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Congestion Pricing Scheme in Mashhad, Iran: Overview Description, Impacts and Behavioural Responsiveness

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Abstract: The cordon pricing scheme is an efficient measure to untie congestion and environmental problems in urban metropolitan areas. Since March of 2007, Mashhad has implemented a restricted Central Business District (CBD) Zone as a seasonal congestion management program. The primary goal of the Mashhad cordon scheme is to reduce traffic congestion throughout the CBD. This paper describes the main features and traffic impacts of Mashhad cordon pricing. In addition, driver's responsiveness to mode and parking attributes and cordon and parking fees are also discussed. Two different surveys were conducted to assess user's attitudes towards the scheme. Based on a traffic volume survey, a high sensitivity to the cordon pricing scheme was reported, as reflected by the 36% decrease in private car travel, crossing the cordon line. A face-to-face survey shows that the in-vehicle and cordon costs as mode effective attributes include the least and the most effects on mode choice, respectively. Furthermore, private car users accepted the current fee as a parking cost, whereas the cordon cost was expressed as a high cost for entering the restricted traffic zone.

Key words: Congestion pricing · Parking cost · Mode choice · Traffic

INTRODUCTION

The process of urban development in communities is inevitable, followed by various civilisation benefits. Problems, including traffic congestion and emissions, have yielded from such an expansion in vehicle number, especially in large metropolitan areas [1]. Traffic congestion is increasingly extending into the urban network and constructing extra infrastructures to reduce the congestion is a lavish solution. It is not only because of Enormous costs are required to satisfy travel demands but due to the fact of induced increscent demands.

To relieve traffic congestion, many researchers have proposed to charge road users as a possible solution and sophisticated scheme [2, 3]. Further road pricing has produced a more effective demand management policy that is designed to either change the behaviour of travellers enough to alleviate congestion by charging them or finance new infrastructures as traditional tolls to improve the congestion and environment [4].

A vast variety of literature regarding road pricing schemes, including toll cordons, toll lanes and congestion charges, have been applied as fiscal measures worldwide [5]. Among them, cordon pricing has demonstrated in most road pricing methods to decrease area-wide traffic congestion in urban regions. Cordon area pricing or congestion pricing is a user tax or fee that provides permission to enter a restricted area, often within a city centre, as part of a demand management policy to relieve traffic jams within that zone. Until now, a few cordon schemes in several cities have been successfully implemented. The first successful implementation of a cordon pricing technique was acquired in Singapore in 1997, known as the Singapore Area Licensing Scheme. Since the system's upgrade in 1998, Singapore has proposed and tested the most advanced and electronic road pricing schemes in the world [6, 7]. Since 1998, the practical implementation of this scheme has rapidly thrived in several European cities. The most famous scheme is the London congestion charge or inner ring road, derived in 2003 with extensions in 2007 [8-11]. Stockholm attempted a seven-month trial in 2006 [12, 13], Oslo, Bergen and Trondheim successfully implemented toll rings in Norway [1, 14-18] and more recently, Milan

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proposed the Ecopass trial program in 2008. In contrast, some of these imposing charge strategies failed to continue due to public opposition, including the Greater Manchester Congestion charge [19], Hong Kong Electronic Road Pricing [20], Edinburgh congestion charge [21, 22], and New York congestion pricing [23].

Many cordon pricing issues are still controversial both at a theoretical and an empirical level. Considering a theoretical point of view, the vast literature concerning cordon pricing have proposed valuation techniques, models and methods to separately determine the various features of the wider effects of cordon charges, which can be composed into two categories:: short- [10, 24-27] and long-term changes [28]. At an empirical level, some studies and overviews that evaluate the effects of cordon pricing on traffic congestion, pollution and changes of residents and road user behaviours exist. Such studies included London [10], Singapore [29], Stockholm [30], Oslo [31] and Milan [32].

To our knowledge, all of the real world implementations of cordon pricing have occurred in developed cities; such a scheme has not yet been reported for developing countries. Therefore, for better judgment, these cases are too specific to permit the scientific association and community to generate final conclusions for different societies (i.e., developing countries) and other developing urban areas with various social perspectives. The objective of this research is to firstly overview the Mashhad cordon charge scheme and to secondly investigate the traffic impacts of this scheme on commuters. Based on previous studies, the overview section describes the introduction and main characteristics of the scheme and reviews the impacts of Mashhad cordon pricing. Two different surveys were performed to assess user attitudes towards the scheme. The impacts of this scheme on traffic volumes and daily trip distributions were evaluated by conducting a traffic volume survey. Furthermore, a face-to-face survey was performed to understand the effect of attributes on mode choice and commuter responsiveness to cordon and parking charges. This paper is structured as the following. The Mashhad cordon pricing scheme overview is described first. The data used in this research is discussed in section 3 and the following results of the investigation are listed in the next section. Conclusions are presented in the last section.

Mashhad Cordon Pricing Scheme Overview

The Birth of the Scheme: Mashhad is one of the 163 most populated cities in the world (2.63 million citizens in 2007) and thus faces traffic problems [33, 34]. Due to the accelerated growth in urban population and number of cars and attraction of more than 20 million pilgrims and tourists each year (second largest holy city in the world), Mashhad has a gripped traffic dilemma regarding its transportation system, especially in the Central Business District (CBD) [35]. Therefore, it is necessary to solve the Mashhad traffic problems within a particular duration of time.

Traffic restrictions, including determination of a limited area to ban entering private passenger vehicles using deterrent factors, such as charging, were implemented in Mashhad city. Regarding the ministry of interior and the high council of traffic approvals because 2007, the Mashhad CBD congestion management program has been initiated each summer, six days a week (excluding Fridays) and covers all of the streets that end at the Imam Reza holy shrine. This program was based on consultant research reports and some studies and findings of different specific issues, which were made in parallel by an expert committee [36]. Mashhad was first among the cities in Iran to establish a pricing scheme, known as the Mashhad traffic restricted area. During its seasonal implementation, charges were inflicted on the vehicles that crossed the cordon boundary around the Mashhad CBD, as shown in the map in Figure 1.

The traffic restriction plan in Mashhad city was implemented to improve traffic, provide easy access to commuters and pilgrims and reduce air pollution and traffic congestion in CBD [37]. These goals are similar to those of Singapore and London (congestion charging) and Stockholm and Oslo (congestion, environment and public transportation infrastructure financing) but contrast with those of Trondheim (infrastructure financing) and Milan (reduce air pollution).

To supplement their cordon pricing scheme, the accompanying traffic management policies introduced four new bus lines and organised taxis for public transportation services. These changes provided rapid and effective alternatives for commuters to travel from outside the cordon area into the CBD at peak hours.

Main Scheme Characteristics and its Implementation: The restricted area of the toll zone is approximately 5.30 km^2 and its border length is 8.30 km^2 [38]. The cordon zone is relatively small when compared to Oslo and London (40 km^2) and Stockholm (30 km^2) but is comparable to Milan (8 km^2) and Singapore (7 km^2) [32]. Table 1 presents the basic characteristics of the cordon pricing schemes in Mashhad and the previously listed five cities.

Table 1: Main cordon pricing system characteristics in six cities

City	Starting time	Charging zone area	Operating hours	Daily charge fee	Charging system
Singapore	1998	7 km^2	7:30–19:00 weekdays (free entry from 10:00 to 12:00)	S$ 0.25,0. 3,0 0.4,0. 5and 1.00 in July 1999 and S$ 1, 2.5, 3 ERP rate in June 2004 are set based on the passenger car unit (PCU)	Advanced electronic road pricing (ERP) technology
Oslo	February 1990	40 km^2	24 h 7 days per week	£0.95 in 1990 and_2.5in 2008 flat charge	Electronic fee collection "Autopass" system
London	17 February 2003	22 km^{2}before 2005, 40 km2, after 2005	7:00 to 18:30 workdays	£5 in February 2003 and £8 in July 2005 flat sojourn charge	Automatic-number-plate-recognition (ANPR) technology
Stockholm	7 month trial in 2006, permanent since August 2007	30 km^2	6:30 to 18:30 workdays	_ 1.1, 1.6 and 2.2 Charges were time-differentiated during the time of day and week in 2009	Automatic-number-plate-recognition (ANPR) technology
Milan	January 2008	8 km^2	7:30 to 19:30workdays	Free, _2, 5 and 10 differentiations depending on Toll classes based on Euro emission standards in 2008	Automatic-number-plate-recognition (ANPR) technology
Mashhad	seasonal since March 2007	5.3 km^2	8:30 to 20:30 workdays	TN 2000 flat charge in 2010	Manually

Sources: [3, 9, 13, 14, 27, 29, 30, 32, 39, 40]

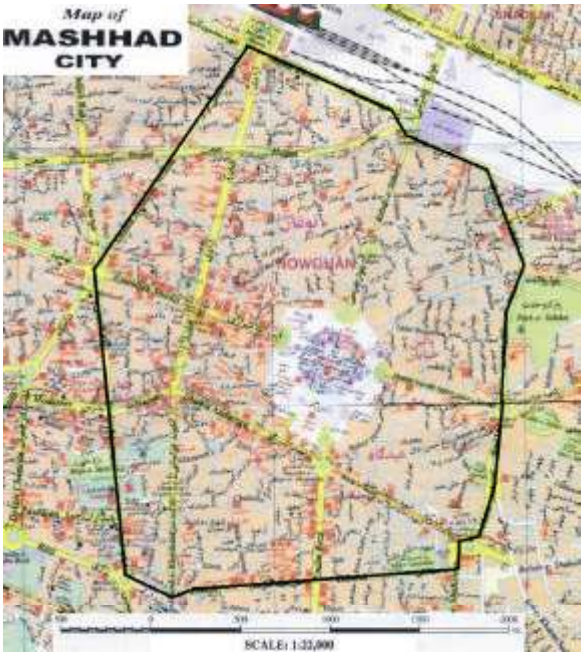

Fig. 1: The Mashhad traffic restricted area (solid black line: cordon charging)

The charges were grouped into two categories over the day. The fee for passing a control point was TN[1]2,000 per day (corresponding to US dollars 2.0 or _1.5 and £1.2 in 2010) between 8:30 and 20:30. This scheme is characterised with a relatively low level of charge and high implementation duration when compared to European cities. For instance, London initially charged £5 per day, between 7:00 and 18:30 and later raised the fee to £8 per day. In Oslo, this rate was _2.5 each day in 2008 [29, 30, 32]. The Mashhad cordon charge was not time-differentiated during the implementation over the day. Similarly, London and Oslo implemented a flat charge. However, Stockholm had a time-differentiated scheme of 1.1, 1.6 and 2.2 Euros. These charges differentiated over the time of day between 6:30 to 18:30 and over the week. In Singapore, charges $ 1, 2.5 and 3 were set based on the passenger car unit (PCU) on weekdays. In addition, because their objective is mainly to decrease pollution rather than traffic congestion, the Milan Ecopass scheme is characterised with a _0, 2, 5 and 10 level of charge differentiation, depending on the toll classes, which are based on their emission standards.

Mashhad cordon fees were not levied at night, in Friday (casual weekend) and on public holidays. The drivers that pass the borders and into the zone without any legal justification will be penalised approximately TN13,000. Exemptions are applied to taxis, buses and residential commuters who live inside the CBD.

A number of stations that sell permission tickets exist near the Mashhad cordon area. Although vehicle charging technologies have progressed in developed cities, commuters were charged without using advanced technologies in Mashhad city. Oslo used an electronic fee collection "Autopass" system, whereas Milan's Ecopass scheme implemented an automatic-number-plate-recognition (ANPR) technology, previously applied in Stockholm and London [32]. Allowing better differentiation according to the prevailing charging level, Singapore tested a more advanced electronic road pricing (ERP) technology.

[1]The toman (TN) is a superunit of the official currency, Iranian Rial (IRR). TN1.00 = IRR10.00, USD1.00 = TN1,000.00

Cordon Pricing Impact Review: The existence of business, religious and cultural and educational service centres causes a trip uptake to be very high in the downtown area, which is approximately 20% of all the daily trips generated in Mashhad. From the latest study in September 2010, 70,000 vehicles entered a 5-km^2 zone and were subject to a charging hour per day scheme, meaning that approximately 1,000 vehicles per hour per square kilometre were observed [39]. This rate differed from other cities, such as London, Stockholm and Oslo with 240,000, 190,000 and 244,000 vehicles entering the cordon area during a charging hour per day scheme, respectively [40]. Meanwhile, the numbers of vehicles per hour per square kilometre were approximately 500 for London and Stockholm and 300 for Oslo.

The increased average speed of 10 to 20 kilometre per hour of urban traffic and subsequent 40% reduction in carbon dioxide (CO_2) emissions by vehicles are results of the cordon charging scheme [38]. The declined air emissions of exhaust inside the Mashhad charging zone was very high when compared to London (16%), Stockholm and Milan (14%) [30, 32].

Data Collection and Methodology: Properly predicting motorists' behavioural responses to actual charging is one of the difficulties in estimating the potential benefits of a cordon pricing scheme. Regarding user attitudes to the cordon pricing, remarkable differences between cities exist. For instance, the conducted survey in Mashhad city indicates that approximately 60% of travellers do not agree with the present implemented cordon charges in the restricted traffic zones [41]. A reasonable explanation is that since the scheme's initiation, drivers have become less aware of the positive impacts of cordon pricing and hence react only to the expected economic burden.

A discussion regarding the observed effects of traffic and travel behavioural changes will be more indicative concerning the direction of the change and degree to which they support findings from literature. In our assessment of the cordon pricing scheme implementation, we desire to distinguish the changes in traffic patterns and traveller responsiveness based on two different surveys.

To collect information on commuter travel patterns and subsequent effects on traffic volume, a survey was performed before (June 21) and after (June 28) the implementation of the cordon charges on Monday in the summer of 2010. These traffic data consist of continuous counts at a large selection of road sections representing all directions of traffic and included major and minor roads. During the period of 7.30–22.30, traffic counts were conducted at the entrance section of the restricted zones of four major roads connected to the CBD. The total types of all the vehicles entering the cordon area were estimated. The detailed data makes it possible to distinguish the traffic development in the corridors and between major and minor roads. Regarding these data, indicators of the traffic development in the CBD were calculated by the Mashhad Traffic and Transportation Organization.

In addition, from 14 to 16 August 2010, a random sampling size of 580 respondents were selected to perform a comprehensive survey to identify the responsiveness of driver behaviours to mode and parking attributes and to cordon and parking fees in Mashhad city during the seasonal cordon introduction. Face-to-face interviews with the drivers travelling inside the cordon zone were conducted. The data were collected after performing personal interviews with the drivers on their departure from designated parking locations in and outside of the CBD.

Users Attitudes Towards the Cordon Pricing Scheme Impacts on Traffic Volumes: After the implementation of cordon pricing in 28 July 2010, the average daily traffic flow during the weekdays in the cordon area decreased in volume by 7.6% (from over 73069 to under 67511, number of passenger cars per day). The congestion in Milan was evaluated as the traffic flow/capacity ratio, which fell by an average of 4.7% within the Ecopass cordon area. Additionally, the traffic flow in Stockholm was reduced by approximately 22% when compared 12 months before and after the first trial implementation months in 2005 and 2006. For the Singapore Area Licensing Scheme, the average daily traffic flow during the weekdays in the month of September 1998 decreased by 20% to 24% (from over 271,000 to 206,000-216,000). Furthermore, in Oslo and Bergen, an approximate 3–5% and 5–7% traffic decline occurred in the first year, respectively [14, 30, 32].

The daily number of all vehicle types crossing the charging area dropped by 13.6% (from 61446 to 53123 units per day). The number of entries in Stockholm reduced by 23.8% in the period ranging from January–May 2006, while the daily number of vehicles entering the restricted area reduced by 14.2% after 9 months of implementing the Ecopass scheme in Milan. The measurements used to define the congestion are not strictly comparable in the discussed cities and the research regarding the traffic reductions in the Mashhad cordon ring are most likely of a similar magnitude to those gained in Milan and Oslo.

Table 2: Effect of the cordon fee on daily traffic volumes in the cordon pricing zone in Mashhad

	Traffic volume (no. of vehicles)			
Vehicle Type	Before	After	Cordon charge	Percentage change
Bicycles and Motorcycle	6359 (8.7%)	7603 (11.3%)	Free	19.6%
Passenger car	34560 (47.3%)	22050 (32.7%)	TN 2000	-36.2%
Taxi	17428 (23.9%)	20454 (30.3%)	Free	17.4%
Van	2558 (3.5%)	1923 (2.8%)	TN 2000	-24.8%
Minibus	1016 (1.4%)	1556 (2.3%)	Free	53.1%
Public bus	10355 (14.2%)	13145 (19.5%)	Free	26.9%
Private bus	252.5 (0.3%)	222.5 (0.3%)	TN 2000	-11.9%
Trucks	540 (0.7%)	557.5 (0.8%)	TN 2000	3.2%
All vehicles	73068.5 (100.0%)	67511 (100.0%)		-7.6%

The traffic volume results, as measured by the number of vehicles driven inside the cordon zone, signify a significant change in the composition of Mashhad traffic (Table 2). Passenger cars, which comprised slightly more than 47% of the city centre traffic before the imposed charge, currently represents nearly 33%, a decrease of 36%. This result is similar to that for London in which the passenger car volume decreased by 34% between 2002 (before the charge) and 2003 [9]. In addition, for private users, the congestion levels of vans and private buses decreased by 24.8% and 11.9%, respectively, when compared to trucks, which slightly increased. In relative terms, as the other vehicles were free of charge, sharp rises in motorcycles and bicycles (approximately 20%), taxis (up to 17%) and public buses (approximately 27%) were observed. Minibuses experienced the highest volume increase (53.1%).

The basic concept governing the traffic volume and congestion decreases was that some commuters decreased their trip numbers to the areas that were being charged. Some commuters shifted to public transportation (i.e., taxis, minibuses and buses), while others changed their travel time to during free of charge hours for all or some of their trips.

Impacts on Daily Trip Distribution: Passenger cars played the main role in decreasing the congestion after reducing their numbers. Hourly traffic flow in private passenger car travel clearly presents the rates of reduction before and after introduction of cordon area during the day from 7:30 to 22:30 (Figure 2). Generally, the largest decrease in hourly traffic volume (22.4%) was observed during the afternoon peak period (between 17:30 and 18:30) and an 18.7% decrease was recorded during the morning peak period (between 9:30 and 10:30).

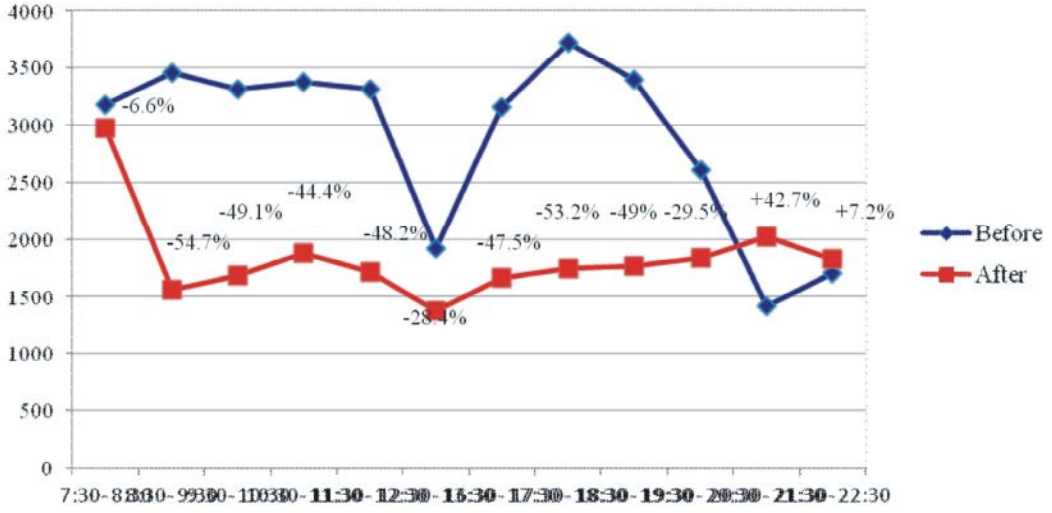

Fig. 2: Distribution of passenger cars passing the cordon line before and after the implementation of cordon pricing

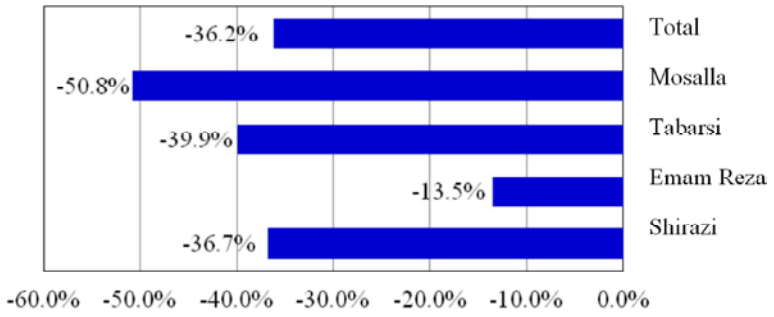

Fig. 3: Average changes in number of passenger cars for four major roads across the toll zone before and after the implementation of cordon pricing

Furthermore, the private car commuters shifted their driving times (approximately 43%) towards the end of the cordon period (21:30). For comparison, in the Milan Ecopass scheme, a sharp decrease (23% between 7:30 and 8:00) of entries and in the Stockholm cordon area, the falling off (23%) was more ample in the afternoon peak period (between 16:00 and 18:00) and lessening (18%) in the morning peak period (between 7:00 and 9:00).

Figure 2 reveals that a greater portion of arbitrary trips occurs during the afternoon peak rather than the morning. These types of trips may be non-work-related rather than work-related in which the arrival times are fixed with a departure time to work. At noon, the number of passenger cars was the same as in the morning, meaning that drivers tended not to exit the cordon to return home for lunch but preferred to stay and not travel outside the CBD area with their private car. The total traffic volume lessened in the evenings. Therefore, the outbound traffic was reduced in the evening due to the fewer incoming vehicles into CBD in the morning.

Reduced congestion effects on roads across the toll cordon area were a main goal of the investments. To breach the cordon area, four major roads, Shirazi, Emam Reza, Tabarsi, Mosalla, must be travelled. Figure 3 shows the percent reduction of passenger car traffic-crossing cordon zones. The cordon pricing impact was the highest (50.8%, private passenger car volume reduction) on Mosallah and was the lowest (13.5%) on Emam Reza. This difference may depend on the characteristics of commuters and their responsiveness to cordon pricing.

Likewise, for three major city streets, the traffic flows were reduced to a lesser extent (6.2, 6.5 and 30.2% for Shirazi, Tabarsi and Mosalla roads, respectively) than before the existence of cordon pricing. Contrastingly, for Emam Reza, the traffic increased by 20% during the day because the portion of traffic was not entirely eliminated but shifted to public or other types of transportation. Apparently, a one-quarter share of the raises on the Emam Reza road seemed to be due to the availability of public transportation for commuters rather than for the other three roads.

Effect of Attributes on Mode Choice: To obtain a realistic picture of the changes in mode shifting, investigations of driver responsiveness to mode and parking choice attributes were conducted in August 2010. A face-to-face survey focused on drivers who had travelled to the CBD with or without their private cars. Thus, the changes in switching to other modes were likely to occur. Search time, walk/egress time, parking fee, in-vehicle cost and cordon fee are the five attributes used to estimate effects on mode and parking choice.

From an overall perspective, these attributes change the mode choice behaviour and influence the choice of parking location. Figure 4 shows the responses to the significance of parking and mode choice variables in changing the mode of the surveyed participant. As expected, the effects of the cordon charge factor for selecting different modes have generally the highest impact of 64%. Search time, walk time, parking fee and in-vehicle cost had impacts of 56.0%, 41.2%, 40.1% and 28.7%, respectively and were placed in the next effective stages. Furthermore, the effects of walk time and parking fee attributes were nearly the same, making it difficult to distinguish which was more efficient. The results indicate that the cordon fee and in-vehicle cost invoked the highest and lowest effects, respectively, on commuter decisions for choosing a travel mode to the CBD.

Cordon and Parking Charge Responsiveness: Acceptability and equity are terms used to show traveller satisfaction of cordon pricing. Equity primarily indicates the distribution of costs and benefits and may differ from personal justice or perceptions [42].

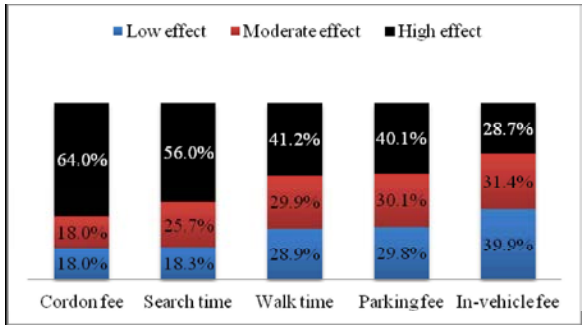

Fig. 4: Effects of parking and mode variables on respondent mode-shifting behaviour

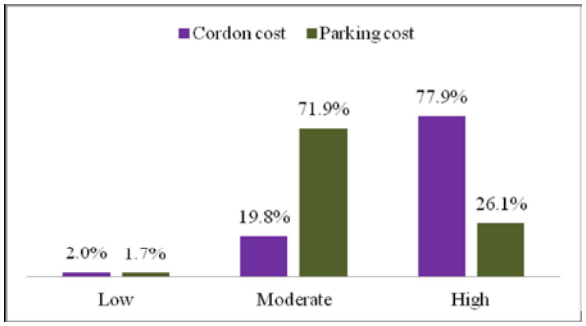

Fig. 5: Perceived cost amount valuations (parking TN 200 per hour and cordon TN 2000 per entry)

Cost is a significant obstacle in achieving traveller satisfaction. Accordingly, we investigated the driver responsiveness to cordon and parking costs after the introduction of cordon costs. Figure 5 shows the driver responses to the perceived costs regarding congestion and parking fees. As illustrated, most of the respondents approved of the low congestion and parking rates (approximately 2%). The charges impacts on parking and cordon made differences in the next rate levels. Approximately 72% of respondents stated that the parking costs were fair and only 26% expressed them as being high rates. These results indicate that travellers do not agree with the present cordon fee charges in restricted traffic zones but accept the current parking pricing.

CONCLUSIONS

Mashhad city faced congestion, pollution from vehicle exhaust fumes and noise. Thus, a seasonal restricted zone for implementation of cordon charges schemes was defined on March 2007, with the goals of reducing peak period traffic flows throughout the CBD, noise and air pollution [37].

The objective of this research was to investigate the effects of cordon and parking charges on traffic and driver behaviours regarding mode and parking choice attributes in the cordon area of Mashhad city. Mashhad, as a developing city, possesses different characteristics when compared to other developing and developed cities. The cordon pricing schemes that were applied in Mashhad were fully described in section two. Meanwhile, comparisons of Mashhad to other large developed cities, Milan, Oslo, London, Singapore and Stockholm, were made. A survey in which the Mashhad cordon pricing scheme had a relatively small cordon charge area and low level of charge but longer duration when compared to European cities was presented. A flat charge exists for the 70,000 vehicles that enter daily into the toll zone. Moreover, the 40% decrease in CO_2 emissions was due to the increase in average speed of 10 to 20 kilometre per hour after the implementation of the cordon pricing scheme [38]. This decline in exhaust was very high when compared to London, Stockholm and Milan.

Based on the two survey results of before and after cordon pricing implementation, different conclusions were obtained. These outcomes indicate that the cordon charge would have a clear negative impression on drivers travelling to the CBD. Private passenger car users were more sensitive to the cordon charges in Mashhad rather than in London. Although the average charge was somewhat low (TN 2,000 per entry), a decrease of more than 36% in passenger cars was observed in Mashhad. In contrast, London initially charged £5 (TN 8,000) per day and a 34% decrease in the number of private passenger vehicles entering inside central London was observed [9], compared to the former implementation period of cordon area. Furthermore, public transportation commuting increased with the introduction of cordon pricing, as expected. The well-functioning public transportation system due to the addition of new bus lines, however, enabled a large number of motorists to switch to the public transportation system when the cordon charges were implemented. In Mashhad, the traffic flow was not as high as in London, Singapore and Stockholm, which was most likely adapted to Milan and Oslo.

The other results of this study are summarised as the following. Cordon pricing enables the road network to be utilised more efficiently, as arbitrary trips can be decreased in peak hours and shifted to off-peak hours when the cordon fee is not charged. The experiences from Mashhad indicate that the in-vehicle costs and cordon fee least and most affect, respectively, mode choices.

The results also indicate that road users do not agree with the present cordon fee charged in a restricted traffic zone but accept the current parking pricing.

Based on reported studies, the introduction of the Mashhad cordon scheme is a brave policy; however, this restricted zone manages to solve congestion and air pollution problems in Mashhad CBD. To make such a difficult task productive and well organised with economic and environmental benefits, potential recommendations can be made regarding Mashhad cordon charge scheme. First, electronic non-stop toll lanes for vehicles crossing the cordon area should be established. Second, for better public satisfaction and balance between acceptability and efficiency, time-differential charges should be proposed to support the traffic management objectives. Finally, the maximum chargeable bound for one crossing within a specific time (e.g., per hours) where every single cordon crossing must be paid for should be considered.

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REFERENCES

1. Meland, S., T. Tretvik and M. Welde, 2010. The effects of removing the Trondheim toll cordon. Transport Policy, 17(6): 475-485.
2. Espino, R., J.D.D. Ortúzar and C. Roman, 2007. Understanding suburban travel demand: Flexible modelling with revealed and stated choice data. Transportation Research Part A: Policy and Practice, 41(10): 899-912.
3. Hensher, D.A. and S.M. Puckett, 2007. Congestion and variable user charging as an effective travel demand management instrument. Transportation Research Part A: Policy and Practice, 41(7): 615-626.
4. Lam, W.H.K., S.C. Wong, H.K. Lo, N. Geroliminis and D.M. Levinson, 2009. Cordon Pricing Consistent with the Physics of Overcrowding, in Transportation and Traffic Theory 2009: Golden Jubilee: Springer US, pp: 219-240.
5. Tsekeris, T. and S. Voß, 2009. Design and evaluation of road pricing: state-of-the-art and methodological advances. NETNOMICS, 10(1): 5-52.
6. Goh, M., 2002. Congestion management and electronic road pricing in Singapore. Journal of Transport Geography, 10(1): 29-38.
7. Olszewski, P. and L. Xie, 2005. Modelling the effects of road pricing on traffic in Singapore. Transportation Research Part A: Policy and Practice, 39(7-9): 755-772.
8. Goodwin, P., 2004. Congestion charging in central London: Lessons learned. Planning Theory and Practice, 5(4): 501-505.
9. Leape, J., 2006. The London Congestion Charge. Journal of Economic Perspectives, 20(4): 157-176.
10. Santos, G. and J. Bhakar, 2006. The impact of the London congestion charging scheme on the generalised cost of car commuters to the city of London from a value of travel time savings perspective. Transport Policy, 13(1): 22-33.
11. Prud'homme, R. and J.P. Bocarejo, 2005. The London congestion charge: a tentative economic appraisal. Transport Policy, 12(3): 279-287.
12. Armelius, H. and L. Hultkrantz, 2006. The politico-economic link between public transport and road pricing: An ex-ante study of the Stockholm road-pricing trial. Transport Policy, 13(2): 162-172.
13. Gudmundsson, H., E. Ericsson, M.B. Hugosson and L.S. Rosqvist, 2009. Framing the role of Decision Support in the case of Stockholm Congestion Charging Trial. Transportation Research Part A: Policy and Practice, 43(3): 258-268.
14. Larsen, O.I., 1995. The toll cordons in Norway: an overview. Journal of Transport Geography, 3(3): 187-197.
15. Ieromonachou, P., S. Potter and J.P. Warren, 2006. Norway's urban toll rings: Evolving towards congestion charging? Transport Policy, 13(5): 367-378.
16. Lian, J.I., 2008. The Oslo and Bergen toll rings and road-building investment-Effect on traffic development and congestion. Journal of Transport Geography, 16(3): 174-181.
17. Odeck, J. and S. Bråthen, 1997. On public attitudes toward implementation of toll roads--the case of Oslo toll ring. Transport Policy, 4(2): 73-83.
18. Lauridsen, H., 2010. The impacts of road tolling: A review of Norwegian experience. Transport Policy, 18(1): 85-91.
19. Whitehead, T., 2005. Transport charging interventions and economic activity. Transport Policy, 12(5): 451-463.

20. Dawson, J.A.L. and I. Catling, 1986. Electronic road pricing in Hong Kong. Transportation Research Part A: General, 20(2): 129-134.
21. Ryley, T. and N. Gjersoe, 2006. Newspaper response to the Edinburgh congestion charging proposals. Transport Policy, 13(1): 66-73.
22. Gorman, D.R., M. Higgins and J. Muirie, 2008. The Edinburgh congestion charging proposals: The devil in the detail. Public Health, 122(11): 1188-1190.
23. Schaller, B., 2010. New York City's congestion pricing experience and implications for road pricing acceptance in the United States. Transport Policy, 17(4): 266-273.
24. Mun, S.I., K.J. Konishi and K. Yoshikawa, 2003. Optimal cordon pricing. Journal of Urban Economics, 54(1): 21-38.
25. Wang, J.Y.T., R. Lindsey and H. Yang, 2010. Nonlinear pricing on private roads with congestion and toll collection costs. Transportation Research Part B: Methodological, 45(1): 9-40.
26. Zhang, X. and H. Yang, 2004. The optimal cordon-based network congestion pricing problem. Transportation Research Part B: Methodological, 38(6): 517-537.
27. Eliasson, J. and L.G. Mattsson, 2006. Equity effects of congestion pricing: Quantitative methodology and a case study for Stockholm. Transportation Research Part A: Policy and Practice, 40(7): 602-620.
28. Santos, G., 2002. Double Cordon Tolls in Urban Areas to Increase Social Welfare. Transportation Research Record: Journal of the Transportation Research Board, 1812(-1): 53-59.
29. Tuan Seik, F., 2000. An advanced demand management instrument in urban transport: Electronic road pricing in Singapore. Cities, 17(1): 33-45.
30. Eliasson, J., L. Hultkrantz, L. Nerhagen and L.S. Rosqvist, 2009. The Stockholm congestion-charging trial 2006: Overview of effects. Transportation Research Part A: Policy and Practice, 43(3): 240-250.
31. Odeck, J. and S. Bråthen, 2002. Toll financing in Norway: The success, the failures and perspectives for the future. Transport Policy, 9(3): 253-260.
32. Rotaris, L., R. Danielis, E. Marcucci and J. Massiani, 2010. The urban road pricing scheme to curb pollution in Milan, Italy: Description, impacts and preliminary cost-benefit analysis assessment. Transportation Research Part A: Policy and Practice, 44(5): 359-375.
33. Tarhe Haftom Consultant Engineering (THCE), 2010. Models to estimate population and growth, Mashhad Transportation and Traffic Organization, 85-101 300-32-01.
34. MTTO(Mashhad Transportation and Traffic Organization), 2010a. Sixth Mashhad transport report, <http://www.mashadtraffic.ir/portal/images/stories/taffic/pdf/amarnameh/amarname%2089.pdf> (Sep. 16, 2010).
35. Mashhad Transportation and Traffic Organization (MTTO), 2010a. Sixth Mashhad transport report, <http://www.mashadtraffic.ir/portal/images/stories/taffic/pdf/amarnameh/amarname%2089.pdf> (Sep. 16, 2010).
36. Behin Taradod Consultant (BTC), 2004. Methods to deal with traffic problems during certain date, Mashhad Transportation and Traffic Organization 2004.
37. MTTO(Mashhad Transportation and Traffic Organization), Evaluation report within Mashhad restricted CBD zone, Specialty Group Traffic Construction Engineering Organization of Khorasan Razavi province, 1-52010b).
38. Mashhad Transportation and Traffic Organization (MTTO), 2011. Restricted traffic zone, <http://www.mashadtraffic.ir/portal/1387-12-20-06-41-09.html> (Jan. 10, 2011).
39. Mashhad Transportation and Traffic Organization (MTTO), 2010c. Restricted CBD zone, vol. 5 December 2010: <http://www.mashadtraffic.ir/en/portal/1387-12-20-06-41-09.html> (Dec. 25, 2010).
40. Jansson, J.O., 2010. Road pricing and parking policy. Research in Transportation Economics, 29(1): 346-353.
41. Azari, K.A. and S. Arintono, 2010. Addressing Parking and Cordon Pricing Problems in Central Business District. 4th International Conference On Postgraduate Education, 1: 41-43.
42. Schade, J. and B. Schlag, 2003. Acceptability of urban transport pricing strategies. Transportation Research Part F: Traffic Psychology and Behaviour, 6(1): 45-61.