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Practices of Traffic Congestion Pricing Policies – Implications and Challenges for Cities in Pakistan

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ABSTRACT

Congestion management problems are acutest among other urban traffic problems. Developed and developing countries are all facing traffic congestion complications. This research evaluates the successfully implemented congestion pricing policies and barriers to such policies to determine the implications and challenges in Pakistan's context. This paper reviews the successful congestion pricing policies introduced by four cities, Singapore, London, Stockholm, and Milan, to determine the behavioral responses and overall impact on urban traffic. It further highlights the factors that drive public acceptability for congestion charges, and congestion management and proposition of congestion charge practices for cities in Pakistan. The results show that incentive-based travel demand management strategies could be more productive in Pakistan's case than traditional congestion pricing schemes. Studying the successful pricing strategies and challenges in finding public support led to another research opportunity and the possibility of future implementations of traffic pricing policies in Pakistan. Regardless of public acceptability challenges, considering societal benefits and including public participation in policy making can be a pioneering step towards congestion management in the country's complicated urban network.

KEYWORDS: Congestion Pricing, Traffic Demand Management, Public Acceptability, Road Pricing, Vehicle Miles Travelled

1 INTRODUCTION

Sustainable transportation is becoming vital for the development of smart societies. Cities, particularly in developing countries are facing road gridlocks, traffic pollution, accidents, climate change, and a decline in public transit. Above all, traffic congestion is becoming a severe problem around the world. A study in the USA showed 3,261,772 vehicle miles driven in 2019, compared to 2,691,335 in 1999, an increase of 17.5% [1]. Research on sustainable transport is relatively new, and the transition from unsustainable societies to green societies is reluctant.

Traditionally, disincentive traffic congestion management measures were taken, but today incentive-based travel demand management (TDM) strategies are preferred. TDM focuses on understanding how people make their transportation decisions and the factors affecting their behaviour. Globally, many TDM policies, such as free entries for electric vehicles, rapid transits,

and high-occupancy vehicles are adopted to reduce traffic. Broader TDM strategies include carrot-and-stick TDM practices, soft and hard TDM policies, and coercive and non-coercive TDM measures. Many countries, such as Canada, Italy, and USA, have applied TDM strategies. However, in this study, TDM practices for road pricing are focused on because congestion charges can have an immediate impact on other TDM strategies in Pakistan's context.

Research on Congestion Pricing Policies (CPPs) is relatively limited, with almost no research on TDM practices in Pakistan. Among many cities for which the congestion pricing models are proposed, only a few have implemented these policies, and a few executed HOT lanes [2]. Public acceptance is the primary resistance to these policies. However, solutions to traffic congestion lie in the promotion of shared mobility and an increase in public transit use [3]. The US FHWA grouped CPPs into two types: toll-based and non-toll-based policies.

This paper aims to study the congestion pricing practices of four cities, Singapore, London, Stockholm, and Bergin, and determine the policies that resulted in their implementation. The purpose is to research the citizens' behavioral response and public acceptance of congestion charges to present congestion management solutions in Pakistan's context. This work will provide insights into the opportunities, challenges, and prospects of developing and implementing CPPs with TDM strategies for cities in Pakistan. Therefore, it is an essential question of how to reduce traffic blockages in developing countries; congestion pricing is one of the answers.

2 LITERATURE REVIEW

Congestion pricing is a technique to balance out the supply and demand of vehicles. If traffic demand overtakes the supply or road capacity, gridlocks occur, which can be regulated by demand pricing [4]. Singapore became the first country to implement the cordon tolling regime in 1975 when it created the Area Licensing Scheme (ALS). Commuters need to display a pre-purchased windshield permit to enter the "Restricted Zone" (RZ) of the central business district (CBD) during peak hours. The scheme was updated to the Electronic Road Pricing (ERP) system in 1998 [5]. A comparison of different congestion charging schemes implemented by four cities is in Table 1.

Table 1: Comparison of Singapore, London, Stockholm, and Milan Congestion Pricing Schemes

City	Charging System/Scheme	Charge[a]	Results
Singapore (1975)	Area Licensing Scheme (ALS) Electronic Road Pricing (ERP)	£0-3.2 / crossing	Traffic Reduction: 35% Emission Reduction: 10-14%
London (2003)	Congestion Charge (CC) Low Emission Zone (LEZ) Ultra Low Emissions Zone (ELEZ)	£15 / day	Traffic Reduction: 15% Emission Reduction: 6-34%
Stockholm (2006)	Stockholm Congestion Tax Stockholm Congestion Charge	£1-3.5/ crossing	Traffic Reduction: 20% Emission Reduction: 15-25%
Milan (2008)	Ecopass Area C scheme	£4.5 / day	Traffic Reduction: 19% Emission Reduction: 6-17%

[a] In British Pounds

London became the second city to implement a congestion pricing scheme on the 17th of February 2003 which operated on license plate recognition systems. Commuters were charged £5 for entering the congestion zone between 7:00 a.m. and 6:30 p.m. on weekdays. The prices increased as the years passed (£8 in 2005, £10 in 2011, and £11.50 in 2014), but the overall system remained the same [6]. Stockholm implemented its congestion pricing scheme in 2006. Since then, traffic volumes remained consistent but were reduced further after the increase in peak hour charges in 2016. Commuters entering a cordoned area in a city centre were charged 2€ in peak hours [7]. Congestion charges in Stockholm increased from 2020 onwards ranging from 1€ to 4€ depending on the time of the day and vehicular category.

Milan named its congestion charge, Ecopass in 2008, charging vehicles entering the city centre on weekdays (7:30 a.m. – 7:30 p.m.). The primary purpose of introducing the congestion charge was to reduce vehicular emissions. The number of vehicles across the charged areas decreased by 56% in the maiden year, and the emissions reduced by 14-23%. A reduction in accidents and time savings was also observed [8]. In 2012, the improved congestion control strategy, the Area C scheme was introduced to replace the Ecopass system [9]. Recent policies allow electric vehicles, hybrids, and motorcycles to access Area C for free. And till October 2022, M1 vehicles emitting less than 100g/km could also access Area C for free.

3 RESEARCH METHODOLOGY

In this research, literature on the practices and implementation of congestion pricing schemes introduced by four cities; Singapore, London, Stockholm, and Milan, are analysed. Then behavioural responses are researched to determine the impact of congestion pricing on the public and urban system performances. The four cities are then compared in terms of their implementation years, charging schemes, current charges, and reductions in traffic volumes and emissions.

Furthermore, a few case studies are analysed to determine the driving forces of public acceptance in some developing countries, resisting factors to the congestion pricing policies and challenges faced by the lack of participation of society. Then, the congestion management practices of Pakistan are evaluated to determine the opportunities for mitigating traffic problems by congestion price policies. The research on congestion management is carried out to identify the implications and prospects of road pricing and travel demand management in Pakistan.

4 ANALYSIS AND RESULTS

London Congestion Charges (LCC) impacted the traffic and influenced the behavioral response. These charges reduced traffic in the charged zones and increased house values. Properties just inside the charging zones were slightly more expensive than outside. On average, residents pay 2.84% (£18,555) more for their houses to have the facility of reduced 8.77% (1562 vehicles) in the cordon zone [10]. If cordon pricing schemes are implemented in the CBD of New York, it can decrease traffic delays by 15% to 32% [11]. The Milan, Stockholm, and Bergen traffic pricing schemes decreased vehicles by 19%, 20%, 5.5% and pollution by 14-23%, 15-25%, and 11%, respectively. Stockholm also reduced traffic waiting times by 30-50% [12, 13].

From the likes of London and Singapore congestion charges, similar congestion tax strategies can be implemented in the cities of Pakistan. All cities have different demographics,

such as tax-paying capacity, and psychographics, such as belief systems, values, and attitudes. Therefore, incorporating these issues, congestion strategies are proposed in Table 2 for Pakistani cities. Differentiated based on city population, pollution index, the density of central business districts (CBDs), traffic volumes during peak and non-peak hours, and the possibility of the traveller's acceptance of these schemes.

Table 2: Proposed Congestion Charge Zones, Times, and Prices for Cities in Pakistan

City	Charging Zone Type		Charge Zone		Charge Time[c]	Charges
	LEZ[a]	ELEZ[b]	Radius	CBD		
Islamabad	√		7 Km	Blue Area	Peak Hours	RS 100
Lahore		√	12 Km	Lahore Fort	Peak Hours	RS 150
Karachi		√	12 Km	Shahra-e-Faisal	Peak Hours	RS 150
Faisalabad		√	10 Km	D Ground	Peak Hours	RS 100
Rawalpindi		√	7 Km	Saddar	Peak Hours	RS 100

[a] Low Emission Zone (LEZ)
[b] Ultra Low Emissions Zone (ELEZ)
[c] 7:45 AM to 10:45 AM and 4:00 PM to 8:00 PM

In the above table, congestion charges are proposed according to the traffic volumes near CBDs. Since Karachi and Lahore have high congestion densities, the charges are higher than in other cities. In addition, the peak hours are from 7:45 AM to 10:45 AM and 4:00 PM to 8:00 PM, when most commuters move to work in the morning and return in the evening. It is seven (7) daily hours (3 morning time and 4 evening time) applicable for congestion taxes. LEZ zone type is selected for Islamabad because it has a green environment and industries are fewer, which results in the minimum release of pollutants and emissions. For these urban cities, Electronic Road Pricing (ERP) techniques, such as ANPR and the Area C scheme of Milano are suggested because of their high success and sustainability.

However, public acceptance has been a prime resistance toward the enforcement of congestion pricing schemes. The major influencing factors in congestion pricing acceptability are personal privacy, a factor of fairness, and increasing risk [14]. Greek drivers, unwilling to accept the environmental congestion charging policy, are also not welcoming the environmental parking charging policy [15]. Insightful results about public acceptance of congestion pricing schemes from the study of Greece, Senegal, and India are shown in Table 3.

Table 3: Public Acceptance of Congestion Charges: Results of Greece, Senegal, and India

Country	Public Acceptability
Greece [15]	Females are more receptive to the implementation of congestion pricing Young drivers are more likely to accept the congestion schemes than old drivers Annual income has almost no effect on the acceptability of congestion charges
Senegal [16]	29% of commuters prefer to delay their trips to get rid of congestion taxes 10% of commuters would choose to change their routes to avoid congestion charges 15% of users would not be affected by the congestion charges[a]
India [17]	High-educated commuters are more likely to accept congestion charges Charge exemption strategies are hardly supported by the public[b]

	Commuters having driving licenses possibly oppose the implementation of charges

[a] Since their daily travel originates and ends within the areas outside of the charging zones
[b] Exemption for electric and hybrid vehicles

Considering the said public acceptance challenges for congestion pricing schemes, Pakistanis would be reluctant to accept these policies. Therefore, incentive-based and innovative measures are suggested in this research. The proposed traffic management solutions for Pakistani cities are two Travel Demand Management (TDM) strategies. (1) carrots and sticks TDM practices and (2) soft and hard TDM policies. Particularly, road users could be penalized for their entry to the restricted zones while rewarding drivers for avoiding congestion zones. Similarly, free CBD entries for EVs and penalties for transports emitting pollutants. Soft TDM practices include engaging public awareness for the use of EVs and education about the consequences of emissions. Impactful hard TDM practices are infrastructure provisions to facilitate traveling through public transport and sharing mobility. Details about other proposed TDM practices are in Figure. 1.

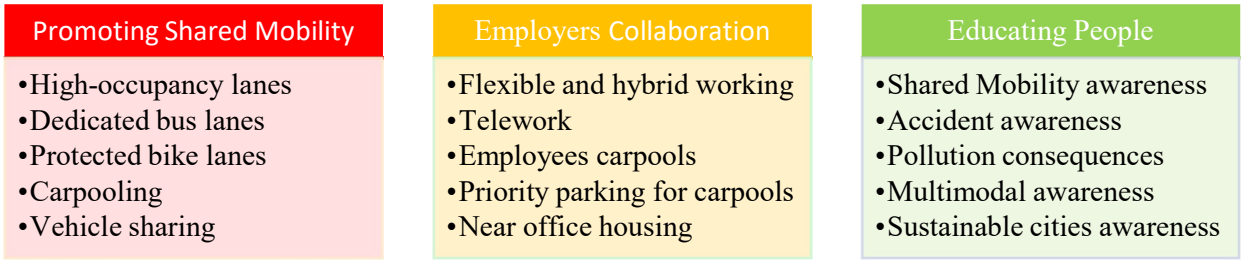

Figure 1: Proposed traffic management strategies for Pakistan

Furthermore, this research showed that the inclusion of ring roads, bypass roads, and logistics management are necessary for controlling traffic congestion in Pakistan. Especially, Rawalpindi does not have a ring road due to which traffic management is not appropriate. Also, separate routes should be constructed for logistics vehicles because currently, trucks pass through the main arterial roads of Islamabad, which results in traffic problems. Although heavy vehicles are not allowed to enter urban areas during peak times, it affects logistics efficiency.

5 DISCUSSION

Congestion pricing strategies have extensively benefited Singapore and London in solving excessive traffic volume problems. However, incentive measures have proven more successful, such as allowing electric vehicles and public transport to enter congestion zones for free. Therefore, for Pakistan's cities similar strategies can be impactful such as, allowing electric vehicles and hybrid vehicles to enter the congestion charge zone for free and free entry for shared vehicles. Cities that applied congestion pricing schemes impressively lowered traffic volumes, carbon emissions, air pollution, and queuing times. These policies can change the transportation industry if implemented correctly with referendum and public support. They are developed in many cities but usually face global non-implementation due to opposing public opinions and resistance [14]. Therefore, public acceptance is a prime challenge Pakistan's government can face

when executing traffic pricing schemes. However, highly educated commuters are more likely to accept congestion charges because they realize the impacts of such public schemes [17]. But the literacy rate in Pakistan is just 58%.

Ashraf has thoroughly researched travel demand management in association with the congestion pricing strategies in Lahore [18]. The Public Favourability Index (PFI) was developed to determine the favourability of travellers against congestion charges TDM measures. The results are shown in Table 4. The PFI is expressed in five intensities; least favourable (LF), moderately favourable (MF), favourable (F), and highly favourable (HF). Furthermore, each TDM Congestion Charge Measure is classified for the period of implementation. Some measures are demanding and require longer periods for implementation, whereas some measures can be implemented in a short period if people are willing to accept. Ashraf divided the period of implementation into three terms i.e. short-term (1-2 years), medium-term (3-5 years), and long-term (5+ years).

Table 4: Rating and classification of selected TDM congestion charge measures in Lahore [18]

TDM Measures of Congestion Pricing	Public Favorability Index				Period of implementation		
	LF	MF	F	HF	Short	Medium	Long
Increase in parking fee on car use	√					X	
Increase in fuel taxes	√					X	
Increase in road tax or toll		√				X	
Improved public transport + parking restrictions at destination (land use)		√				X	
Improved public transport + 100 PKR parking charges on car use			√			X	
Improved public transport + 100 PKR road tax or toll on car use			√			X	
Improved public transport + car entry restriction in public transport area				√		X	
Double travel cost of car use + improved public transport		√			X		
Double travel cost of car use + policy of office-based transport				√	X		
Double travel cost of car use + ride sharing with friends/ colleagues			√		X		

From the above table, it is observed that commuters are interested in incentive-based or soft TDM practices along with congestion charges rather than disincentive strategies or entirely congestion taxes. Imposing parking fees, congestion taxes, and increased fuel costs are the least favourable. Therefore, congestion schemes providing other benefits, such as improvement in public transport and parking management, are great deals to interest travellers. Furthermore, most of these TDM measures are practically achievable within five (5) years since they do not require significant changes in the present physical urban transport infrastructure.

Considering the above challenges incentive-based TDM congestion pricing schemes can be highly effective in cities of Pakistan if well-planned policies are enforced with public support. It becomes hard to replicate transport management models from developed nations to developing countries, but there is always a possibility of policy-making that interests commuters. Developing countries like Pakistan are more vulnerable to traffic bottlenecks because of unplanned road infrastructures. Therefore, congestion charges with the implementation of TDM could reduce

traffic blockages, influence people to use other alternatives, and promote shared mobility and carpooling options.

Congestion pricing schemes can also help Pakistan's government promote the ridership of public transport and shared mobility. Since Pakistan is a developing country, slight congestion charges may seem expensive for middle- or lower-class people, but this would cause them to carpool and prioritize public transport over private vehicles, which could significantly make transportation sustainable, and it is the aim of TDM. In addition, charging heavy and commercial vehicles would also improve road use by businesses and industries as they will become more vigilant toward optimizing city logistics.

6 CONCLUSION

Urbanization and changing transportation trends have hugely affected societies with severe problems of traffic congestion, air pollution, and accidents. Congestion Pricing Policies and Travel Demand Management are the solutions to these issues; Singapore, London, Stockholm, and Malan are great examples that lowered traffic problems with these strategies. Pakistan is facing acute traffic problems. Lahore is among the world's most polluted cities. Hence, congestion management practices with incentive-based travel demand management are solutions to these problems.

Despite public acceptability challenges, it has become vital for decision-makers to implement tactics to solve traffic congestion problems. This research does not imply that congestion charging schemes should be implemented forcefully since public involvement is the backbone of successful urban systems. It is however recommended that future researchers perform national-level surveys to determine the response of the local public, keeping in view that people are always interested in benefits.

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