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INVESTIGATION OF DEPARTURE TIME IN THE JOURNEY TO WORK IN TABUK CITY

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ABSTRACT

Purpose: The purpose of this paper is to investigate departure time choices and impacts on travel decisions.

Methodology: In this context, this paper investigates departure time choice as a travel option which is affected by personal factors as well as system factors and influence the level of congestion of the transport system. The paper investigates the factors which affect the decisions of departure times in the Kingdom of Saudi Arabia using the household survey data. A number of statistical analysis techniques have been utilised in this research.

Findings: Departure time choice modelling is lacking behind in comparison with other travel choices. This research is investigating departure time and travel time flexibility in the city of Tabuk in Kingdom of Saudi Arabia (KSA), where female travellers do not have access to car driving. A binary probit model has been calibrated. The results show that show that the female members of the family are more flexible in terms of departure and arrival times choices. This might be because female members of the family in KSA do not have access to driving private cars and it is only the male members of the family do drive.

Originality: Investigation of departure time choices are lacking behind in comparison with other travel choices, in particular in the KSA. This research is investigating departure time and travel time flexibility in the city of Tabuk in KSA.

Keywords: departure time choice; sustainable modes of travel; Saudi Arabia; Tabuk.

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INTRODUCTION

Very little attention has been given on departure choice modelling compared to other travel demand, trip mode choice models. This is especially true in the developing countries. Due to limited research and data availability and state-of-art and practice in travel choice modelling; local, state and countries transportation agencies do not have an explicit component to accommodate departure time choice in their travel model systems, and as a result simplistic, aggregate-level approaches are often adopted. This research investigate departure time choice and travel time flexibility in the city of Tabuk in the Kingdom of Saudi Arabia (KSA). Commuter departure time choice analysis has gained importance because it provide better understanding of the behavioural mechanisms behind peak-period road congestion. Better understanding of behavioural mechanisms can provide congestion relief measures that can be better coupled with commuters' decision processes to gain effective policy decision. There are two aspect of behaviour paradigm shift. First aspect is based on the notion of random utility maximisation, and implicitly assumes the network conditions are known to commuters (e.g. Hendrickson and Plank, 1984; Mahmassani and Herman, 1984; Palma et al., 1983) while second one relaxes this assumption considerably and acknowledges the roles of heuristics in human decision, and adopts the concept of bounded rationality proposed by Jou and Kitamura (2002), Mahmassani and Chang (1987) and Mahmassani and Liu (1999).

Due to limited research and data availability and state-of-art and practice in travel choice modelling; local, state and countries transportation agencies do not have an explicit component to accommodate departure time choice in their travel model systems. These agencies apply simplistic, aggregate-level, factors to apportion total daily travel demand among each of several time periods (see e.g. Bhat, 1998).

Transport models are used primarily to predict travel demand forecasts under a number of scenarios. For example when building a new railway line, planners need to have an idea on the predicted demand of the planned service. Moreover, the design and specification of the service will benefit from some modelling on the acceptance of the users and infrastructure capabilities of the transport system.

There is a large number of research work, modelling techniques, investigation and approaches available in each of these three main categories of transport modelling. Research is also still continuing. In this work we adopt a well know and well established model (the binary probit model) to model departure time choice and travel flexibility in Tabuk city in the KSA. The aim of this research therefore is to investigate departure time choices and travel time flexibility in the case of Tabuk city as a case study. Saudi Arabia is a Middle Eastern Islamic country, and female travellers do not have access to driving. There is a five-day working week starting on Saturday, and the normal working hours are 8 am to 2.30 pm.

In Section 2 the general background and literature review on departure time investigations are presented. Section 3 introduces the case study of Tabuk. The data collection and statistical analysis is presented in Section 4. Further discussions of the findings are presented in Section 5. The work is concluded in Section 6.

DEPARTURE TIME INVESTIGATIONS: PREVIOUS WORK

Ignoring the time-of-day dimension of travel and applying factors that remain unchanged in the modelling process is inadequate for a number of reasons. Firstly, the 1990 Clean Air Act Amendments (CAAAs) require travel demand models to provide accurate estimates of the number of new vehicle

trips during different times of the day. One can obtain such accurate estimates only by explicitly modelling the departure time of trips. Secondly, from a forecasting perspective, the application of static time-of-day factors does not consider the potential shifts in trip departure times due to non-uniform (across time-of-day) changes in network level-of-service between the estimation and forecast periods. This is likely to lead to inaccurate future year highway assignments by time of day. Thirdly, from a policy standpoint, travel demand models have to be able to evaluate a variety of Transportation Control Measures (TCMs) such as peak-period pricing, congestion-pricing, and ride-sharing or transit-use incentives (see Stopher, 1993; Weiner and Ducca, 1996). Many of these TCMs will not only have an impact o n travel mode, but will also affect departure time choice.

Many of the departure time choice modelling focus on work trip (see Bhat, 1997; Horowitz, 1993; Ben-Akiva and Lerman, 1985; Fischer and Nagin, 1981; Swait and Ben-Akiva, 1987 and Train, 1980 for work mode choice modelling; Abkowitz, 1981; Chin, 1990; Hendrickson and Plank, 1984; Mannering, 1989), non-work trip like shopping trip or social trip (Bhat, 1998; Chu 1995), tour-based model concept (Bowman and Ben-Akiva, 2000) tourism arrival time trip (Cho, 2003). Bhat (1997) proposed the Multinomial Logit (MNL) model, the Nested Logit (NL) model with departure time alternatives within each mode specified to share common unobserved random utility attributes for the higher-level mode choice decision and the standard Ordered Generalised Extreme-Value (OGEV) formulation for the lower-level departure time choice decision also termed as the MNL ± OGEV formulation model for shopping trips.

Cho (2003) proposed Autoregressive Integrated Moving Average (ARIMA) and Elman's Model of Artificial Neural Networks (ANN), to predict travel demand (i.e. the number of arrivals) from different countries to Hong Kong and found Neural Networks is best for forecasting visitor arrivals, especially those series without obvious patterns. Bowman and Ben-Akiva (2000) proposed NL models, which has ability to capture important activity-based demand responses, such as the choice between trip chaining on one tour and conducting two separate tours (an inter-tour trade) or the choice between conducting an activity at home and conducting it on a tour-an on-tour versus at-home trade. Their model was capable for better for policy sensitive forecasting.

Zhang (2010) used Dynamic Traffic Assignment (DTA) and Simultaneous Departure Time and Route (SDR) with choices in transportation networks with bottlenecks, where both link and path capacities are time-dependent. The explicit results showed that an inappropriately added new link could deteriorate the existing network in terms of the increase of individual and system travel costs. DTA-SDR solution is explicitly calculated in the classical Braesss network. Interestingly, Braesss paradox also occurs in dynamic circumstance, and the mechanism is quite different. They found paradoxes which are caused by the self-optimising behaviour of individual commuters. Specifically, the self-optimising behaviour includes three types of competitions among commuters, namely competition between different ODs (Akamatsu, 2000), competition between different routes and competition between different departure times. The paradox was caused by a new type of self-optimising behaviour, was namely the SDR competitions in Zhang' research.

Fujii and Kitamura (2004) investigated Drivers' Mental Representation of Travel Time and Departure Time Choice in Uncertain Traffic Network Conditions using MNL model. They found that the decisions drivers make, such as choice of route or departure time, constitute typical decision making under uncertainty. They studied drivers' decision making within the framework of expected utility theory. They observed empirical decisional phenomena violating the premise of expected utility theory. Their findings have indicated that decision making is critically affected by the decision frame. It has also been pointed out that the uncertainty of outcome is perceived as an interval of possible resultant values. Results data indicate that commuters differentiated between

the five alternatives (the risk of being late, the risk of being early for the required arrival time, safe, failed period) if and only if the required arrival time was important for them.

Senbil and Kitamura used two decision frames in order to access the value and weight functions, two pivotal elements of the Prospect theory. Weight function was associated with a new model coupled as Contingency Adjustment Model (CAM). CAM model has theoretical background on individual updating of perceived likelihood of any arrival time conditioned on a certain departure time. In this regard, the weights were assumed to be realised with respect to a comparison between expected (at the departure time) and realised arrival times. Commuter holds an expected arrival time at a departure time which was established by his commute history, but the same time, every day was taken as another episode of risks and uncertainties: commuter re-evaluated his chances and takes actions, such as listening the radio broadcast carefully when it was raining, or lane changing to make a null probability a possible gain arrival, etc. Although our non-linear regression estimation of the weight function complies with the basic premise of the Prospect theory, it was required to know other structural elements, the effects of observed and unobserved heterogeneity, affecting behavioural responses to the expected probability.

For this reason, they used linear and probit regressions that control for heterogeneity but only refer to over- and under-weighting of probabilities. The weight function yielded results that were significant for trip attributes but not for most of the commuter attributes. The value function was devised by using two decision frames, the first one was symmetric about the preferred arrival time for gains and losses, and the second one is not symmetric. The estimation of the value function by the binary Probit model yielded approximately similar results for both of the decision frames. In both of the decision frames, it was significantly true that commuters are responsive to the time deviations from reference points in their decision frames. The arrival points in the gain region were not equal in values and the choice of the departure time is strongly conditioned on the possible arrival times.

CASE STUDY: CITY OF TABUK IN SAUDI ARABIA

Tabuk is one of the provincial capital situated in north-western Saudi Arabia, which has induced enormous intra- and inter-city transportation demand due its rapid economic growth and due to recent oil and gas-based growth economy in recent years. Travel condition in Tabuk city of Saudi Arabia are influenced by the Islamic culture and norms and the high income due to cheapest oil prices (Al-Atawi and Saleh, 2013). These led to huge investments in infrastructures and urban developments, including but not limited to public transportation services. In order to aim to achieving a sustainable transport system, it is of crucial importance to acquire information and understanding of travellers' behaviour, preferences, attitudes and choices. In the context of mode choices and captivity to modes, Al-Atawi and Saleh (2014), showed that the private cars, private drivers and car sharing are the most used modes of transport in Tabuk city. They also show that policy-relevant variables such as travel cost or time, travel mode attributes in do not affect choice of modes of travel.

DATA COLLECTION AND CURRENT TRAVEL PATTERNS IN TABUK

Data collection

The data used in this study was collected using a questionnaire. In total 1226 surveys were distributed throughout the city of Tabuk, overall 516 completed surveys forms were returned

which is an overall response rate of 42.0% for the study as a whole in month of September 2012. Questionnaires were distributed in different sectors in order to cover broad spectrum of characteristics of different workplaces in Tabuk city. This includes, health services (hospitals, healthcare centres, military's hospitals), educational services (schools and universities), military services, security, private, Tabuk Municipality and the water Authority.

The questionnaire comprised of five separate sections. The first section of the questionnaire analysed the current travel patterns of the respondents in which they were asked to identify the mode of transportation which they use to reach their place of work along with some characteristics of this mode which were specific to them such as the travel time, travel cost and the needs which these modes most satisfy for the user. In the second section of the questionnaire the respondents were asked to provide their attitudes and preferences on alternate modes of transport in relation to comfort, reliability cost travel time, etc. This was aimed at determining how willing individuals would be to change their mode of transportation and what it is that would instigate the decision to change.

The questionnaire gathered information on preferences and attitudes related to the times which individuals travelled to their place of work in the third section. In addition, preferences and attitudes to their travel patterns were also investigated. The fourth and final sections of the questionnaire collected information of respondents' preferences and attitudes to a number of traffic and travel transport policies and socio economic and household structure of respondents.

Current travel patterns in Tabuk

From the collected data it was seen that the mode of transportation most commonly used on a regular basis to reach the workplace within Tabuk was to drive a private vehicle which was indicated by 55.7% (287) of the respondents to the survey. This was followed by the participation in informal car share schemes which were used by 17% (88) of respondents. A total of 46 (8.9%) of the respondents indicated that they regularly utilised the services of a contracted driver in order to reach their place of work. This level of usage was followed by the use of a private driver or chauffeur which 42 (8.16%) of the respondents indicated that they employed. Cycling was the mode of transportation which was used by 6.4% (33) of the respondents on a regular basis; this was followed in prevalence by walking which was undertaken by 25 (4.85%) of the respondents. The use of private buses was indicated by 18 (3.5%) of the respondents as the means by which they reach their place of work most often. The options for utilising a taxi service and other modes of transport were both indicated by 10 (1.94%) respondents as their most commonly used mode of transportation. Unfortunately within the other option none of these individuals specified the mode which they used therefore further investigation of these modes is not possible.

In relation to the least utilised or never option it was seen that cycling was the mode identified by the majority of respondents as not being utilised with 284 (55.15%) responses in this area. This was followed by walking to work which was never undertaken by 278 (54%) of the respondents. Driving was the mode which resulted in the lowest response rate within this category with only 75 (14.6%) of respondents indicating that they never drove to their place of work.

When asked to identify the factors which affected the choice of mode it was seen over all of the mode options available that comfort was the most common factor which influenced the individuals choice.

This was indicated by a total of 262 (50.87%) of the individuals as being a determining factor in their decision-making process. The next most influential factor was that of privacy which was indicated by 231 (44.9%) of the respondents and was followed by cost effectiveness of the mode which was indicated by 209 (40.58%). The fact that such a large proportion of respondents

indicated cheapness as being a determining factor leads us to believe that they are not fully aware of all of the factors of each mode they take as in most instances the use of bicycles and walking are much cheaper than that of the private car however this desire to utilised the cheapest mode is not reflected in the actual mode choices as the private vehicles is by far the most commonly used mode.

Environmental considerations was the factor which had the least influence on the mode choice of the survey group with only 66 (12.8%) of the respondents indicating that it influenced their mode choice. Reliability was also a factor which was not deemed important by many individuals with 80 (15.5%) responses in the category. A total of 37 (7.18%) individuals did indicate that other factors affected their mode choice however these once more were not expanded upon.

When asked to identify the duration of their journey from their home to their place of work it was seen that the overall average journey time was 20.63 min. When a more detailed analysis of the data is completed we see that those which participated in formal car share schemes had the shortest average journey time of 15 min. This was followed by those whom took part in informal car shares with 16.56 min. On average drivers journey times stood at 21.29 min which was slightly above the average journey time. Those which had the highest journey time were those whom hired taxies to reach their destination and it was seen that their average journey time was 80 min. This journey duration differs greatly from the average journey time and therefore it was deemed prudent to determine an overall average journey time when these users are excluded. When this takes place the average journey time is seen to be reduced to 20.24 min. Only a small adjustment in the figures takes places as only two individuals indicated that they utilised taxis in this sector. The use of buses are seen to have the next highest average journey time at 26.67 min and is in turn followed by walking at 23.89 min.

In relation to the cost of commuter journeys initially respondents whom used private vehicles were asked to identify the cost of refilling their vehicles and how often they refilled them. From this data it was seen that the average cost of refuelling a vehicle varied from 320.55 to 287.78 SR per month depending on the level of usage and extremes of expenditure taken into account.

Following on from this, individuals whom employed private drivers and utilised taxies for their commute were asked to provide data on their expenses. From this data it was seen that users of taxis on average paid 360.25 SR per month while those whom employed private drivers spent on average 457.69 SR per month.

Respondents were required to provide a detailed account of their perception of the relative importance of certain attributes in relation to their most frequently used mode of transportation to their place of work. A total of 455 individuals provided a response in this category with a total of 353 (79.33%) of these individuals rating safety as being very important. The lower ratings of important, moderately important, only slightly and not at all each gained the support of 80 (18%), 16 (3.6%), 3 (0.67%) and 3 respondents each. The second most important factor for respondents was that of travel time with a total of 355 (73.3%) of the 457 respondents whom provided data in this section indicating it as a very important factor. A total of 308 (67.1%) respondents indicated that comfort was very important for them.

The same attributes were examined as in the previous section with respondents being asked to rate them on a scale of very good, good, fair, poor and very poor. From this summary of the collected data we can see that reliability achieved a slightly higher rating when compared to any of the other attributes examine achieving responses in the very good category by 274 individuals and 124 in the good category. The second highest rating was achieved by comfort which achieved 219 and 127 in each of these categories, respectively. When the data with regards the fair rating

is examined we see that environmental friendliness gains the higher rating with 119 responses followed by flexibility and convenience with 72 and 71 responses each. In relation to the lower achieving attributes we see that the majority of responses in the poor and very poor categories were achieved by the travel cost category with 32 responses in these categories. Drivers accounted for a total of 14 of these respondents. This indicates that a certain amount of drivers do recognise that their mode of transportation is not the most cost effective however they still choose this mode.

One of the main factors which will influence the mode which is chosen by a commuter is whether or not they have additional commitments on their journey to their place of work. In this section the respondents who drove to work were asked to identify any possible commitments which they may have. It was seen that 123 (33.43%) indicated that they had additional commitments while a further 243 (66.57%) said they did not. A total of 76 (67.26%) of these individuals indicated that they were required to transport their children or other family members to their place of education during their commute. This was followed by the need to carry out shopping which was indicated by 10 (8.85%) of the respondents.

DISCUSSIONS OF THE FINDINGS: DEPARTURE TIME AND TRAVEL CHOICE FLEXIBILITY

This section the questionnaire attempts to identify the possibility of respondents altering their travel patterns and if so by what degree this could be done. In instances where there is an inability to change these patterns the respondent is asked to identify the reasons as to why no alterations can be made.

In total 175 (37.8%) of the respondents indicated that their working day began before 07:00, while a further 207 (44.71%) commenced their work between the hours of 07:00 and 08:00. A further 45 (9.72%) indicated that they commenced working between 08:01 and 09:00. This shows that working departure time is distributed between 07.00 to 8.00 clock.

Following on from this, individuals were asked if they would be capable of finishing work after their usual time. A total of 221 (52.2%) respondents indicating that they would be able to alter their finishing time while a further 153 (36.2%) indicated that they would not be able to make any alterations. A total of 49 (11.6%) respondents indicated they did not know if they could change their finishing times. It was seen that an alteration of 60 min was the most popular option being selected by a total of 95 (42%) individuals. This was followed by 120 min which was selected by 43 (19%) respondents as being a possible alteration in their finishing time.

A total of 153 (35.25%) of the respondents indicated that they finished their working day before 14:00 with a further 133 (30.65%) ending their working day between 14:00 and 14:30. A total of 97 (21.89%) individuals indicated that they finished between 14:31 and 15:00. A total of 3 respondents finished work between 15:30 and 16:00, with the 16:01 and 16:30 time frame once more seeing an increase in activity with 27 respondents departing their place of work. Between the hours of 16:30 and 18:00 a total of 17 further respondents finished with 6 respondents indicating that they finished after 18:00. Finish time of work is ranging before 14.00–15.00 clock.

Respondents were then asked to identify whether or not they felt that they were able to commence their working day earlier or later than they currently did. When the respondents were asked by how much earlier or later they could starting paradoxically a larger number of responses were seen than those who indicated that they could alter their work times. In total 249 (56.2%) responders indicated that they would be able to start earlier while a total of a 194

(43.8%) responses were seen in the area of being able to start later. This shows that largely people in Tabuk are flexible to start before their actual start time and also finish their work before usual time of working hours.

Within the group whom indicated that they were able to begin their work earlier it was seen that the modal response was a 30 min alteration in the start time being indicated by a total of 72 (28.9%) respondents followed by the ability to start 60 min as was indicated by 55 (22%) individuals. This is significant finding. However the flexibility of departure time is linked with several factor such as valuable mode, cost, safety, traffic rule. Many factors were used to understand the relation between departure choice and its flexibility. The modelling analysis is discussed below.

CONCLUSIONS

Departure time choice modelling is lacking behind in comparison with other travel choices. This research is investigating departure time and travel time flexibility in the city of Tabuk in KSA, where female travellers do not have access to car driving. The results show that show that the female members of the family are more flexible in terms of departure and arrival times choices. This might be because female members of the family in KSA do not have access to driving private cars and it is only the male members of the family do drive. One of the implications of this is that the male members of the family take all responsibilities related to any activities which need travelling such as shopping, dropping children or picking up other members of the family. On the other hand, female members of the family do not get this type of commitments. Further research in this area is definitely still needed.

REFERENCES

Al-Atawi, A. and Saleh, W. (2014) 'Travel behaviour in Saudi Arabia and the role of social factors', *Transport*, May, Taylor & Francis.

Al-Atawi, A. and Saleh, W. (2013) *Travel Behaviour in Tabuk*, Final Report.

Abkowitz, M.D. (1981) 'An analysis of the commuter departure time decision', *Transportation*, Vol. 10, pp.283–297.

Akamatsu, T. (2000) 'A dynamic traffic equilibrium assignment paradox', *Transportation Research*, Vol. 34B, pp.515–531.

Ben-Akiva, M. and Lerman, S. (1985) *Discrete Choice Analysis: Theory and Application to Travel Demand*, Cambridge, MA: The MIT Press.

Bhat, C.R. (1997) *Incorporating Observed and Unobserved Heterogeneity in Urban Work Travel Choice Modelling*, Manu-script, Department of Civil Engineering, University of Texas, Austin.

Bhat, C.R. (1998) 'Analysis of travel mode and departure time choice for Urban shopping trips', *Transportation Research Part B*, Vol. 32, No. 6, pp.361–371.

Bowman, J.L. and Ben-Akiva, M.E. (2000) 'Activity-based disaggregate travel demand model system with activity schedules', *Transportation Research Part A*, Vol. 35, pp.1–28.

Chin, A.T.H. (1990) 'Influences on commuter trip departure time decisions in Singapore', *Transportation Research-A*, Vol. 24, pp.321–333.

Chu, X. (1995) 'Alternative congestion pricing schedules', *Paper presented at the 79th American Economic Association Annual Meeting*, Washington, DC, January.

Cho, V. (2003) 'A comparison of three different approaches to tourist arrival forecasting', *Tourism Management*, Vol. 24, pp.323–330.

Fischer, G.W. and Nagin, D. (1981) 'Random versus fixed coefficient quantal choice models', in C. Manski and D. McFadden (Eds.). *Structural Analysis of Discrete Data with Econometric Applications*, pp.273–304, Cambridge, MA: MIT Press.

Fujii, S. and Kitamura, R. (2004) 'Drivers' mental representation of travel time and departure time choice in uncertain traffic network conditions', *Networks and Spatial Economics*, Vol. 4, pp.243–256.

Hendrickson, C. and Plank, E. (1984) 'The flexibility of departure times for work trips', *Transportation Research A*, pp.887–902.

Horowitz, J. (1993) 'Semi-parametric estimation of a work trip mode choice model', *Journal of Econometrics*, Vol. 58, pp.49–70.

Jou, R. and Kitamura, R. (2002) *Commuter Departure Time Choice: A Reference Point Approach*, Mimeograph.

Mahmassani, H. and Herman, R. (1984) 'Dynamic user equilibrium departure time and route choice on idealized traffic arterials', *Transportation Science*, Vol. 18, pp.362–453.

Mahmassani, H.S. and Chang, G. (1987) 'On boundary rational user equilibrium in transportation systems', *Transportation Science*.

Mahmassani, H.S. and Liu, Y. (1999) 'Dynamics of commuting decision behaviour under advanced traveller information systems', *Transportation Research C*, Vol. 7, pp.91–107.

Mannering, F.L. (1989) 'Poisson analysis of commuter flexibility in changing routes and departure times', *Transportation Research-B*, Vol. 23, pp.53–60.

Palma, A., Ben Akiva. M., Lefevre, C. and Litinas, N. (1983) 'Stochastic equilibrium model of peak period traffic congestion', *Transportation Science*, Vol. 17, pp.430–453.

Swait, J. and Ben-Akiva, M. (1987) 'Empirical test of a constrained choice discrete model: mode choice in Sao Paulo, Brazil', *Transportation Research-B*, Vol. 21, pp.103–115.

Stopher, P.R. (1993) 'Deficiencies of travel-forecasting methods relative to mobile emissions', *Journal of Transportation Engineering*, Vol. 119, No. 5, pp.723–741.

Train, K. (1980) 'A structured logit model of auto ownership and work mode choice', *Review of Economic Studies*, Vol. 64, pp.357–370.

Weiner, E. and Ducca, F. (1996) 'Upgrading travel demand forecasting capabilities: USDOT travel model improvement', *TR News*, Vol. 186, pp.2–6.

Zhang, X. and Zhang, H.M. (2010) 'Simultaneous departure time/route choices in queuing networks and a novel paradox', *Networks and Spatial Economics*, Vol. 10, pp.93–112.

BIOGRAPHICAL NOTES

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