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Agent-Base Modeling of Refueling Vehicles based on Demand Management Approach and Comparing its Result with the Stated Preferences Method in Tehran

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ABSTRACT: The increasing demand for private cars and the unbalanced and dense growth of land-uses in the north of Tehran metropolis have caused fuel supply stations (gas stations) to face the demand queue most of the time. On the other hand, the exorbitant price of land in these areas does not make the construction of a new location cost-effective. Demand management policies such as increasing the cost of using the facility are the possible solution to solve such problems. In this paper, the gas station users' data in the north of Tehran were collected using the stated preference method and analyzed using SPSS statistical analysis software to define the agent features and build agent-based modeling. The survey results were used to define the characteristics of factors and interactive rules in the NetLogo simulation software. Then, the existence of a fast-passing line (with five different pricing scenarios) was simulated compared to the normal condition. The results showed that although the price increase scenarios (scenarios 4 and 5) are more welcome by relying on the statistically-based stated preference method, the agent-based simulation shows the popularity of cheap scenarios (scenarios 1 and 2) based on the interactive behavior of people are more valid. This indicates that the stated preference method's responses cannot be reassured in cases where interactive behaviors exist. Also, due to the imbalance of supply and demand due to the region's context, creating a tolled high-speed passing line is an effective solution to adjust the queue length and reduce waiting time.

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1- Introduction

The expansion of cities and metropolises has always been the source of new problems. These problems in the traffic sector include congestion, noise pollution, air pollution, etc., which are due to the lack of urban traffic facilities and inequality of supply and demand. One of these essential facilities is gas stations, where congestion and long queues can be formed, especially on holidays and weekends. This is especially the case in metropolitan areas such as Tehran, especially in the north, due to the high price of land. Waiting in line and wasting time is unpleasant and stressful for many users; this issue is more evident in users who have more time value.

Based on previous studies, one of the best ways to adjust the queue is to use supply and demand control policies. These policies, which usually link their characteristics to price changes, are examined as scenarios of price increases and their impact on congestion. Since time is not the same for everyone, raising fuel prices, in general, will not make sense to manage queue length. Therefore, this increase can be considered selectively and in a separate queue only for users who, for any reason, do not want to wait in line.

In this paper, using two methods of statistical analysis of the answers of the Stated Preference (SP) method and modeling the refueling method of vehicles and examining the queue length by the Agent-based method, the effects of different demand management scenarios of individuals with price increase policy are investigated.

2- Methodology

According to the objectives of this article, it is necessary to examine the views of users of fuel supply stations. Therefore, the data were collected through a questionnaire with a combination of open and closed questions and also the scenario in relation to pricing in 1398 from the metropolitan area of Tehran through face-to-face interviews. The experimental questionnaire has three parts: 1) demographic characteristics (individual characteristics and demographics) 2) information related to refueling (to determine the behavior of the Agents and the rules governing them and the environment in NetLogo software) 3) Scenarios (analysis Sensitivity in NetLogo software and comparison of results with preferred results). The number of scenarios in 5 classes is 1200, 1400, 1600, 1700, 1800 and 2000 Tomans (at the time of the research 17159 Tomans Iran = 1 US dollar). A total of 60 experimental

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questionnaires were collected from the statistical population, Velenjak gas stations, Yadegar Imam and Dadman (20 each). Of these, 39 were healthy questionnaires (13 each) and 21 were distorted and had defects. The reliability and validity of this questionnaire were assessed with SPSS software and some of its parts were removed due to low Cronbach's alpha score and the main questionnaire was designed. The statistical population according to the objectives of the article, field study and annual land price statistics randomly led to the selection of Velenjak (Zone 1), Yadegar Imam (Zone 2) and Dadman (Zone 2) gas stations. Also, to maintain random sampling at the appropriate hours and days of the week, collection was performed. The sample size is 387 according to Morgan's table. A total of 387 questionnaires were collected from three positions, the share of each position was 129. Of these, 360 were healthy questionnaires and 27 were distorted and had defects. After checking the reliability and validity of the main questionnaire (Cronbach's alpha = 0.948) data in SPSS software in two categories of the approximate value of the vehicle (million Tomans) and the waiting tolerance threshold in the classification queue and lead to recognition of Agents, attributes and rules They and the environment. Using these results, the environment in NetLogo software is considered as a regular gasoline line with two pumps and two refueling stations with a normal price of 1000 Tomans, and a fast-pass gasoline line with two pumps and two refueling stations with price scenarios. People waiting in the normal queue of gasoline applicants with a normal price of 1000 Tomans and willing to tolerate more waiting, and people waiting in the fast-passing queue of gasoline applicants with higher prices and do not want to tolerate more waiting. All drivers of waiting cars in two queues of solitude and crowds are considered as one operating group. The number of Agents is selected as a variable by the slider (Car-Number). The input rate of Agents per hour is selected as a variable by the slider (Inc). Wealth, waiting time and the degree of fullness or emptiness of the tank are defined as the attributes of the agents based on the information obtained from SPSS software. The rules governing agents were also defined in six paragraphs. Scenarios were also defined as a drop-down menu called (Scenario) with five prices of 1200, 1400, 1600, 1800 and 2000 Tomans (17159 Iranian Tomans = 1 US dollar - at the time of research). Software outputs in the form of a queue and queue diagram in a graph called "queue diagram", a diagram of the number of refueled and unused agents at the moment called "current status", a graph of the wealth of agents joining a crowded queue with The title of "crowded queue organizers", the chart of the amount of wealth of agents joining the queue with privacy as the title of "less crowded queue organizers", the threshold chart of tolerance of joining crowded queues as the "tolerance of crowded queue" and the chart of tolerance of crowded queues Privacy is defined as the "tolerance of a low-congestion queue." Finally, the simulation results in Net Logo software and the questionnaire were compared using SPSS software.

3- Results and Discussion

After validation, it was found that the simulation results are more in line with the research of Kho et al. [1] based on the effect of price increase on demand reduction. The results are also consistent with research by Khalilikhah et al. [2] in which increasing fuel prices to control demand was the least acceptable among users and reduced demand. On the other hand, the simulation results showed that increasing the number of nozzles regardless of their price can have positive effects on adjusting the queue length. This result is completely consistent with the results of other researches [3-5].

In this paper, agent recognition, data collection and analysis are the basis for Agent-based simulation of fuel supply stations. This data, which was analyzed in SPSS software, was mostly related to refueling methods and scenarios, and it was found that users often wait for 2-14 minutes in the queue from their point of view, while the simulation shows that the time most users can stand in the waiting queue is 10-18 minutes, however, their tolerance range is 2 to 42 minutes Based on inquiries. From the users' point of view, scenarios 4 and 5 are more popular for joining the privacy queue in terms of preferred analysis. Of course, their wealth and tolerance threshold have a significant effect on this, because it was found that users' wealth has a direct relationship with their willingness to pay. Also, users with a high tolerance threshold are less willing to pay or cancel, and even get to zero. These results were achieved while the simulation with the NetLogo software showed the popularity of scenarios 1 and 2 among users. In other words, as the cost of scenarios decreases, more users are joining the low-traffic or high-speed queue that they have to pay for. In lower-priced scenarios, users with lower categories of wealth are seen joining, and in scenario 5, where the price is higher than all scenarios, only users with category 6 wealth join the fast-pass queue. On the other hand, in all 5 scenarios, the wealth category 1 users are the most crowded members of the queue. Also, in all 5 scenarios, users who join the fast-pass queue have a tolerance threshold between categories 1 (2 to 10 minutes) and 2 (10 to 18 minutes), and people in the crowded queue are mostly in categories 3, 4 and 5 are tolerance thresholds. Comparison of SPSS and NetLogo results shows that individuals are more inclined to more expensive scenarios due to their own judgments and mental imagery in the preferred mode, while Agent-based simulation results show the opposite.

4- Conclusions

In a situation where users are faced with an abnormal situation where there is a long queue for refueling, relying on the answers obtained from the preferred method cannot be the correct basis for making a decision. In addition to the results, in general and based on each of the results, it can be said that the prediction of high-speed lanes at gas stations with long queues, higher prices and shorter queues in urban areas where land prices are much higher than the city average and most Residents also have a moderate to the high economic status of the community can be a way to adjust the queue length.

References

[1] H.L. Khoo, G.P. Ong, W.C. Khoo, Short-term impact analysis of fuel price policy change on travel demand in Malaysian cities, Transportation Planning and Technology, 35(7) (2012) 715-736.

[2] M. Khalilikhah, M. Habibian, K. Heaslip, Acceptability of increasing petrol price as a TDM pricing policy: A case study in Tehran, Transport Policy, 45 (2016) 136-144.

[3] A.O. Odior, Application of Queuing Theory to Petrol Stations in Benin-City Area ff Edo State, Nigeria, Nigerian Journal of Technology (Nijotech), 32 (2013) 325-332.

[4] M.R. Galankashi, E. Fallahiarezoudar, A. Moazzami, N.M. Yusof, S.A. Helmi, Performance evaluation of a petrol station queuing system: A simulation-based design of experiments study, Advances in Engineering Software, 92 (2016) 15-26.

[5] M.R. Galankashi, E. Fallahiarezoudar, A. Moazzami, S.A. Helmi, J.M. Rohani, N.M. Yusof, An efficient integrated simulation–Taguchi approach for sales rate evaluation of a petrol station, Neural Computing and Applications, 29(4) (2018) 1073-1085.

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