UNIVERSITI PUTRA MALAYSIA

MODELLING MODE AND PARKING CHOICE BEHAVIOUR UNDER CORDON PRICING POLICY IN MASHHAD CENTRAL BUSINESS DISTRICT, IRAN

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By

KIAN AHMADI AZARI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

December 2012

DEDICATION

Especially dedicated to:

My beloved father Khalil

&

My mother Samaneh

Abstract of the thesis presented to the senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy

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Transportation problems such as traffic congestion, crash, pollution (air and noise) are results of increased private cars in use, especially in large metropolitan areas such as Mashhad Central Business District (CBD). For many years, parking policy in downtown areas has been considered as one of the best and efficient tool for travel demand management (TDM). Recently, road pricing has shown greater promise in alleviating congestion in urban areas, but has still to prove its worth in TDM. In previous studies, researchers focused on the role of congestion pricing and its effects on mode choice. Meanwhile, the literature has ignored studying travellers' response to mode and parking choice behaviour in the presence of cordon pricing measures, especially in developing countries. The main objective of this research is to evaluate the effect of cordon pricing and parking policy measures on parking location and mode choice in CBD of Mashhad, Iran. This will lead to assess the effectiveness of

both parking and cordon related policies aimed at implementing a good scheme in order to encourage private car users to shift mode, but not discourage visitors from coming to the city center.

Two surveys were conducted to assess user's attitudes towards Mashhad cordon pricing scheme. To determine the traffic impacts, the survey was performed before and after implementation of cordon charges in 2010. Traffic counts were done in the entrance section of the restricted zone in four major roads connected to the CBD. To develop the mode and parking choice behaviour model, a random sample size of 586 respondents was requested to perform a comprehensive questionnaire-based survey. Employing stated preference method, the drivers' mode and parking choice behaviour were advanced by multinomial logit model, by addressing two different models; general and trip purpose-based model.

Based on the traffic survey, volume of passenger cars travelling inside the cordon zone declined by 36% (12,510 vehicles per day), which caused increased volume of taxi (17.4%) and bus (26.9%). Furthermore, the daily trip distribution shows that the largest reduction of passenger car volume was observed during the afternoon peak (53%) rather than in the morning peak, which reveals that a greater portion of arbitrary trips occurred during afternoon peak. Results from the hypothetical question analysis shows that the in-vehicle cost is the least (33%) and cordon cost the most (67%) important attributes affecting mode choice. Further, the results suggest that increasing cordon and parking costs by TN3000 (TN1000= USD ($)1.0) and TN600, respectively, will drive 80% of commuters away from using private car to travel inside the cordon area.

For the general mode and parking choice model, it is found that the estimated coefficients from the SP experiments (cordon/parking/in-vehicle cost, and search/egress time) were all embedded in the final model with negative signs, implying that the utility of travelling to the CBD decreases as the time and cost for car users increase. Meanwhile, drivers have high sensitivity to cordon charge (-1.145), significantly higher than to parking cost, search and egress times. Finally, drivers' willingness to pay for parking fee is 2 to 3 times higher than for cordon toll. A comparison of purpose-based models shows that cordon cost and the thresholds of parking costs have significant effect on non-workers than on workers to shift mode. Besides, the effect of reduced travel time is more effective than increased travel cost to encourage workers to shift mode. The elasticity values for cordon (-2.262) and parking (-0.331) indicate that non-workers, due to their more flexible travel schedule are more sensitive than workers, to changes in the attributes. Finally, the willingness-to-pay for workers is 2.3 times higher than for non-workers in the case of cordon charge.

Overall, it is concluded that cordon pricing is an effective policy to alleviate congestion and manage travel demand in city centres. Based on the results, the study suggests policy implications for improvement of public transport services, parking at the fringe or outside the CBD, and time-wise cordon charging which would affect mode and parking location preference and result in significant reduction of car use inside the CBD.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PEMODELAN MOD DAN PERILAKU PILIHAN MELETAK KENDERAAN DI BAWAH POLICI PENETAPAN KOS JARINGAN JALANRAYA DI DAERAH PUSAT PERNIAGAAN MASHHAD, IRAN

Oleh

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Masalah-masalah pengangkutan seperti kesesakan jalanraya, kemalangan, pencemaran (udara dan bunyi) diakibatkan oleh peningkatan penggunaan kereta-kereta peribadi, terutamanya di kawasan-kawasan metropolitan yang besar seperti Daerah Pusat Perniagaan (CBD) Mashhad. Selama ini, polisi pemarkiran kereta di kawasan-kawasan pinggir bandar dianggap sebagai salah satu alat yang terbaik dan paling berkesan dalam aspek pengurusan keperluan perjalanan (TDM). Baru-baru ini, penetapan kos jaringan jalan telah memberi satu harapan baru dalam mengurangkan kesesakan di kawasan-kawasan bandar, tetapi ianya masih perlu membuktikan keberkesanannya dalam TDM. Dalam kajian-kajian awal, para pengkaji telah memfokus kepada peranan penentuan harga kesesakan dan kesannya ke atas pilihan mod pengangkutan. Sementara itu, literatur telah mengabaikan maklumbalas pengembara kepada mod dan perilaku pilihan pemarkiran dalam

pengaplikasian kaedah-kaedah penentuan harga zon jaringan jalanraya, terutamanya di negara-negara sedang membangun. Objektif utama kajian ini adalah mengkaji kesan penentuan harga zon jaringan jalanraya dan kaedah dasar pemarkiran ke atas pilihan lokasi meletak kenderaan dan mod di CBD Mashhad, Iran. Ini membawa kepada penilaian keberkesanan pemarkiran dan dasar penetapan harga yang bertujuan melaksanakan satu kaedah yang baik untuk menggalakkan pengguna-pengguna kereta peribadi untuk beralih kepada kaedah pengangkutan lain, tetapi tidak menghalang para pelawat untuk mengunjungi pusat bandar tersebut.

Dua tinjauan telah dibuat untuk menilai sikap pengguna keatas kaedah penetapan harga zon jaringan jalanraya Mashhad. Untuk menentukan impak di jalanraya, tinjauan dijalankan sebelum dan selepas pelaksanaan caj jaringan jalan pada tahun 2010. Kiraan trafik dilakukan di bahagian pintu masuk zon terhad di empat jalanraya utama yang bersambung dengan CBD. Untuk membangunkan model perilaku pilihan mod dan pemarkiran, sampel rawak yang diwakili oleh 586 orang responden telah diminta mengambil bahagian dalam tinjauan berasaskan soal-selidik yang komprehensif. Dengan menggunakan kaedah ‘stated preference’, perilaku pemandu keatas pilihan mod dan tempat meletak kenderaan telah dikaji melalui penggunaan model logit multinomial yang menjurus kepada dua model yang berlainan; model am dan model berasaskan kepada tujuan perjalanan.

Berdasarkan kepada tinjauan trafik, jumlah kereta yang bergerak dalam zon jaringan jalanraya telah menurun sebanyak 36% (12,510 kenderaan sehari), yang menyebabkan pertambahan volum teksi (17.4%) dan bas (26.9%). Tambahan lagi, pengagihan perjalanan harian menunjukkan bahawa penurunan terbesar volum kereta

terjadi pada masa sibuk di waktu petang (53%) dan bukan di sebelah pagi, yang menunjukkan bahawa sebahagian besar perjalanan rambang berlaku pada waktu petang. Keputusan-keputusan daripada analisis soalan hipotetikal menunjukkan bahawa kos kenderaan ialah paling kurang, iaitu 33% dan kos zon jaringan jalanraya yang terbanyak (67%) sebagai ciri-ciri utama yang memberi kesan kepada pilihan mod. Tambahan pula, keputusan-keputusan menunjukkan bahawa penambahan kos zon jaringan jalanraya dan pemarkiran sehingga IRR30,000.00 (IRR10,000.00 = USD1.00) dan IRR6,000.00, masing-masing, akan menyebabkan 80% daripada pengguna mengambil langkah tidak membawa kereta sendiri untuk masuk ke dalam kawasan zon jaringan jalanraya.

Untuk model am pilihan mod dan pemarkiran, didapati bahawa koefisien yang dianggarkan dari eksperimen SP (kos jaringan-jalanraya/pemarkiran/kenderaan dan masa mencari/berjalan) terkandung sekali dalam model terakhir dengan tanda-tanda yang negatif, menunjukkan bahawa utiliti perjalanan ke CBD berkurangan bila masa dan kos untuk pengguna-pengguna kereta meningkat. Sementara itu, para pemandu mempunyai sensitiviti yang tinggi ke atas caj yang dikenakan ke atas zon jaringan jalanraya ini (-1.145), jauh lebih tinggi dari cas pemarkiran, masa pencarian dan berjalan. Akhir sekali, kesanggupan pemandu untuk membayar tambang parkir adalah 2 ke 3 kali lebih tinggi dari tol zon jaringan jalanraya. Perbandingan model-model yang berasaskan tujuan perjalanan membuktikan bahawa kos-kos zon jaringan jalanraya dan kos-kos parkir mempunyai kesan ketara ke atas mereka yang tidak bekerja daripada pekerja-pekerja untuk bertukar mod. Disamping itu, kesan masa perjalanan yang semakin berkurangan adalah lebih efektif dari kos perjalanan yang meningkat, untuk menggalakkan para pekerja bertukar mod. Nilai kenyal untuk zon

jaringan jalanraya (-2.262) dan parkir (-0.331) menunjukkan bahawa, untuk mereka yang tidak bekerja, perancangan perjalanan yang lebih fleksibel menyebabkan mereka lebih sensitif kepada perubahan dalam ciri-ciri tersebut, dari mereka yang bekerja. Akhir sekali, kesanggupan pekerja-pekerja untuk membayar tambang adalah 2.3 kali lebih tinggi dari mereka yang tidak bekerja, dalam hal caj zon jaringan jalanraya.

Pada keseluruhannya, dapatlah disimpulkan bahawa penetapan harga zon jaringan jalanraya adalah satu dasar yang berkesan, untuk meringankan kesesakan jalanraya dan melicinkan lagi pengurusan keperluan perjalanan di pusat-pusat bandar. Berdasarkan keputusan-keputusan tadi, kajian menyarankan bahawa implikasi polisi untuk penambahbaikan perkhidmatan-perkhidmatan pengangkutan awam, seperti meletakkan kereta di pinggir atau luar CBD, dan dari aspek masa, penetapan caj zon jaringan jalanraya, akan menjejaskan mod dan lokasi parkir yang disenangi pengguna, dan ini boleh dikaitkan dengan penurunan ketara penggunaan kereta dalam CBD.

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I certify that a Thesis Examination committee has met on 12 December 2012 to conduct the final examination of Kian Ahmadi Azari on his thesis entitled "Modelling Mode and Parking Choice Behaviour Under Cordon Pricing Policy in Mashhad Central Business District, Iran" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The committee recommends that the student be awarded the Doctor of Philosophy.

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DECLARATION

I declare that this thesis is my original work except for quotations and citations which have been duty acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

KIAN AHAMADI AZARI

Date: 12 December 2012

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