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A STUDY ON AWARENESS AND EFFECTIVENESS OF CONGESTION MANAGEMENT THROUGH PARKING PRICING FOR PATNA, INDIA

Abstract:

Road traffic congestion is a major problem with rapid urbanization, increased travel demand and use of personal vehicles. In old cities of developing nations, with narrow roads and unmanaged raodside parkings, congestion problems require special attention. Parking management and pricing, including penalty for illegal parking, can go a long way in reducing congestion of the city. This paper attempts to understand the underlying factors determining level of awareness of people about congestion and its effects, their willingness to take responsibility, their perception about parking management and pricing and its effectiveness through study of perception of people of Patna, Bihar, India using structured questionnaire. Factor Analysis is done to identify the factors which can be modeled with willingness to pay.

Keywords:

Road traffic congestion, Congestion pricing, Parking Management, Perception Survey, Factor Analysis

JEL Classification: R41

1 Introduction

Road traffic congestion is a major issue worldwide. The old small cities of developing countries have mixed land use and narrow roads. Due to rapid urbanizatrion there is an increase in travel demand, in these cities. The issue of congestion here needs special focus. The triplengths in such cities usually vary from 2 to 6 kilometers, and people prefer using personal vehicles. Patna, the capital city of Bihar, India is such a typical city where people prefer using personalized vehicles for convinience and door to door connectivity. This increases traffic in the narrow roads, which are also blocked by parked vehicles. Most of the parking spaces used are not designated for parking. The issue of congestion needs to be addressed for reducing traffic congestion, thereby improving individual travel times and reducing pollution. Congestion reduction can be done by demand or supply management. Improving supply of public transport or building new road and parking infrastructures cannot solely manage congestion issue as people have the tendency to continue using personalized vehicles due to unawareness of problem, social norms or convenience.

Thus, congestion pricing, a popular demand management tool, may be adopted for traffic congestion reduction. There is no single congestion pricing strategy available that may be universally adopted. The strategies adoped in different places include high occupancy tolls and cordon charges and parking pricing, that indirectly provide incentives for using public transport and discourage use of personal vehicles.

In India, pricing for congestion in terms of area based tolls is not adopted as yet, apart from tolls collected in major newly constructed roads in some cities. In those places also the major objective is to recover costs of infrastructure maintenance rather than reducing congestion. In Patna, within city limits there are no forms of road pricing other than the charges for parking in legal parking spaces. Illegal parking is very common in the city. Thus, proper parking management and pricing, including penalty for illegal parking, can go a long way in improving congestion scenario of the city (Siva Kumar, 2018). However, people’s acceptance and WTP is important for successful implementation. The literature shows very few related studies conducted in this region of the country (Swamy & Rawat, 2016). The designing of parking pricing and management calls for understanding of the various factors that affect driving and the factors that affect willingness to pay for parking and congestion.

This paper tries to understand the perception of people in Patna about the consequences of parking and their wilingness to accept the burden of congestion through a structured questionnaire. The objectives of this paper is to understand the underlying factors that determine

i. level of awareness of people about congestion and its effects, their willingness to take responsibility and reduce car use in future
ii. perception of people about parking management and pricing in the city and

iii. perception of people about the effectiveness of the parking management and pricing schemes in reducing congestion in the city

The next section provides a review of literature related to congestion pricing, factors determining public acceptability of congestion pricing, its effect on travel behavior, and parking management and pricing as a possible congestion management tool. Section 3 describes the methodology adopted for the study. Section 4 provides a brief overview of the data, data analysis and results. Section 5 provides the conclusions and plan for future work.

2 Literature review

Congestion pricing is a demand management tool in which the usage of road infrastructure is charged with the objective of shifting demand to less congested areas or to off-peak hours or to high occupancy public transit systems. It attempts to charge for costs of causing congestion that includes delays, pollution and accidents. Such pricing is expected not only to reduce congestion, delays, emissions and accidents but also provide funding for infrastructure maintenance (Benko & Smith, n.a.). Singapore, London, San Diego, Stockholm and Milan are some cities which have successfully adopted congestion pricing in various formats, based on their culture and needs (Brown, 2011). However, public acceptability of congestion pricing is low in most parts of the world, which becomes a major barrier in the way of its widespread implementation.

Palma & Lindsey (2011) provided a detailed review of the methods and technologies used for congestion pricing of roads. Lindsey (2012) recommended a short run marginal cost pricing for efficient road usage. He observed that the common objections to road pricing are paying for something that was previously free, double taxation, and inequity.

Gavanasa, Tsakalidisb, & Pitsiava-Latinopoulou (2017) described a method to assess marginal and total social cost due to congestion in urban road network using speed flow relation and floating car data taken from Tsimiski Street in Thessaloniki, Greece. The estimated cost may be used as a basis for efficient pricing of transportation services and infrastructure.

Vanoutrive & Zijlstra (2018) conducted a survey to understand who should be granted the right to travel during peak hours. They opined that this will provide a new perspective on the allocation of mobility, which replaces the traditional congestion pricing approach that distributes road space through an impersonal and anonymous allocation mechanism based on the willingness-to-pay of the person who travels.

Various authors have attempted to understand the factors that determine acceptibility of congestion pricing.

Xianglong, Shumin, & Jian (2016) studied the socio-demographic and attituditional factors that influence acceptability of congestion pricing in Xinjiekou, Nanjing, China using a hierarchical structural equation model. Perceived fairness in distribution of revenue and personal freedom were found to be strong determinants of acceptability, while socio-demographic fators had low association.

Gu, Liu, Cheng, & Saberi (2018) reviewed nine area-based congestion pricing schemes to analyze public acceptance using a qualitative case study approach. They identified privacy, equity, complexity and uncertainty as critical factors determining congestion and proposed a three-step interaction-oriented approach for improvement of public acceptance toward congestion pricing.

Schade & Schlag (2003) investigated the acceptability level of various urban transport pricing strategies by surveying 952 motorists in four European cities: Athens, Como, Dresden and Oslo. Two competing pricing strategies comprising time differentiated cordon pricing, increase in parking charges and fuel taxes, and revenue hypothecation were tested. A stepwise multiple regression analysis showed that motorists' stated acceptability of pricing is low and variables like social norm, personal outcome expectations and perceived effectiveness can explain acceptability of pricing strategies much better than socio-economic variables.

Gehlert, Kramer, Nielsen, & Schlag (2011) used a segmentation approach to identify groups of car users with a similar background in relevant socioeconomic variables and compared their responses towards road pricing. Three groups are identified: young families, suburban families, and singles and couples. These groups were found to differ in their car use adaptation towards urban road pricing as well as in their preferred revenues use.

Schuitema, Steg, & Rothengatter (2010) examined the relative importance of the expected effects of two transport pricing policies on one's own car use, and awareness of congestion and environmental problems for the acceptability and personal outcome expectations of these policies. They observed that the acceptability of transport pricing policies are not necessarily low because car users expect negative effects on their car use, but rather because they are not convinced that transport pricing policies will reduce congestion and environmental problems.

Borger & Proost (2016) attempted to understand factors affecting acceptability of centralized and uniform pricing structures in countries having multi-layered government structure. They found that if two regions are symmetric, with both having majority drivers, centralized and uniform pricing can achieve better efficiency and welfare and drivers will accept it.

Russo (2013) also studied the issues in political acceptability of road pricing using an illustrative case of Copenhagen in 2012. He showed how institutional setup may influence traffic congestion policy when regional government controlled cordon toll and city council controlled parking charge. He observed that earmarking revenues from road pricing for public transport improvements can improve acceptability.

Daganzo & Lehe (2015) proposed an efficient usage-based toll (U-toll) using a FIFO idealization of the system and comparesd it to an optimal trip-based toll (T-toll). The researchers also used non-FIFO agent-based simulation to compare the performance of the two tolling methods, with the simulation's physical parameters chosen to approximate those of Yokohama, Japan. They found that U-tolls reduce congestion with smaller schedule penalties and toll payments than T-tolls.

Nikitas, Avineri, & Parkhurst (In press) highlighted the need for packaging road pricing with measures promoting pro-social branding, peer-to-peer communication accepting citizens as social influencers, tailored consultation, pre-implementation trials, clear administrative roles, transparency and political patience for public acceptability. They observed that studying the attitudes of older people is significant because of their increasing demographic and political importance and vulnerability to transport-related social exclusion.

Various authors have attempted to understand the effect of congestion pricing on travel behaviour.

Cools, Brijs, Tormans, Moons, Janssens, & Wets (2011) examined the effect of road pricing on people's tendency to adapt their current travel behavior using a stated adaptation experiment. It was found that road pricing charges must surpass a minimum threshold to affect changes in activity-travel behavior and that the benefits of road pricing should be clearly communicated, taking into account the needs and abilities of different types of travellers. Effectiveness, fairness and personal norm had significant impact while socio-cognitive factors were not significant. The relevance of using latent rather than aggregate indicators was also underlined.

Eliasson (2014) explored changes in behaviour and attitudes over time when road tolls were proposed to partially finance a large infrastructure package for Stockholm. Six surveys conducted between 2004 and 2011 showed that public attitudes to the charges were negative during the initial period but became dramatically more positive over the years as trials started.

Jin, Hossan, Asgari, & Shams (2018) examined how underlying behavioural attitudes affect drivers' choices in utilizing managed lane facilities through stated preference survey in South Florida Expressway. Factor analysis was conducted based on ten attitudinal statements, and four latent attitudinal factors were identified: willingness to pay, willingness to shift travel schedule, utility (cost/time) sensitivity, and congestion tolerance. Multinomial logit (MNL) models were developed which indicated significant contribution of attitudinal factors. These factors were used in a cluster analysis to identify major segments of roadway users.

Abulibdeh (2018) examined the impact of implementing HOT lanes and cordon pricing on traveller's willingness to pay and travel behaviour in MENA Region, Abu Dhabi. Stated and revealed preference survey was conducted to understand willingness to pay, trip urgency, trip conditions, speed and distance, travellers' socioeconomic characteristics and mode shift. The results showed that travellers from different socioeconomic groups

were willing to pay to use HOT lanes to escape congestion and willingness increased as trip conditions worsened. However, overall effect of cordon pricing was found to be regressive as high-income travellers who were willing to pay to save travel time benefited the most.
Various researchers have studied parking behavior, effect of on-street parking on travel time and congestion and parking pricing.

Guo, Gao, Yang, Zhao, & Wang (2012) proposed a proportional hazard-based duration model to analyze the influential factors related to on-street parking, including effective lane width, the number of parking manoeuvres, and occupancy. The results showed that on-street parking has a significant impact on the travel time of vehicles.
Hensher & King (2001) conducted a stated preference survey of car drivers and public transport users in Sydney central business district during 1998 to estimate the role of parking pricing and supply by time of day. A nested logit model of mode and parking choices was developed and it was observed that change in parking share attributable to supply by time of day was less than 3% while 97% was attributable to parking prices.

Teknomo & Hokao (1997) studied parkers' behavior in choosing a parking location in Central Business District of Surabaya. Three types of parking location choice models were developed namely Parking Demand Regression Models, Analytic Hierarchy Process and Multinomial Logit Models. It was observed that parking location choice is mainly influenced by the availability of parking spaces, trip purpose, search & queue time, walking time, parking fee, security and comfort.

Arjun & Nagakumar (2014) analyzed the existing condition of parking, Level of Service (LOS), delay in signalized intersection and behaviour of commuters in Bangalore, India. Primary survey was carried out to estimate volume count, parking duration, accumulation, demand survey and Willingness to Pay (WTP) survey. In WTP survey, only 39% of the road users agreed to implement the new parking policy. Regression model was used to measure the relationship between parking demand and parking space capacity per activity roads.

3 Methodology

In order to determine the perception of people in Patna about the consequences of parking and their willingness to accept the burden of congestion, a structured questionnaire was designed. The questionnaire takes information about the socio-economic details of the respondents and their feedback on the following details regarding congestion and congestion pricing.

i. level of awareness about congestion and its effects, their willingness to take responsibility and reduce car use in future
   - fifteen variables were considered

ii. perception of people about parking management and pricing in the city
   - eleven variables were considered

iii. perception of people about the effectiveness of the parking management and pricing schemes in reducing congestion in the city
    - seven variables were considered

All the above variables were considered in 5-point Likert scale from strongly agree to strongly disagree. In the survey, 117 respondents from the city of Patna participated. The above three sets of variables were tested separately for reliability using Cronbach's Alpha model. Also three separate factor analysis was conducted to identify the underlying factors that explains the variables considered using IBM SPSS Statistics 20.

The details of the analysis and results are shown in the next section.

4 Data

Data was collected from 117 respondents in the city of Patna. 77% respondents were males and remaining females. Around 5% respondents had monthly income below Rs.10,000; 17% between Rs.10000 to Rs.25,000; 22% between 25,000 to Rs.50,000 and 55% above Rs.50,000. 65% of respondents travel frequently for work while others travel for studies, shopping, recreation or other purposes. Considering vehicle ownership around 44% respondents own 2-wheelers, 17% respondents own 4-wheelers, 19% own both while 21% did not own any vehicles. Only 27% respondents use shared public transport for commuting while others use personalized vehicles that include own 2-wheelers, own 4-wheelers or dial-a-ride like ola. Of those using shared public transport in the city, only 8% use public buses, 63% use Intermediate Public Transports like autos/ e-rickshaws and remaining use mixed modes. Respondents not using public transport stated various reasons: 28% stated that they do not use it because no direct option is available, around 40% state time constraint, 29% state it is not convenient/ comfortable and remaining 3% state that it is not socially acceptable.

5 Analysis and Results

In this initial part of the work, the main aim was to identify the underlying factors that determine the people's awareness towards congestion and its effects, acknowledgement of responsibility for causing congestion, and intent to reduce car use; their attitude towards congestion reduction through parking management and their effectiveness. The sub-sections below describe the variables considered, the analysis done and results obtained.

5.1 Awareness and intent to reduce car use

Fifteen variables were initially considered as shown in Table 1. Many of these factors related to intent to reduce car use are adapted from existing literature (Xianglong, Shumin, & Jian, 2016).

Table 1: Initial Variables for Awareness and Intent to reduce Car Use

Congestion is created by more use of private vehicles (A1)
Congestion is a significant problem at Patna (A2)
Congestion leads to environmental (air/ noise) pollution(A3)
Congestion leads to road accidents (A4)
Congestion leads to excess stress that affects well-being of individuals (A5)
By using private vehicles I am contributing to traffic congestion and its related problems (A6)
I should be ready to pay for causing congestion (A7)
Paying a price for congestion will reduce my guilt of causing congestion (A8)
Paying a price for congestion will make me think of using alternative public modes of transport (A9)
Most people who are important to me think that I should reduce car use (A10)
When it comes to reduce car use, I want to do what most people who are important to me want me to do (A11)
I have complete control of using the car (A12)
If I want to, I could easily reduce car use (A13)
I feel morally obliged to reduce my car use, regardless of what others do (A14)
I intend to reduce car use in the future (A15)

The responses were obtained in 5 point Likert scale. The reliability was tested and reliability statistics (Cronbach's Alpha) and ANOVA test result is shown in Table 2.

Table 2: Reliability of Awareness and Intent Scale

Cronbach's Alpha	N of Items		
.797	15		
Scale Statistics			
Mean	Variance	Std. Deviation	N of Items
38.05	79.154	8.897	15

Cronbach's alpha measures reliability, or internal consistency, of multiple-question Likert scale surveys and shows how well a test measures what it should. The Cronbach Alpha value of 0.797 indicates that the scale is internally consistent.

Factor analysis was conducted on the 15 items. The results of KMO and Barlett's test is shown in Table 3.

Table 3: KMO and Barlett's Test for Awareness and Intent

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.693
Bartlett's Test of Sphericity	Approx. Chi-Square	518.683
	df	105
	Sig.	.000

Kaiser-Meyer-Olkin Measure of Sampling Adequacy value indicates the proportion of variance in the variables that might be caused by underlying factors. A value of 0.693 shows that factor analysis may be useful with the data. The significance vaue of 0 in Bartlett's test of sphericity test result also shows suitability of factor analysis.

The factor analysis was conducted with Principal Component Analysis as the extraction method. result for communalities are shown in Table 4. It shows the variance of each variable that is accounted for in the factors extracted.

Table 4: Communalities for Awareness and Intent

	Initial	Extraction
A1	1.000	.618
A2	1.000	.718
A3	1.000	.721
A4	1.000	.607
A5	1.000	.723
A6	1.000	.646
A7	1.000	.672
A8	1.000	.781
A9	1.000	.733
A10	1.000	.763
A11	1.000	.826
A12	1.000	.649
A13	1.000	.725
A14	1.000	.545
A15	1.000	.606

The total variance explained is shown in Table 5.

Table 5: Total Variance Explained for Awareness and Intent

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.135	27.564	27.564	4.135	27.564	27.564	2.612	17.416	17.416
2	2.204	14.696	42.259	2.204	14.696	42.259	2.527	16.848	34.264
3	1.749	11.660	53.919	1.749	11.660	53.919	2.128	14.183	48.447
4	1.195	7.968	61.887	1.195	7.968	61.887	1.791	11.941	60.388
5	1.051	7.008	68.895	1.051	7.008	68.895	1.276	8.506	68.895
6	.913	6.084	74.979						
7	.744	4.959	79.938						
8	.629	4.190	84.128						
9	.506	3.370	87.498						
10	.426	2.840	90.338						
11	.404	2.690	93.028						
12	.358	2.388	95.417						
13	.249	1.663	97.080						
14	.230	1.534	98.614						
15	.208	1.386	100.000						

Five factors were extracted with eigen value more than1 and the total variance explained by these factors is approximately 69%. The rotated component matrix is shown in Table 6. The rotation method used was Varimax with Kaiser Normalization. The rotation converged in 6 iterations.

Table 6: Rotated Component Matrix for Awareness and Intent

	Component				
	1	2	3	4	5
A1	.175	.275	.171	.670	-.182
A2	.810	-.009	.215	.068	-.106
A3	.790	.011	.253	.175	.036
A4	.583	.076	-.213	-.052	.462
A5	.842	.088	-.015	.062	.043
A6	.251	.607	-.087	.453	.045
A7	.138	.783	.194	.043	.015
A8	-.132	.829	.070	-.033	.266
A9	.007	.834	-.017	.190	-.040
A10	-.030	.015	.067	.779	.389
A11	.025	.144	.156	.112	.876
A12	-.032	-.019	.785	-.172	.049
A13	.067	.043	.768	.333	.131
A14	.317	.171	.611	.201	-.045
A15	.211	.145	.533	.506	-.016

It may be observed that five factors were extracted in the process of factor analysis. The interpretation of factors was done using the rotated component matrix combining those variables that are highly correlated with a particular factor. The five factors that were extracted are named as shown in Table 7.

Table 7: Factors Identified for Awareness and Intent

Factor	Variables combined	Name
Factor 1	A2, A3, A5	Awareness of congestion and its effects
Factor 2	A7, A8, A9	Accepting responsibility
Factor 3	A12, A13	Control over driving
Factor 4	A1, A10	Reduce car use
Factor 5	A11	Social norm

5.2 Congestion reduction through parking management

Eleven variables were initially considered as shown in Table 8.

Table 8: Initial Variables for Congestion Reduction through Parking Management

On-street parking should be banned (P1)
Availability of off-street parking facility should be enhanced (P2)
Proper well designated on-street parking facilities should be available (P3)
Parking fee should be higher in places where road is more congested (P4)
Per hour parking should be increased when time of parking increases (P5)
All congested areas of the city should have uniform parking fees (P6)
Parking fees should be collected by centralized authorities (P7)
Heavy penalty should be imposed for illegal parking (P8)
Fine should be collected from vehicle owners on the spot (P9)
Fine should be collected from vehicle owners on the spot after jamming the vehicle wheels (P10)
Fine should be collected from vehicle owners after towing the vehicle away to central location (P11)

The responses were obtained in 5 point Likert scale. The reliability was tested and shown in Table 9.

Table 9: Reliability of Congestion Management Scale

Cronbach's Alpha	N of Items
.719	11

Scale Statistics

Mean	Variance	Std. Deviation	N of Items
24.47	52.992	7.280	11

The Cronbach Alpha value of 0.719 indicates that the scale is internally consistent.

Factor analysis was conducted to reduce the number of variables. The KMO and Barlett's test output is shown in Table 10.

Table 10: KMO and Barlett's Test for Congestion Management

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.694
Bartlett's Test of Sphericity	Approx. Chi-Square	313.065
	df	55
	Sig.	.000

The KMO value of 0.694 and Bartlett's test result shows the sampling is adequate and factor analysis is suitable.

The results for communalities are shown in Table 11. It shows the variance of each variable that is accounted for in the factors extracted.

Table 11: Communalities in Factor Analysis for Congestion Management

	Initial	Extraction
P1	1.000	.533
P2	1.000	.699
P3	1.000	.565
P4	1.000	.760
P5	1.000	.701
P6	1.000	.203
P7	1.000	.424
P8	1.000	.678
P9	1.000	.717
P10	1.000	.671
P11	1.000	.275

Extraction Method: Principal Component Analysis.

The total variance explained is shown in Table 12.

Table 12: Total Variance Explained in Factor Analysis for Congestion Management

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.299	29.992	29.992	3.299	29.992	29.992	2.560	23.276	23.276
2	1.687	15.337	45.329	1.687	15.337	45.329	1.895	17.227	40.503
3	1.240	11.270	56.599	1.240	11.270	56.599	1.771	16.096	56.599
4	.991	9.013	65.613						
5	.936	8.505	74.118						
6	.753	6.847	80.965						
7	.591	5.377	86.342						

8	.557	5.063	91.404						
9	.367	3.337	94.741						
10	.307	2.792	97.533						
11	.271	2.467	100.00						

Extraction Method: Principal Component Analysis.

Three factors were extracted with eigen value more than1 and the total variance explained by these factors is approximately 57%. The rotated component matrix is shown in Table 13. The rotation method used was Varimax with Kaiser Normalization. The rotation converged in 5 iterations.

Table 13: Rotated Component Matrix in Factor Analysis for Congestion Management

	Component		
	1	2	3
P1	.610	.217	.337
P2	.827	.116	.054
P3	.733	.135	-.095
P4	.212	.846	.020
P5	.206	.805	.103
P6	.319	.139	.286
P7	.620	-.191	-.052
P8	.579	.225	.541
P9	.111	-.056	.837
P10	-.195	.312	.732
P11	-.088	.497	.140

The three factors that were extracted are named as shown in Table 14.

Table 14: Factors for Parking Management

	Variables combined	Name
Factor 1	P2, P3	Improved facilities
Factor 2	P4, P5	Increased fees
Factor 3	P9, P10	Fine for parking

5.3 Effectiveness of proposed congestion reduction schemes

Eight variables were initially considered to understand effectiveness of congestion reduction schemes (parking fees increase) is shown in Table 15.

Table 15: Initial Variables for Effectiveness of Parking Management

Increasing parking fees will be extremely effective in reducing congestion (E1)
People will be ready to pay extra price for enhanced parking facilities (E2)
Car use will significantly reduce if parking fees are enhanced (E3)
Heavy fine for illegal parking will reduce vehicle use (E4)
Increasing fine for illegal parking will be extremely effective in reducing congestion (E5)
Congestion pricing will affect my freedom to choose travel mode myself (E6)
Introduction of this measure will make my personal daily trips more difficult (E7)

The responses were obtained in 5 point Likert scale. The reliability was tested and shown in Table 16.

Table 16: Reliability of Effectiveness Scale

Cronbach's Alpha	N of Items		
.645	7		
Scale Statistics			
Mean	Variance	Std. Deviation	N of Items
18.57	22.999	4.796	7

The Cronbach Alpha value of 0.645 indicates that the scale is internally consistent.

Factor analysis was conducted to reduce the number of variables. The KMO and Barlett's test output is shown in Table 17.

Table 17: KMO and Bartlett's Test for Effectiveness

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.613
Bartlett's Test of Sphericity	Approx. Chi-Square	158.886
	df	21
	Sig.	.000

The KMO value of 0.613 and Bartlett's test result shows the sampling is adequate and factor analysis is suitable.

The results for communalities are shown in Table 18. It shows the variance of each variable that is accounted for in the factors extracted.

Table 18: Communalities in Factor Analysis for Effectiveness

	Initial	Extraction
E1	1.000	.475
E2	1.000	.337
E3	1.000	.675
E4	1.000	.431
E5	1.000	.562
E6	1.000	.735
E7	1.000	.732

The total variance explained is shown in Table 19.

Table 19: Total Variance Explained in Factor Analysis for Effectiveness

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.442	34.892	34.892	2.442	34.892	34.892	2.432	34.742	34.742
2	1.505	21.507	56.399	1.505	21.507	56.399	1.516	21.656	56.399
3	.896	12.800	69.199						
4	.786	11.229	80.428						
5	.618	8.822	89.250						
6	.423	6.048	95.298						
7	.329	4.702	100.000						

Two factors were extracted with eigen value more than1 and the total variance explained by these factors is approximately 56%. The rotated component matrix is shown in Table 20. The rotation method used was Varimax with Kaiser Normalization. The rotation converged in 3 iterations.

Table 20: Rotated Component Matrix in Factor Analysis for Effectiveness

	Component	
	1	2
E1	.683	-.095
E2	.581	.011
E3	.815	-.102
E4	.646	.118
E5	.730	.172
E6	.104	.851
E7	-.058	.853

The results of factor analysis show that the seven variables could be reduced to two factors which are names as in Table 21.

Table 21: Factors Identified for Effectiveness

	Variables combined	Name
Factor 1	E3, E5	Effectiveness of fine
Factor 2	E6, E7	Personal freedom

6 Conclusions

This article studied the perception of people about congestion in the city of Patna, India and their intent to reduce car use; congestion reduction through better parking management and pricing and the effectiveness of such pricing. Factor analysis identified five factors that can describe the awareness and intent to reduce car use; three factors that can describe congestion reduction measures through parking management and pricing; and two factors that can describe the effectiveness of the proposed parking management and pricing schemes.

The above factors along with the socio-demographic details obtained from the survey may be may be used for modelling to understand which variables determine the willingness to pay a fine for congestion with more data points.

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