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UNDERSTANDING TRAFFIC CONGESTION FROM STAKEHOLDERS' PERCEPTIONS IN THE CENTRAL AREA OF LAHORE, PAKISTAN

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Congestion on roads results in infrastructural deficiencies including massive delays, greater fatalities, and enhanced mental stresses, reduced transit efficiency, and increased travel costs. Traffic is a major problem specifically in the central area of the Lahore city. This study is aimed at understanding the traffic congestion from the stakeholders' perspective and suggesting congestion mitigation measures. A sample of 365 respondents was included through the administration of the questionnaire survey to record the explanatory variables. For this purpose, random cluster sampling method was employed to select respondents (135 pedestrians, 107 shopkeepers, 116 motorists). In-depth interviews were conducted with 7 individuals from Traffic Engineering and Planning Agency (TEPA) and Department of Transportation Engineering and Management (DTEM), about their perceptions of traffic management in the Lahore city. The results are described in the form of statistics of the data, qualitatively and quantitatively. The study has shown that the illegal parking on roadside, bad attitude of motorists and shop keepers, encroachments and running business on streets are the primary reasons for traffic congestion. These traffic congestions are hindering the efficient movements of the flow entities and causing mental stresses in the local residents. The findings of this study endorse that strict enforcement of traffic laws, provision of adequate parking spaces, provision of overhead pedestrian bridges, and education of traffic rules among masses could help to manage the traffic congestion in the central area of Lahore city.

Key words: traffic congestion, stake-holders' perception, traffic mitigation, traffic management

INTRODUCTION

Experts around the globe rank traffic congestion among one of the nine major infrastructural deficiencies, which is a major cause of massive delays, greater fatalities, more mental stresses, more operating costs and overall reduced transit efficiencies [1]. Traffic congestion is one of the very severe problems especially in the developing world which is expected to get worse over the next decade if not prevented or mitigated by effective management [2], [3]. Traffic congestion is affecting developed countries as well. For example, according to the mobility report by Texas Transportation Department [4], traffic congestion has increased substantially in the last two and half decades which accounts for an extra incurred cost wastage of 83-124 billion dollars. The worst traffic jam has been experienced by the Brazilian city of Sao Paulo, where on average people are stuck on the roads 3-4 hours on daily basis [5]. Hebei, a province in China, had the worst ever traffic jam in the recent history when the people were stuck on the roads up a length of 100 km between 14th to 26th of August 2010 [6].

Traffic congestion situations are having very clear and obvious implications on economic activities, fuel and time wastage, and economic loss [7]. The major cities of

Pakistan such as Karachi, Lahore, Hyderabad, and Faisalabad are much vulnerable to the effects of the traffic congestion, which have attracted very less attention and interests of the researchers from academia and traffic management organizations [8]–[13].

Pakistan has witnessed some of the institutional reforms on over the last two decades which shaped the current transport system of the country. These reforms include the establishment of the Department of Transportation Engineering at University of Engineering and Technology, Lahore, which is one of the prestigious engineering institutions in the country back in 2001. The Lahore Development Authority (LDA) [14] constituted an autonomous body Traffic Engineering and Transport Planning Agency (TEPA), which formulated a Transport Plan for Lahore city in close coordination with Japan International Corporation Agency (JICA) for the first time in 1991 and then in 2011, 2012 keeping in view of the Transport Master Plan 2021 [15]. Thus, TEPA is responsible for the management, maintenance, and operations of the transportation infrastructure in the Lahore city.

The very common characteristic of the many roads in the Lahore central area is the presence of the critical congestion points where the mobilization of humans

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and vehicles is maximum due to large volumes of traffic in peak hours [9], [15]. These central areas are mainly busy shopping markets with poor traffic management systems. These congestion bottlenecks are very troublesome for reliable transit movements but have attracted very little attention for research point of view [11]–[13].

Research objectives

This study is aimed at understanding the main causes of traffic congestion, effects of traffic congestion from stakeholders' perceptions, and how these findings can be used to influence the effective policymaking for better traffic management in central Lahore. These findings can also be replicated in other busy market areas of Pakistan, with similar characteristics and traffic patterns. This study can be used as a milestone for transport / urban planners for traffic management from stakeholders' perspectives in developing countries. The results of this research study can be helpful in understanding the existing traffic problems in the central Lahore area and can be implemented in other cities with similar traffic characteristics. However, the selection of the characteristics is an important and essential part of choosing suitable and feasible measures [9]. In this study, an attempt is made to answer the following questions:

- What are the main reasons behind traffic congestion in the central Lahore area from stakeholders' perspectives?
- What are the effects of traffic congestion in the central Lahore area from stakeholder's perspectives?
- What strategies and measures can be adopted for effective and efficient traffic management control from stakeholders' perspectives?
- How these measures can influence the policy formulation for traffic management control in central Lahore?

The remainder of this research paper is divided in seven sections; section 2 discusses the literature review with major focus on causes, effects of traffic congestion, and traffic management policies which can be put in place in developing countries, section 3 discusses the study area, section 4 is focused on research methodology, highlights research design and demographic features of the respondents, section 5 and 6 describes the research findings and discussions, and section 7 concludes the final recommendations about policy implications and future research directions.

LITERATURE REVIEW

Traffic congestion

There is no concur definition of traffic congestion, however, it is considered as a physical and relative phenomenon [16]. In physical phenomenon, the traffic demand exceeds the capacity of the road network causing massive delays, increased transportation costs, and greater time spending on roads. However, relative phenomenon

is the difference between the road infrastructure performance and users' expectations about the serviceability of the transit network.

Traffic congestion is an unavoidable scenario in many of the vibrant cities around the globe, which are economically and socially active [17]. Urban congestion is greatly because of the two types of flow entities, namely passengers and freight, both of these domains of circulation share the same infrastructure. Traffic congestion is perceived as an inevitable situation because of the scarce transportation facilities such as road width, parking arrangements, signal control systems, and archaic traffic management systems [18]. Traffic congestion is broadly categorized into two different types based on their patterns of occurrence, named recurrent congestion and non-recurrent congestion. The report by Litman et al. [19] at Victoria Transport Policy Institute defined recurrent congestion as, it occurs at the same location on the road intersections, at the same time on daily basis in peak hours and can be predicted. This occurs as a result of the common or familiar factors of commuting for special purposes or weekend trips. However, non-recurrent congestion is the effect of the unplanned or unexpected large events or factors such as accidents, road maintenance activities, religious / social gatherings. They influence the efficiency of the transit network randomly and are not predictable easily. Vickrey classified six different types of traffic congestion based on the interaction of the flow entities and type of occurrence; (1) simple interaction: two vehicles are moving closely on the homogenous road and cause delay, (2) multiple interactions: multiple vehicle travelling on homogeneous route interact with each other and cause delay, (3) bottlenecks: multiple vehicle converge in narrow lanes to pass the same point and cause delay, (4) trigger neck: initial narrowing of lanes generates a long queue of vehicles which do not follow the jammed itinerary, (5) network control: traffic signals programmed to control the traffic during peak hours delay traffic during off-peak hours, (6) network morphology: this is also called as poly-modal polymorphous congestion which is depict the state of traffic itineraries for all transit modes. The cost of intervention on a specific route or segment affects the whole road network because of the effects of the triggered congestion problems [20].

The possible reasons for traffic congestion are not confined and may not be easy to identify all of them in the same research study because of the complexity of the traffic scenarios and schemes. However, there are some of the much specified instances, which aggravate traffic congestion such as; drastic increase in urban populations, surge in vehicle ownership, economic activities and greater employment opportunities in urban centers, poor infrastructure design and investment policies, lack of traffic rules awareness, poor urban and traffic management designs, road-side illegal parking, non-feasible traffic control designs, social and political gatherings, and unpleasant weathers [1], [3]–[5], [18], [21]–[25].

Traffic congestion in developing countries

Jain et al. [26] identified some of the very common and known reasons of traffic congestion in developing countries such as; unplanned expansion of cities, poor traffic sense, lack of public transportation, archaic traffic management systems, and poor road pavement markings. The unplanned expansion of the cities has resulted in narrowing of roads which are poorly built. As most of the cities expand in ad-hoc manner without any prior planning, very little or no attention is given to scale the capacities of the road networks. This results in creation of bottlenecks on many of the routes which extends for an undefined period of time. Most of the road users are not well-educated and not trained enough to follow the traffic rules for smooth mobility. Mistakes by few individuals such as jumping red light can result in massive delays which cost a total wastage of money, resources and deteriorate the already crowded situations. In many of the developing countries, the surge in vehicle ownership is also an important factor which contributes to traffic congestion. Many of the cities are have very poorly designed or non-availability of effective public transit systems, which encourages the riders to own their own private vehicles. More vehicles on-road results in more traffic congestion. Another, important consideration in the developing countries is that people are compelled by social stigma to riding by personalized vehicle and public transport ridership is considered as lower echelons in society. Still, in many of the developing countries, the traffic signal control is archaic and unmanned in many cases. It allows road users to drive in chaotic manners and encourages them to jump the traffic rules. Even if there is any of the traffic police officer or red light, it only controls the traffic of the respective intersection in the direction of the maximum flow. These kinds of poor traffic management strategies further worsen the situation due to the mismanagement accelerating further congestion collapse. Many of the roads in vibrantly active economic cities are not equipped with proper pavement markings or road cosmetics. For example, in case of narrow roads, lane dividers are not provided which allows mixing of the incoming and outgoing traffic, causing traffic delays.

Traffic congestion in central Lahore area

According to the observations of the authors and literature from Mensah et al. [27], some of the obvious factors of traffic congestion in central Lahore can be as follows but not confined to; poor road networks, poor public transport, security check posts, poorly designed traffic signal controls, loading and off-loading of passengers and freight along the roadside, pedestrian obstructions, trading obstructions, narrow traffic lanes, road-side parking lots, illegal parking patterns, lack of self-discipline and awareness of traffic rules.

Effects of traffic congestion

The main effects of traffic congestion can be broadly

grouped into economic, environmental, social and health [21], [24], [25], [28], [29]. However, the nature and severity of the effects may differ based on the conditions of the road infrastructure, availability of transport modes, Spatio-temporal and travel behaviors [2].

Though there is an increasing trend of hybrid vehicles on roads, still vehicles stuck in traffic produce a lot of emissions and noise which causes many of the problems such as smog and respiratory-related issues. The riders who use non-air-conditioned vehicles and are exposed to the open air are more prone to get health risks as compared to commuters who are traveling by closed doors and air-conditioned vehicles. Apart from stress-related issues, there is high probability that their lungs might get affected because of more exposure to the open-air environments. According to the WHO report [30], air pollution causes an apparent 3.2 million deaths each year worldwide. The data record of 2012 by the National Emissions Inventory (NEI) shows that around 71% of the pollution comes from vehicles on road. However, these numbers are expected to grow around 85% as per the records of National Capital Region (NCR).

Traffic management strategies

It is not possible to completely eliminate the traffic congestion but somehow it can be reduced to an acceptable level by employing some of the following measures suggested by Rodrigue et al. in his report [8]. There are basically two methods to mitigate the impacts of traffic congestion namely, Transportation System Management (TSM) and Transportation Demand Management (TDM). Both of these methods include strategies and measures that direct implications on the performance of the transportation system. Some of the measures suggested included speed control, lane management, deterrent measures, dedicated lane systems, awareness of traffic education, road capacity building, enforcement of traffic laws, and provision of proper parking places along the roadside. These traffic management strategies can work well if properly implemented but of course not without incorporating their associated challenges in the planning and execution phase of remedial measures. To address the menaces of traffic congestion, some of the strategies are listed as follows:

Speed control

It has been observed by many of the traffic and land-use planners that variable speed limits on different road segments can greatly improve the traffic flow on the road and it is an effective strategy to regulate the traffic dynamically. As sudden brakes can block the traffic and are not considered good for smooth flow of traffic. However, proper management of speed control can help in improving the traffic flow in a smooth manner. Adjusting speed on the road segment can help in improving traffic condition in the following two ways:

- It greatly reduces the chances of accidents and fatal-

ities on the road,

- It improves the smooth traffic flow instead of sudden traffic jamming.

Lane management

An effective lane management system should be properly and strictly implemented. Different kinds of vehicles should run in their specified lanes and heavy penalties should be imposed on driver who does not comply with lane management systems.

Deterrent measures

The law enforcement agencies should strictly adhere to their SOPs and ask the drivers, pedestrians, and traders to follow the road traffic sense as advised and implemented. Heavy fines should be imposed on drivers who inherently do not follow guidelines by wrong overturning, lane changing, wrong parking, one-way driving and picking, and off-loading passenger and goods at improper places. The pedestrians should be forced to follow proper pedestrian crossings and direct infiltration from unspecified points on roads should be discouraged. They must be compelled to use over-head pedestrian facilities wherever they are provided on major arterial city roads. The traders and shop keepers should be warned, and heavy penalties must be imposed on wrong road-side parking, loading and unloading of goods on roadside.

Traffic education

Traffic awareness and education have positive impact on improving smooth traffic flow and reducing traffic congestion. Traffic awareness seminars should be conducted on regular and consistent manner in schools, universities, and organizations to educate people about the road sense and traffic laws. The textbooks must include traffic safety material with appealing colored diagrams to motivate children's interests in focusing and obeying traffic rules.

Road capacity

The traffic congestion can be effectively reduced by proper Traffic Demand Modelling (TDM). It can be done either by improving the road capacity (supply) or adjusting the traffic (demand) on the road network. There are various ways of improving TDM on the route; increasing number of lanes, creating new or multiple routes connecting the existing road network, proper lane management, parking restrictions, carpooling, provision of better public transport, and reduction in private vehicles on road.

Enforcement of rules

It is mandatory to change the inherent behaviors of road users through the intervention of traffic laws and making them compelled to follow them. However, the recruitment of traffic wardens or traffic police will not be only sufficient for better traffic management. They must be trained frequently and periodically for better traffic control in unexpected events. Also, they must be authorized fully to implement traffic rules without any socio-political pressure.

Provision of proper parking lots

Provision of proper parking places is inevitable for central market areas, especially which are main attraction points from business point of view. There must be proper bus stops and places for pick and drop of passengers by Transportation Network Companies (TNCs) and taxis.

The Triad conceptual framework of effective traffic management [31] is presented below, it highlights the main contributing causes of traffic congestion in developing countries. The main causes include poor discipline, poor cities planning, lack of road traffic sense, archaic management systems, curbside parking, and infiltration of unwanted movements in the main traffic stream. The possible effects of traffic congestion include environmental, economic, social, and psychological effects. The impact of these effects on individual level may cause higher

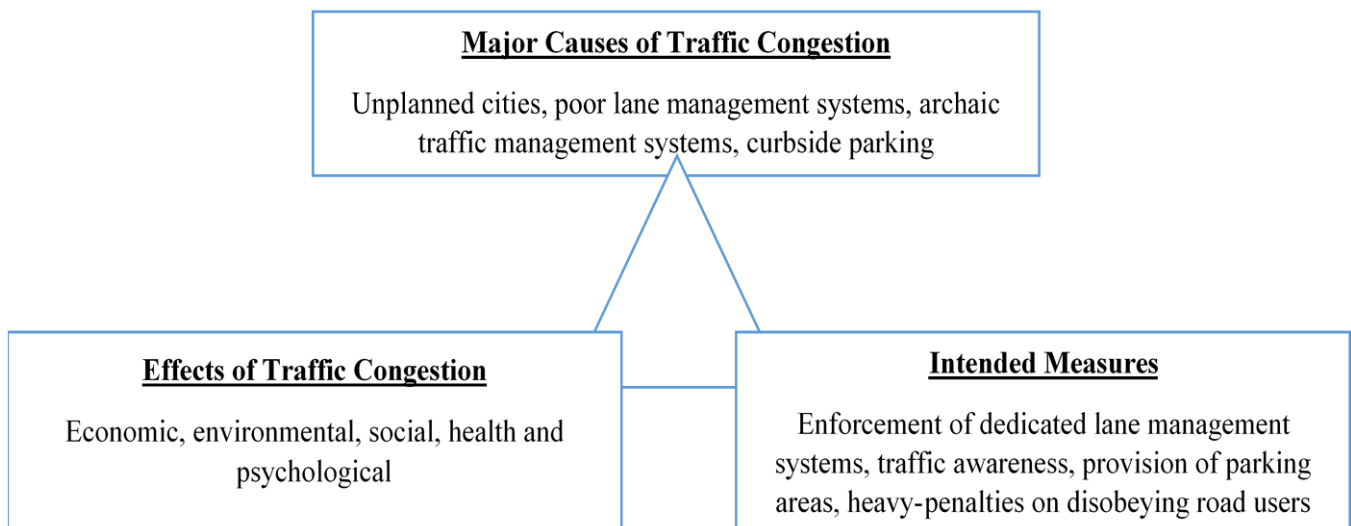


Figure 1: Triad of traffic congestion management [31]

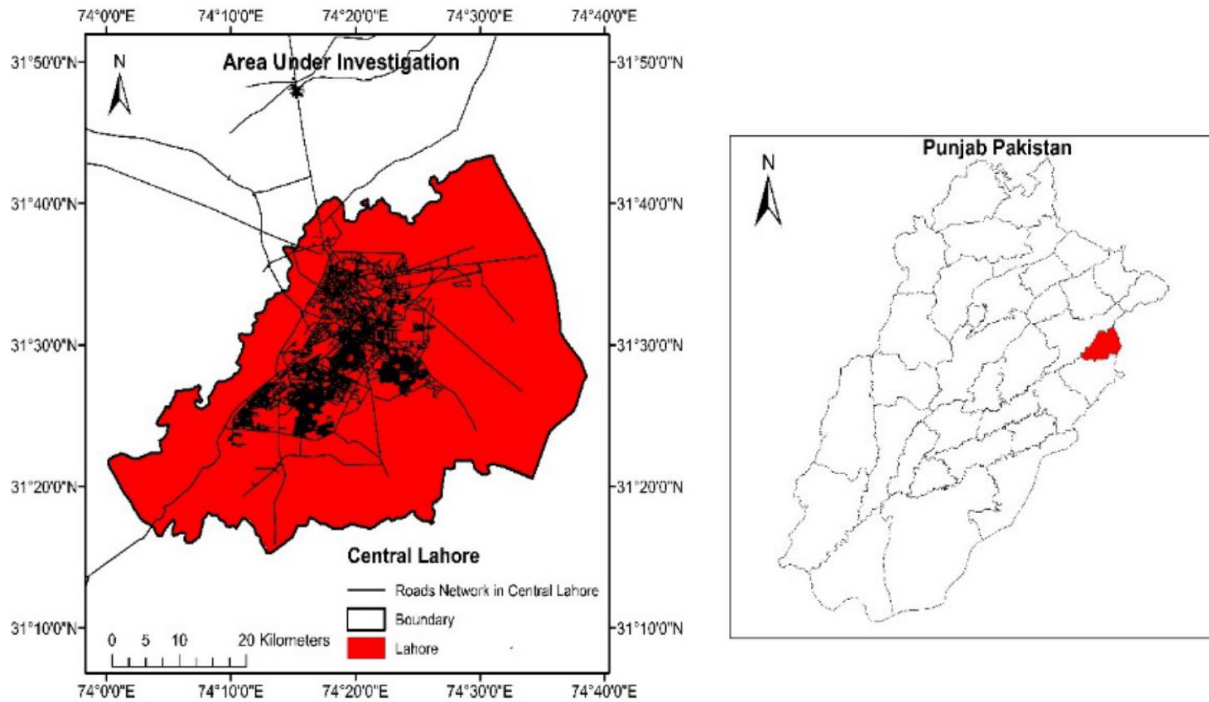


Figure 2: Map showing the location of the Lahore city and road network of Central Lahore

stress levels and road rage [28]. On collective level traffic congestion has adverse effects on economy by reducing the production levels, air pollution [2]. But certain measures can be opted to mitigate the hostile effects of traffic congestion by imposing heavy penalties on violations, strict implementation of traffic rules and regulations in the central Lahore area. This may decrease the menaces of traffic congestion both on individual and collective level.

STUDY AREA

The map of the Lahore city which is the capital of the most populated province of Pakistan is shown in Figure 1. According to estimation the population of the Lahore city is 11.13 million which has increased unprecedentedly over the last decade due to huge infrastructure development investment as compared to the other cities in the province. It is the second most populated city in Pakistan.

The Lahore central area is formally characterized for the informal economy. The most part of the city is covered with traders of foodstuff, cookware, clothing, building materials, shoes, and jewelry. However, it is also congested residences with narrow streets and irregularly planned pathways. There are a lot of banks and other saving financial firms located in the central area. With respect to the recent economic active population, males are the dominant gender who shares a greater part of the traders there. The central part of Lahore city is concentrated with many educational and medical facilities, employment centers, and public offices. There is a high migration of masses from suburban and other parts of the country. The city population has increased rapidly in the last two decades due to concentration of facilities in it and migration trend. Over the years, Lahore has expand-

ed rapidly with the development of housing societies in outer parts. All these trends of urban population growth and suburban development have resulted in increase in traffic demand on main arteries of central Lahore city. The present public transport systems connecting major hubs of the central Lahore city are not efficient and underdeveloped despite construction of BRT on one of major artery. There is still a big gap between the demand and provision of a good quality public transport system. The multitude of small vehicles on road networks in central Lahore has become major problems in terms of traffic management and environmental concerns. Motorcycle traffic has a major share in the road traffic and posing a serious threat to public in terms of traffic safety and demand. Low and middle-income groups consider it as a family mode as it is cheaper than public transport. Uncontrolled land use pattern, inefficient and underdeveloped public transport system, two and three-wheeler traffic and roadside encroachment are contributing factors in traffic congestion. Traffic congestion has become a major issue for the masses as it tends to increase social costs in terms of increase in generalized travel cost and environmental pollution. This traffic congestion is affecting both the commuters from urban and suburban areas. Traffic management and urban land-use policies are required to be considered for mitigation of traffic congestion.

METHODOLOGY

Research design

In this research study, the explanatory type of research design was followed to get an understanding of the conclusive evidence about traffic congestion problems and

their apparent causes in the central part of Lahore city. Explanatory type of research is always followed to get an idea of the existing problems and how they can be managed wherever it is very little or no research is conducted [32].

Demographic features of the respondents and data collection

In this research study, a random cluster sampling technique was employed to select the respondents to know their perspectives about major traffic congestion causes and their remedial measure. Out of a total of 365 respondents, there were 135 (36.98%) pedestrians, 107 (29.31%) shopkeepers, 116 (31.78%) motorists, 7 (0.019%) experts from TEPA and DTEM. There were very few female respondents included in this research study, as there are inherently very few female respondents who are traders (shopkeepers) and motorists. They constitute very small share of respondents, 89 (24.38%) out of total 365. There were three age brackets defined in the questionnaire survey: less than 30 (59.43%) years old, 30-50 (34.92%) years old and more than 50 (0.06%) years old. Most of the respondents were educated with

highest number of University graduates, 186 (50.59%). Keeping in view of the privacy concerns of the respondents regarding the education disclosure, "Others" option was also included if they do not intend to disclose it. The administration of the questionnaire surveys was carried out through road-side survey methods. The response was collected in the form of statistics of data, both quantitatively and qualitatively. The questionnaire was divided into five main parts. The first part includes the basic demographic information of the respondents such as gender, age, marital status, education, and category of the stakeholders. In the second part, major causes of traffic congestion were listed based upon the observations of the researchers, from literature review, and recommended reasons from transport experts. The respondents were given the options of "yes" or "no" to select against each cause of traffic congestion. The third part contains the options for selecting the obvious effects of traffic congestion on the lives of the respondents, which include economic, environmental, social, health, and psychological. The fourth part includes selecting the most responsible stakeholder of traffic congestion in the central Lahore are with options of traders (shopkeepers), pedestrian, motorists, or inadequate planning from transport and traffic planners. The last part includes the descriptive remarks of the respondents about suggestions and recommendations how the menaces of traffic congestions can be reduced. However, the response of the transport and traffic experts was recorded via face-to-face meetings or recorded phone calls. The socio-demographic features of the respondents are shown in Table 1.

Table 1: The socio-demographic features of the respondents

Demographic features	Frequency (N=365)	Percentage (%)
Gender		
Male	276	75.61
Female	89	24.38
Age		
<30	217	59.43
30-50	127	34.92
>50	21	0.06
Marital Status		
Single	196	53.69
Married	160	43.85
Divorced	9	2.46
Education		
High School	67	18.35
College	91	24.93
University	186	50.95
Others	21	5.75
Category		
Traders (Shopkeepers)	107	29.31
Pedestrian	135	36.98
Motorists	116	31.78
Transport experts	7	1.92

RESULTS

As per the response results, most of the people (44%) consider that maximum traffic congestion is between 12:00 – 02:00 PM (Figure 3). This is the opinion of the respondents and may not exactly reflect the actual situation. As the study conducted by JICA as a part of the master plan of the city suggested that the peak-hours at maximum location are between 06:00 – 10:00 am and 04:00 – 07:00 pm [33]. This response can be attributed as most of the shopkeepers open their businesses during this time and park their vehicles on the roadside. It is significantly less as per their perceptions before (7%) and after (19%) this time period. This may also be inferred as most of the respondents are shopkeepers, so they experience the most traffic congestion during this time frame. The second highest response of traffic congestion is experienced between 02:00 – 04:00 PM, which can be attributed as people are moving back from schools and offices, which results in traffic congestion. As per their response, there is very few traffic on roads during early morning (2%) hours as there are only people on roads which are either going to schools or offices. The descriptive statistics of the response of the respondents pertinent to traffic congestion during different times of the day can seem in Figure 3.

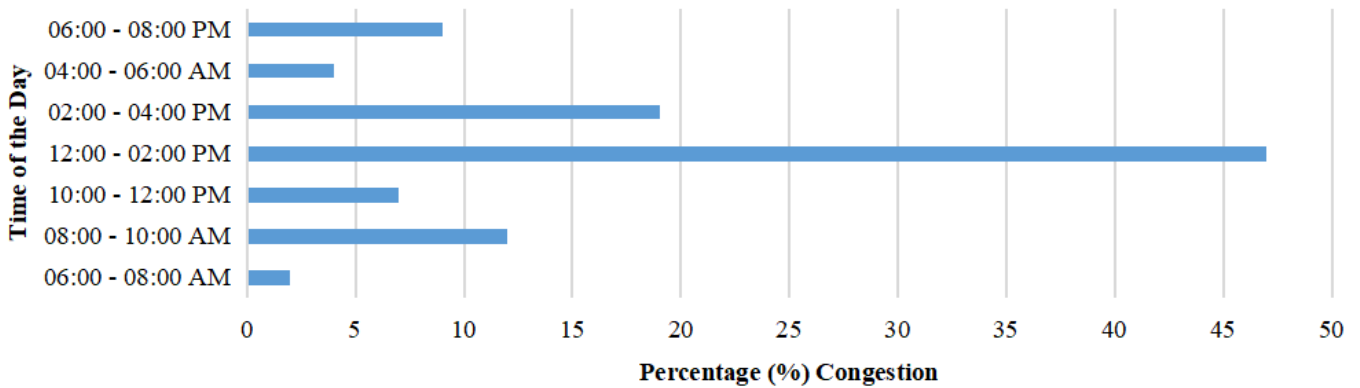


Figure 3: Percentage (%) response to traffic congestion during different day time

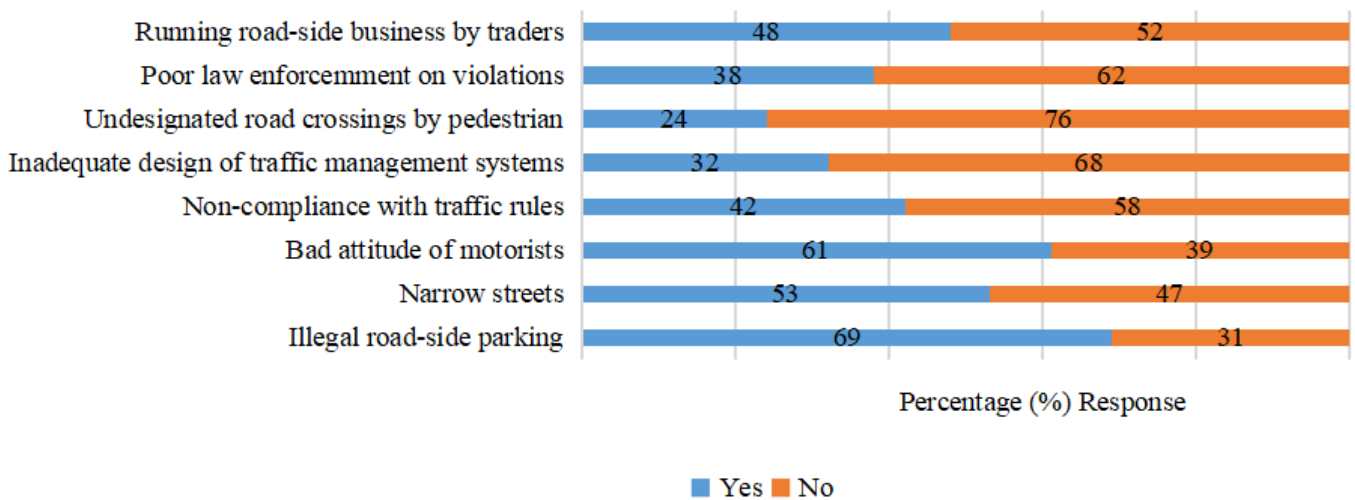


Figure 4: Main contributing factors of traffic congestion in the central Lahore area

As evident from Figure 4, illegal road-side parking (69%), bad attitude of the motorists (61%), and running road-side businesses (48%) by hawkers are the top three reasons of traffic congestion in central Lahore area. The traders and visitors usually park their vehicles alongside the roads which is a major cause of traffic congestion. The bad attitude by drivers and motorists are also main causes of traffic congestion in the area. These street vendors encroach their businesses on road which results in impedance of traffic flow on already narrow roads. As indicated in Figure 4, narrow streets (53%) and non-compliance of traffic rules (42%) also main contributing factors of traffic congestion.

As indicated in Table 2, many of the respondents perceive that economic (41.64%) and environmental (28.76%) are the most important and direct effects of traffic congestion. However, many of them perceive that it has negative impacts on social (13.15%) and psychological (9.59%) behaviors of road users. The descriptive statistics of their response are shown in Table 2.

However, many of the respondents perceive that illegal parking on roadside and vendors' activities are one of the obvious reasons for traffic congestion in central Lahore area. It suggested that major source of traffic congestion are traders and shop keepers who do their businesses

Table 2: Perceptions about the effects of traffic congestion

Effects of Traffic Congestion	Frequency (N=365)	Percentage (%)
Economic	152	41.64
Environmental	105	28.76
Social	48	13.15
Health	25	6.84
Psychological	35	9.59

and activities on roads without complying the traffic rules and regulations. As it constitutes more than fifty (53%) percent of the total response. The second highest contributor to the traffic congestion is non-compliance and violations by drivers and motorists which contribute around 22% of the respondents' perceptions. The inadequate and scarce policies by transport and traffic planners are also an important consideration (18%) for traffic congestion. However, pedestrians are perceived to be the least contributing factor (7%) of traffic congestion in central Lahore area. Details of Perception of the respondents about users responsible for traffic congestion are shown in Figure 5.

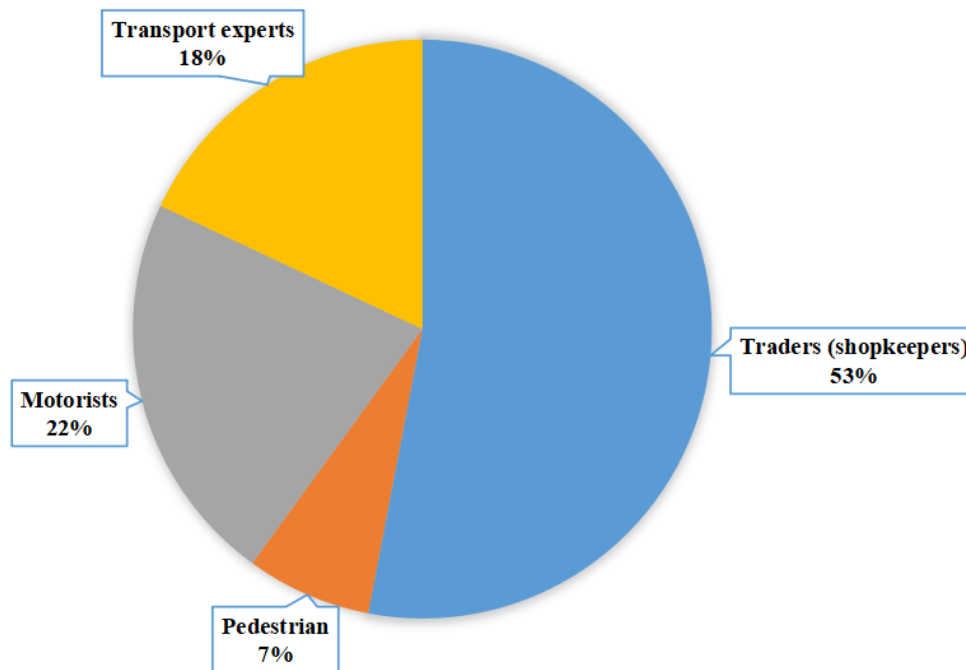


Figure 5: Perception of the respondents about users responsible for traffic congestion

Many of the respondents suggested the remedial measures which can be adopted and implemented to minimize the above-mentioned menaces of traffic congestion in the central Lahore area. Most of them were the repetition of the almost same strategies and were overlapping with each other as discussed and proposed in section 6 and section 7 of discussions and concussions, respectively. However, some of them are listed as under for the convenience of the readers. A shopkeeper responded:

According to me the traders who park their vehicles on the streets usually in front of their shops cause major traffic congestion and they should be dealt very strictly by the law enforcement agencies.

A pedestrian commented:

The provision of the proper pathways and restricting shopkeepers and motorists to comply traffic rules can be an effective strategy to manage traffic in central Lahore area.

A driver showed his observations:

If the law enforcement agencies come in play effectively to remove on-street vendors who use streets right of way, it can greatly improve the situation in the area.

One of the transport experts from the Department of Transportation Engineering and Management (DTEM) gave his opinions as under:

I think it is very much important to mention that there must be a strong linkage between academia and industry, which unfortunately is very lacking in the recent scenario. The policymakers and government officials must present their proposals to the relevant stakeholders before the on-ground execution of the proposed traffic management strategies.

A transport planner from the Traffic Engineering and

Planning Agency (TEPA) said:

The main problem in central Lahore area is the narrow right of way for streets and the residents are residing in decades on constructed houses and shopkeepers are having previously constructed shops. In previous years, these wide roads were serving the needs of the occupants. However, as the population of the city has increased immensely within recent years and many of the core businesses are in central Lahore area. It leads to congestion on main roads in peak hours due to limited capacity of these roads. However, our institution is continuously working on developing effective strategies for the reduction of traffic congestion. As our main core purpose is to make policies, which are being implemented by Government in conjunction with other law enforcement agencies. So, sometimes, proposed policies are not executed on-site or observe delayed execution due to limited funding options.

DISCUSSIONS

Traffic congestion has some of the severe impacts on the lives of the road users who continuously and daily experience it [2], [26], [34]. However, these bottlenecks can be of recurrent or non-recurrent nature [28]. Most of the main causes and factors of traffic congestion in the central Lahore area can be perceived of recurrent nature which is result of on-road parking and use roads right of way by on-street vendors (traders), especially during peak hours. The increase in the vehicle ownership and non-availability of efficient public transport systems is also one of the main cause traffic congestion [3], [11], [19]. The narrow streets and non-compliance of traffic rules and regulations by motorists and traders are also an urgent issue of traffic congestion in central Lahore

area. Due to limited right of way, it seems impossible to expand these narrow roads due to heavy residency on both sides, to meet the needs of the increased vehicle occupancy and expanded traffic volumes. In the central Lahore area, the major reasons for traffic congestion include illegal road-side parking by motorists and traders, the bad attitude of motorists and running of on-road business by traders (Figure 4).

Some of the bad attitudes of motorists include; one-way driving, violating traffic lights, on-road picking, and dropping off passengers, and wrong turns [15], [16]. As evident from this study, traders are one of the main reasons for traffic congestion because they occupy the streets and curb the pedestrians' right of way as well. This restricts and compels the pedestrian and motorists to share the same right of way of the already narrow roads in the city.

Some of the very obvious effects of traffic congestion that are categorized in this study are economic, environment, social, health and psychological. In many of the studies, the respondents put economic effect in the top as it is directly related with the transportation and fuel costs [1], [2], [9], [13], [17], [19], [24], [29], [35]. It is reported that on average, in the US alone, the economic burden of 83-124 billion dollars is experienced annually [4]. The extended time period spent on roads result in wasted working time and economic losses [2].

Traffic congestion is also an important contributor to increased pollution because of more fuel burning on roads in congested environments. The stationary vehicles on road consume an extra amount of fuel which emits an approximately 15,434 kiloton of CO₂ in the atmosphere from UK, Germany, and the US alone. It has been estimated that it will be increased by 16% up till 2030 which will result in 17,959 kilotons of CO₂ emissions [36]. Traffic congestion can cause serious health issue as it is main source of carbon monoxide, nitrogen dioxide, and greenhouse gasses emission [37]. The effects of traffic congestion on public health are inevitable especially in densely populated area due to the lack of non-existent Advanced Traveler Information Systems (ATIS) [38].

The road users who are exposed to traffic congestion are more prone to get psychological issues due to these hazardous gases exposures [39]. The individuals who experience traffic congestion more frequently as compared to other road users are more subject to mental stresses and premature mortality issues [34].

The traffic congestion in the central Lahore area cannot be totally eliminated but however can be managed to an acceptable level by employing some of the traffic management strategies. To manage the traffic effectively some traffic management measures may be adopted considering their specific nature. The selected measures should focus on changing travel behavior pattern of masses. These measures would be proper control on land use and development, public transport development and improvements, and pricing policies on use land and

road infrastructure. Generally, a combination of incentive and disincentives measures is more effective in reducing traffic congestion through behavioral changes. Public transport improvements should be introduced considering the target group of travelers and must be integrated with land use control measures, for example, parking management [40]. Public transport improvements and development would help in making modal shift from private transport to public transport. Therefore, provision of an efficient, well management, and safer public transport should be focus of authorities. Service quality of improved public transport should be competent enough to auto transport so that status-conscious people do not mind in using it. Social marketing programs should be used in order to improve the image of public transport to users. Para-transit modes are required to restrict as feeder modes to bus and rail transit lines. Public transport improvements alone will not be effective in changing travel behavior. The imposition of pricing strategies and restrictions on use of private vehicle is important such as parking management and road tax or toll on private vehicle entry in specific areas or roads. Improvements in public transport network on one side would provide incentive to the travelers, and on the other hand, imposition of fiscal and entry restrictions on private vehicle would be disincentive on use of private vehicle. Parking management should include area wise parking fee and limited parking facilities in those areas served by public transport and main market areas. Land-use policies need to revise and implement in relation to above measures. An urban road-based pricing scheme can be considered, and the implementation of such policies should be assessed from stakeholders' perspectives. Parking charges are required to be imposed gradually at commercial areas. Public awareness is much important about the benefits associated with the implementation of pricing measures. Public awareness programs such as radio, TV, seminars, and workshops must be used in this context. In addition, share mobility-based policies are required to be encouraged among public. These include carpooling, car sharing and vanpooling. Suitability of such policies should be assessed from social and operational aspects.

Also, TEPA and DTEM must work in close conjunction with other law enforcement agencies to implement these traffic management strategies in central Lahore. They can be implemented for efficient and smooth flow of traffic in the central region. Some of them are listed as follows:

- The provision of proper parking lots near main markets is inevitable and road-side parking of vehicle by motorists and traders should be strictly discouraged.
- The proper pedestrian pathways or overhead pedestrian bridges must be provided to avoid the intrusions of a pedestrian on narrow roads.
- More traffic police wardens should be deputed in main market areas to ensure compliance with traffic

rules and regulations.

- The selling of the wares by traders' along-side the road should be strictly prohibited, and heavy penalties should be imposed on those who violate traffic regulations.
- The frequent and periodic traffic awareness seminars should be conducted in schools, colleges, and main traffic attraction centers by TEPA and law enforcement agencies stressing upon the after-mentioned effects of traffic congestion.
- The transport planners must ensure the engagement of other stakeholders for effective and sustainable policymaking and must incorporate the valuable inputs from them.

CONCLUSIONS, POLICY IMPLICATIONS, AND FUTURE RESEARCH DIRECTIONS

It can be concluded from this research study that the main urgent causes of congestion in central Lahore are from stake-holders' perspectives are; illegal parking on road-side, bad attitude of vehicle drivers (motorists), and selling of wares along road-side by traders. The negative externalities of traffic congestion are mainly of economic, environmental, and social nature as per stakeholders' perspectives. The main contributors to traffic congestion in central Lahore area are hawkers (traders) and motorists.

No holistic traffic management strategy can be determined to mitigate the effects of traffic congestion in the central Lahore area. However, TEPA and other law enforcement agencies must strive hard to get the hawkers and motorists comply with traffic laws. The offenders must be arrest if required or penalized heavily for improved mobility in congested roads. The traffic police wardens must be trained and directed to exercise their all powers to hold accountable the culprits who violate traffic rules. Also, on-road parking signs if existent near main market areas should be removed immediately and proper parking lots should be provided. The traffic safety and awareness seminars must be conducted frequently in main congested market areas for better understanding of the dos and don'ts for on-road traffic safety among masses.

For the continuation of this research study, the impacts of traffic congestion on the social desirability of the central Lahore area occupants from economic, environmental, and psychological perspectives will be studied. Also, more respondents should be included in the study to closely evaluate the implications of traffic congestion on their social lives and behaviors.

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