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## Investigating the impact of gender and work profile on attribute importance for mode choice: A Multi-Criteria Decision-Making approach

Aditya Saxena<sup>a</sup>, Ankit Kumar Yadav<sup>b,\*</sup><sup>a</sup> Ph.D. Scholar, Centre for Urban Science and Engineering (CUSE), Indian Institute of Technology (IIT) Bombay, Powai, Mumbai 400 076, India<sup>b</sup> Postdoctoral Research Fellow, Schepens Eye Research Institute of Massachusetts Eye and Ear, Department of Ophthalmology, Harvard Medical School, Boston, MA, USA

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### ABSTRACT

In the recent years, there has been an increase in research exploring the factors that influence mode choice for commuting. Yet, the impact of gender (female vs. male) and work profile (formal vs. informal) on mode choice for decision-making is not well-known, especially in the Indian context. In this study, a multi-criteria decision-making tool was utilized to bridge this gap, exploring which attributes are most important to respondents from different genders and work backgrounds while choosing a mode of transportation for commuting. Focus group discussions were conducted at six selected locations. Using Fuzzy-AHP (analytical hierarchy process), it was determined that female respondents and formal workers place the greatest importance on travel time and safety, while male respondents and informal workers place the greatest importance on travel cost. In terms of their influence on mode selection, comfort and privacy were the least weighted factors for all four groups. Also, among the four categories, formal workers attributed the significant weight to hygiene and cleanliness (10%). In addition, it was revealed using Kendall's Concordance test that gender and work profiles are associated with the mode of transportation chosen by respondents for commuting. By examining the factors influencing intercity travel for commuting, traffic departments can gain insight into passengers' travel decision structures and develop an effective policy for travel demand management.

### 1. Introduction

According to the Census (2011) data, 58.1% of rural and 48.9% of urban Indian workers commute on foot or by bicycle (Tiwari & Nishant, 2018). In urban areas, motorized two-wheelers account for nearly 20% of transport, while cars (or SUVs/vans) and para-transit account for less than 5%. In both urban and rural districts, public transportation (bus and train) is used by more than 20% of commuters traveling to work. Nearly 70% of workers in rural and urban districts travel less than 5 km and fewer than 10% of rural and urban workers work further than 10 km from their homes Tiwari & Nishant (2018). Despite this, the growth of private vehicle ownership and usage is a matter of concern. In India, from 2010 to 2016, the number of two-wheelers and four-wheelers rose by 83.7% and 79.88% respectively (Saxena & Shrivastava, 2021). Since motorization rates are increasing, so are the negative externalities of transportation (congestion, air pollution, noise pollution, road crashes, etc.), causing a substantial economic loss to the nation (Sen et al., 2010; Saxena & Choudhury, 2022; Saxena & Gupta, 2023). In order to increase the use of sustainable transportation (public transport and

non-motorized transport), it is prudent to identify the factor that influences the mode choice of Indian citizens at a disaggregated level and take appropriate action. Census data shows that women make up 50% of the population, while 81% of Indian labourers work in the informal sector. In everyday life, commuting plays an integral role in individual and household productivity. It links personal and professional life, enables reach and access to the labour market and can manifest gendered relationships between women and men (Mazúrová et al., 2021).

Therefore, it makes sense to understand the travel behaviour and mode choice of workers based on their work profiles and genders. However, the literature of mode choice studies is predominantly seen at an aggregate level in India (Agarwal et al., 2020; Pawar et al., 2021; Devika et al., 2020; Jain et al., 2014; Krishnapriya & Soosan George, 2020; Kumar et al., 2015). The aim of the present study is to fill this gap by identifying the factors influencing mode choices for commuting and investigating the importance accorded to the selected factors by respondents from varied work profiles (formal vs. informal) and gender (female vs. male). The objectives of the present study are as follows:

\* Corresponding author.

E-mail address: [akyadav@meei.harvard.edu](mailto:akyadav@meei.harvard.edu) (A. Kumar Yadav).<https://doi.org/10.1016/j.cstp.2023.100994>

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- (i) To determine which of the selected factors play a significantly greater role in mode choice decision-making when correlated with respondents' gender and work profile;
- (ii) To determine if the importance of the selected factors is significantly different when correlated with respondents' gender and work profile.

**2. Literature review**

**2.1. Mode choice behaviour**

Mode choice decision-making is influenced by various factors such as accessibility, safety, travel time, travel cost, convenience, etc., (Bhaduri et al., 2020; Krahl, 1999; Leung & Lai, 2002). Mode choice decisions (MCD) have become more crucial in times of urbanization and pollution, as they determine the look and impact of a city (Jochem et al., 2021). When the modes of transportation are compared for a specific purpose (eg. traveling to and from work), the difference based on socio-economic profile becomes apparent (Matthies et al., 2002). Considering what influences people's choice of modes of transportation for commuting can help transportation and planning agencies implement more effective Travel Demand Management (TDM) policies (Dill & Wardell, 2007). The choice of travel mode depends on travel characteristics including trip cost, trip purpose, and modal characteristics of available transport (Hatamzadeh, 2021). Past research suggests that men and women differ in their commuting patterns and in their propensity to switch between travel options (Patterson et al., 2005). However, many of the existing mode choice models fail to adequately capture the differences between men and women in mode choice decision-making. From a social equity perspective, understanding these differences helps develop sustainable cities (Rahul et al., 2020). To analyse the factors determining the mode choice decision-making of individuals, various studies have been performed utilizing numerous analytical techniques. A brief summary of the reviewed literature is shown as follows in Table 1.

**2.2. Multi-criteria decision-making (MCDM)**

In the past studies, discrete choice models, particularly the Multinomial Logit (MNL), were found to be a quite popular method to assess the mode choice decision-making (Gadepalli et al., 2020; Hasnine & Habib, 2018; Liu et al., 2021; Masoumi, 2019; Matowicki et al., 2021; Mirzaei et al., 2021; Weis et al., 2021; Wong & Farooq, 2021). The issue with traditional discrete choice models is their complex expressions for choice probabilities. It is implied in discrete choice models that each user can make their own independent choices based on a set of options and assigns all the weight to one of them. In contrast to this, the multi-criteria decision-making method (MCDM) weighs and prioritizes the available alternatives based on their relative importance (de Palma et al., 2007).

MCDM methods such as AHP, fuzzy AHP, TOPSIS, etc. are extensively used for weighing competing opinions since they allow to perform pair-wise analyses of the responses in terms of numeric values that can be processed and compared for each element of the hierarchy in a rational and consistent manner. However, one of the major limitations of AHP is that it considers only crisp numbers (1–10). To overcome this problem, fuzzy AHP was developed in which natural linguistic terms express their judgments (for example, equally important, weakly important) can be adopted (Afolayan et al., 2020; 2016; Wong & Li, 2008). Many researchers have utilized MCDM to investigate the factors influencing mode choice decision-making (Cieřla et al., 2020; Jain et al., 2014; Leung & Lai, 2002; Mayo & Taboada, 2020; Yannis et al., 2020). Leung & Lai (2002) emphasized utilizing the application of MCDM for mode choice analysis. They applied the entropy weight method and proposed the use of the goal-programming model as an alternative approach to discrete choice models for resolving mode choice-based problems. Mayo & Taboada (2020) examined the factors affecting the

**Table 1**

A summary of studies investigating the factors affecting mode choice for commuting.

Source	Study Area	Influencing factors	Analysis technique
Dill & Wardell (2007)	Portland, Oregon	Location, Accessibility, Travel Cost	Regression Model
Basheer et al. (2019)	England	Trip Purpose, Family Size, Travel Distance, Accessibility, Vehicle Ownership, Work Profile	Multinomial Logit Model (MLM)
L. Ding & Zhang (2016)	China	Waiting Time, In-Vehicle Time, Travel Cost, Comfort Level	Cluster Analysis and discrete choice models
Palma & Rochat (2000)	Geneva, Switzerland	Comfort Level, Travel Time, Travel Cost, Income Level, Perceived Accessibility Level	Nested logit approach
Lu et al. (2015)	China	Travel Cost, Parking Fees	Nested Logit Model
Buijs et al. (2021)	Amsterdam, Netherlands	Travel Time, Parking Fees, Walking Time And Accessibility	Artificial Neural Network
Cingel et al. (2021)	Slovakia	Travel Time, Travel Distance, Travel Cost And Accessibility	Multinomial Logit Model (MLM)
Márquez et al. (2021)	Colombia	Safety, Vehicle Ownership, Travel Time	Discrete Choice Model
Hatamzadeh (2021)	Tehran	Travel Cost, Trip Purpose, Socio-Economic Characteristics, Safety	Binomial Random Effect
Heinen & Chatterjee (2015)	Great Britain	Accessibility, Socio-Economic Characteristics, Vehicle Ownership	Fractional logit models
Jochem et al. (2021)	Germany	Travel Cost, Trip Time, Socio-Economic Characteristics, Work Profile	Multinomial Logit Model (MLM)
Hidayati et al. (2020)	Jakarta and Kuala Lumpur	Gender, Safety	Correlation and Logistic regression
Agarwal et al. (2020)	Patna, India	Socio-Economic Characteristics, Travel Cost, Travel Time	Bayesian framework-based calibration technique
Patterson et al. (2005)	Montreal, Canada	Socio-Economic Characteristics, Travel Time, Travel Cost, Parking Fee	Discrete Choice Model
Almasri & Alraee (2013)	Gaza, Palestine	Travel Distance, Socio-Economic Characteristics, Work Profile, Vehicle Ownership	Multinomial Logit Model (MLM)
Krishnapriya & Soosan George (2020)	Kochi, India	Travel Time Travel Cost, Socio-Economic Characteristics, Accessibility	Multinomial Logit Model (MLM)
Srinivasan et al. (2007)	Chennai, India	Comfort Level, Reliability, Safety, Convenience	Discrete Choice Model
Gadepalli et al. (2020)	Visakhapatnam, India	Travel Time Travel Cost, Socio-Economic Characteristics, Accessibility	Correlation and Logistic regression

mode choice decision-making process of public transport commuters in the Philippines using an analytic hierarchy process (AHP). Their findings suggest that safety is ranked higher than accessibility, cost of travel, comfort, and concern for the environment regardless of age, gender, income, and intent to travel. Using a similar approach (AHP), Jain et al.

(2014) examined the opinions of private vehicle users and identified their priorities while shifting to the public transportation system. Their study found that safety ranked highest among the criteria for encouraging commuters to shift from private vehicles to public transportation, followed by reliability and cost, and comfort.

### 2.3. Research motivation

It can be observed from the past research that the application of the MCDM technique for examining the factors influencing mode choice of urban commuters in India has not been yet explored. To fill this gap, the present study employs a Fuzzy-AHP based approach to investigate the influence of selected factors on mode choice decision making at disaggregate level (based on gender and work profile). Existing literature on travel mode choice has been majorly performed to identify the factors which influence the mode choice of an individual. A person's gender and work profile are often considered predictors of their mode choice, however existing literature does not consider gender and work profile as fixed variables and then investigate what other factors, such as travel time, travel cost, convenience, safety, accessibility, comfort, privacy, hygiene, and cleanliness, may determine mode choice for an individual. The rationale for conducting such a study is that several researchers have indicated that mode choice differs greatly between males and females, and between workers in the formal and informal sectors (Gadepalli et al., 2020; Hidayati et al., 2020; Kawgan-Kagan, 2020; Matthies et al., 2002; Rahul et al., 2020; Tiwari & Nishant, 2018; Yang et al., 2013). The present study attempts to explore this missing aspect in the context of Indian commuters.

Moreover, research in India has majorly focused on Tier-1 cities such as Delhi, Bangalore, Pune, Chennai, Mumbai, etc. However, the population of these cities is approaching saturation. Proactively, the need of the hour is to pay much more attention to Tier-2 Indian cities as they are rapidly growing in size and population. Specifically, the present study has been conducted in the city of Bhopal, which is the capital of an Indian state but is rated Tier-2 in terms of population. In recent years, the population of Bhopal has increased significantly which has put a lot of stress on the transport system of the city and hence will have a definite influence on the mode choice of the residents. The study findings can help the city authorities and urban planning professionals to understand the needs of the residents in based on their gender and socioeconomic profiles, and frame policies that are more sensitive towards their needs.

## 3. Method

### 3.1. Selection of variables

From the comprehensive literature review, travel time, travel cost, convenience, safety, accessibility, comfort level were adopted as the influencing factors; however, several researchers have also studied the effect of COVID-19 on travel behaviour and mode choice decision-making approach (Bari et al., 2021; Bhaduri et al., 2020; Luan et al., 2021; Scorrano & Danielis, 2021; Tan & Ma, 2021). Considering the effect of COVID-19, two more factors; hygiene & cleanliness and privacy were also added to the already selected factors. To clearly state the definition of every selected parameter, a descriptive table was tabulated while conducting the Focus Group Discussions. The description of the selected factors is depicted as follows in Table 2.

A systematic approach is used in this study to examine the impact of selected factors on mode choice decision-making for commuting. From the literature review, eight factors were selected to study their influence on mode choice (see Table 2). In order to perform fuzzy analytical hierarchy process (FAHP), a 9-point comparison scale was formulated (as shown in Table 3).

**Table 2**  
Description of selected factors.

Factor	Code	Description
Travel Time	P1	Amount of time required to reach a designated location
Travel Cost (INR)	P2	Amount of money required to invested for reaching a designated location
Convenience	P3	Ease of using a Mode
Accessibility	P4	Ease of accessing a mode
Comfort Level	P5	Perception of being relaxed
Safety	P6	A feeling of being protected against anti-social activities and accidents
Privacy	P7	Not to be physically or mentally disturbed by other people
Hygiene and Cleanliness	P8	Conditions or practices conducive to maintaining health and preventing disease, especially through cleanliness.

**Table 3**  
Scale of Relative Importance.

Scale of relative Importance	Description	Fuzzy Triangular Scale
1	Equal importance	(1,1,1)
3	Moderate Importance	(2,3,4)
5	Strong Importance	(4,5,6)
7	Very Strong Importance	(6,7,8)
9	Extreme importance	(9,9,9)
2, 4, 6, 8	Intermediate Values	(1,2,3), (3,4,5), (5,6,7), (7,8,9)
1/3, 1/5, 1/7, 1/9	Values for inverse comparison	

### 3.2. Focus group discussions

Based on the probable work profile of respondents and the convenience of surveyors, a total of six locations were selected in the city of Bhopal, India for primary data collection, and focused group discussions (FGD) were conducted at the selected locations (twice per location). As a thumb rule, 3 to 21 participants per group were selected as part of the FGDs (Nyumba et al., 2018). In this study, 242 participants shared their opinion on the comparative importance of selected factors to consider when choosing a mode of transportation for commuting. As part of the monitoring and coordination process, one group leader was nominated, but the opinion of the nominated group leader was excluded in order to reduce the possibility of biased opinions. Equal weight was given to opinions obtained from each of the six sites and from each of the twelve focus groups. A summary of the participants of each FGD is shown in Table 4.

At each of the six selected locations, two FGDs were conducted. A total of six focus group discussions (FGDs) were conducted with women and men working in three slums (which included street vendors and hawkers) Chen (2016). Before starting the FGDs at slum locations, the work profiles of the participants were also verified. A similar method was used to collect primary data from three offices from the government and private sector for data collection. Following the obtaining of data through FGDs, the results were analysed using Fuzzy AHP (FAHP). Further, Kendall's concordance test was performed to examine whether opinions regarding the importance of various factors for choosing a mode of travel differed with respect to the work profile and gender.

### 3.3. Fuzzy analytical hierarchical process (AHP)

To perform the Fuzzy AHP, the following steps were followed (Dang et al., 2019):

**Step 1:** In Fuzzy AHP, Experts adopt natural linguistic terms (e.g., equally important, weakly important) to express their judgments, as shown in Table 3. The first step is the construction of fuzzy pairwise

**Table 4**  
Profile of Focus Group Discussions.

FGD No.	Location Feature	FGD Conducted on	No. of Participant	Gender of Participants	Work Profile of Participants
1	Slum 1	Weekends	21	Female	Informal
2	Slum 1	Weekends	20	Male	Informal
3	Slum 2	Weekends	19	Female	Informal
4	Slum 2	Weekends	20	Male	Informal
5	Slum 3	Weekends	21	Female	Formal
6	Slum 3	Weekends	21	Male	Formal
7	Government/Private office 1	Weekdays	21	Female	Formal
8	Government/Private office 1	Weekdays	21	Male	Formal
9	Government/Private office 2	Weekdays	18	Female	Formal
10	Government/Private office 2	Weekdays	19	Male	Formal
11	Government/Private office 3	Weekdays	20	Female	Formal
12	Government/Private office 3	Weekdays	21	Male	Formal

comparison matrices

$$A^k = \begin{bmatrix} d_{11}^k & d_{12}^k & \dots & d_{1n}^k \\ d_{n1}^k & d_{n2}^k & \dots & d_{nn}^k \end{bmatrix} \tag{1}$$

Where  $d_{ij}^k$  represents the  $k^{th}$  decision maker's preference of the  $i^{th}$  criterion over the  $j^{th}$  criterion. In our case, a single decision matrix was formed from each FGD on the basis of consensus among participants.

**Step 2:** Calculate the fuzzy geometrical mean and the fuzzy weights for each criterion by using the geometrical mean technique.

$$r_i = (\pi_{j=1}^n d_{ij})^{1/n}, i = 1, 2, \dots, n, \tag{2}$$

where  $r_i$  is the fuzzy geometrical mean and  $d_{ij}$  is the decision maker's preference of the  $i^{th}$  criterion over the  $j^{th}$  criterion.

**Step 3:** Determination of the fuzzy weight of the criteria.

$$w_i = r_i \otimes (r_1 \oplus r_2 \oplus \dots \oplus r_n)^{-1} \tag{3}$$

where  $w_i$  is the fuzzy weight criteria.

**Step 4:** Calculate the average and normalized weight criteria.

$$M_i = \frac{w_1 \oplus w_2 \oplus \dots \oplus w_n}{n} \tag{4}$$

$$N_i = \frac{M_i}{M_1 \oplus M_2 \oplus \dots \oplus M_n} \tag{5}$$

where  $M_i$  is the average, and  $N_i$  is the normalized weight criteria.

**3.4. Analysis and results**

The present study followed a systematic approach to investigate the importance of selected variables and validated if the perceived importance varies with gender and work profile of participants using a combination of Fuzzy AHP and Kendall's Concordance test. To collect primary data regarding experts' opinions, a pairwise survey questionnaire was prepared. There were nine matrices in each set of the questionnaire for comparing the factors with each other.

The performed calculations are as follows:

**Table 5**  
Pairwise Comparison Matrix for FGD 1.

Factor	P1	P2	P3	P4	P5	P6	P7	P8
P1	1,1,1	0,20,0,33, 1	1,3,5	1,1,1	3,5,7	1,2,3	5,7,9	3,5,7
P2	1,3,5	1,1,1	1,3,5	1,3,5	1,3,5	1,1,1	5,7,9	4,6,8
P3	0,20,0,33, 1	0,20,0,33, 1	1,2,3	1,1,1	3,5,7	1,2,3	3,5,7	4,6,8
P4	1,1,1	0,20,0,33, 1	1,1,1	1,1,1	3,5,7	1,3,5	3,5,7	4,6,8
P5	0.14,0.20,0.33	0,20,0,33, 1	0.14,0.2,0.33	0.14,0.2,0.33	0,20,0,33, 1	0,20,0,33, 1	1,3,5	1,1,1
P6	0.33,0.50,1	1,1,1	0.33,0.50,1	0,20,0,33, 1	1,3,5	1,1,1	1,3,5	1,2,3
P7	0.11,0.14,0.20	0.11,0.14,0.2	0.14,0.2,0.33	0.14,0.2,0.33	0,20,0,33, 1	0,20,0,33, 1	1,1,1	0,20,0,33, 1
P8	0.14,0.20,0.33	0.13, 0.17,0.25	0.13, 0.17,0.25	0.13, 0.17,0.25	0,20,0,33, 1	0.33,0.50,1	1,3,5	1,1,1

**3.5. Fuzzy AHP**

In order to investigate the importance of selected factors in mode-choice decision making, the initial step was to conduct FGDs at selected areas and obtain the primary data. After obtaining the primary data, twelve pair-wise comparison matrices were formed with respect to each FGD. Table 5, Table 6, and Table 7 depicts the pairwise comparison matrix, geometric mean and fuzzified and defuzzified weights calculation for FGD 1 only. Similar calculations have been executed for all other response collected from other FGDs (FGD 2 to FGD 12). The outcome of these calculation for all twelve FGDs is depicted in Table 8.

As shown in Step 2 and Step 3 of section 2.1, the geometric mean was calculated (as shown in Table 6) and fuzzy weights were determined. The obtained Fuzzy weights were normalized and defuzzified using 'Centre of Area' method, as depicted in Table 7.

The obtained weights were converted into percentage weight for better representation. Table 8 depicts the obtained weights from all the twelve FGDs.

From Table 8, it can be observed that in general, Travel Time, Travel Cost, Accessibility and Convince were given significantly higher weightage as compared to Privacy, Comfort level and Hygiene & Cleanliness.

**3.6. Kendall's concordance test**

In a non-parametric manner, Kendall's coefficient of concordance

**Table 6**  
Geometric mean obtained from the responses of FGD 1.

Factor	Fuzzy Geometric Mean		
Travel Time	1.32	2.08	3
Travel Cost	1.45	2.76	3.82
Convenience	1.05	1.69	2.78
Accessibility	1.28	1.87	2.58
Comfort Level	0.32	0.48	0.81
Safety	0.62	1.05	1.72
Privacy	0.19	0.27	0.62
Hygiene and Cleanliness	0.31	0.44	0.63

**Table 7**  
Fuzzified and Defuzzified Weights for FGD 1 using centre of area method.

Fuzzified Weights			Defuzzified Weights	Defuzzified and Normalized Weights
0.082	0.195	0.459	0.245	0.191
0.091	0.260	0.583	0.311	0.243
0.066	0.159	0.424	0.216	0.169
0.080	0.176	0.394	0.217	0.169
0.020	0.045	0.124	0.063	0.049
0.039	0.099	0.262	0.133	0.104
0.012	0.026	0.095	0.044	0.034
0.020	0.041	0.097	0.053	0.041

**Table 8**  
Importance of Selected Factors with respect to all FGDs.

No.	P1	P2	P3	P4	P5	P6	P7	P8
FGD 1	19%	24%	17%	17%	5%	10%	3%	4%
FGD 2	21%	28%	16%	15%	4%	2%	2%	3%
FGD 3	20%	27%	17%	15%	5%	11%	3%	4%
FGD 4	20%	29%	17%	16%	6%	3%	3%	3%
FGD 5	23%	27%	17%	12%	5%	11%	3%	4%
FGD 6	20%	27%	16%	16%	5%	3%	3%	3%
FGD 7	24%	18%	13%	12%	8%	16%	5%	9%
FGD 8	25%	18%	20%	20%	6%	4%	4%	10%
FGD 9	30%	20%	15%	13%	7%	17%	6%	10%
FGD 10	23%	20%	16%	21%	5%	4%	5%	11%
FGD 11	23%	11%	16%	12%	5%	18%	5%	9%
FGD 12	24%	18%	15%	20%	4%	4%	4%	10%
<b>Average</b>	<b>23%</b>	<b>22%</b>	<b>16%</b>	<b>16%</b>	<b>5%</b>	<b>9%</b>	<b>4%</b>	<b>7%</b>

(W) estimates the degree of agreement among various expert groups (Dobrovolskienė & Tamošiūnienė, 2016). To obtain the pairwise comparison questionnaire, 12 FGDs were conducted in this study. Kendall's coefficient of concordance (W) was therefore used to obtain the degree of agreement among participants of the FGDs. Equation (6) illustrates the calculation of Kendall's concordance (Patel & Patel, 2020).

$$W = \frac{12S}{m^3(n^3 - n)} \tag{6}$$

where, W signifies Kendall's coefficient of concordance, S indicates the sum of rank mean deviation. The number of experts and criteria are represented by m and n respectively. Table 9 lists out the standard values to test the agreement of decision makers in Kendall's Concordance test (Duleba & Moslem, 2018; Patel & Patel, 2020).

Based on equation (6), Kendall's concordance test was conducted for the primary data obtained, as illustrated in Table 10.

The Kendall's Coefficient (W) value from Table 10 indicates a weak agreement between the decision-makers or participants. Furthermore, the significant value was greater than 5%, implying that the null hypothesis was accepted. Additionally, Kendall's concordance test was conducted based on participants' gender and job profiles. Based on the averaged factor importance values of FGDs 1 to 6 (informal workers) and 7 to 12 (formal workers), a concordance test was performed. The obtained result is shown in Table 11.

In a similar manner to Table 12, Kendall's concordance test was conducted to determine if participants' respective values of importance were in agreement based on gender by taking the average of these values. It can be seen from Table 4 that female respondents participated in FGDs 1, FGD 3, FGD 5, FGD 7, FGD 9, and FGD11, while male respondents participated in FGDs 2, FGD 4, FGD 6, FGD 8, FGD 10, and FGD12.

**Table 9**  
Kendall's agreement degree scale.

W	0	0.1	0.3	0.6	1
Interpretation	No agreement	Weak agreement	Moderate agreement	Strong agreement	Perfect Agreement

**Table 10**  
Kendall's Coefficient of Importance for all participants.

N	8
Kendall's W	0.157
Chi-Square	13.788
df	11
Asymp. Sig.	0.245

**Table 11**  
Kendall Coefficient values based on participant work profile.

N	8
Kendall's W	0.250
Chi-Square	2.000
df	1
Asymp. Sig.	0.157

**Table 12**  
Kendall Coefficient values based on gender of participant.

N	8
Kendall's W	0.063
Chi-Square	0.500
df	1
Asymp. Sig.	0.480

Tables 11 and 12 show a disagreement in the importance given to selected factors when considering mode choice decision making based on the work profile and gender of the participants, as the significance value for both tests was greater than 5% indicating acceptance of the null hypothesis and a Kendall coefficient (W) value lower than 0.6 indicating a disagreement.

#### 4. Discussion

Investigating the factors affecting the mode choice of intercity travellers can reveal how passengers make travel decisions and show how to develop a demand management strategy that is effective (Li et al., 2021; Pawar et al., 2020). As per the Census of India (2011), the female population constitutes 50% of the population, while nearly 81% of the employed in India are in the informal sector (International Labour Office, 2018). Therefore, it is imperative to assess the influence of various parameters on modes of transportation for commuting on a disaggregated basis. The majority of the studies that have been conducted in India so far have not dealt with the disparities between gender and work profile in mode choice decision making.

MCDM techniques have a wide range of applications, and have been extensively used by the researchers in the field of transportation planning (H. Ding et al., 2021; John et al., 2014; Xin Li et al., 2016; Moradian et al., 2019; Nassereddine & Eskandari, 2017; Samanta & Jana, 2019) as well as other areas such as supply chain management, identifying economic barriers, as well as medical and agricultural industries (Lamba et al., 2020; Mishra et al., 2018; Saraswat et al., 2021). The majority of the studies utilizing the MCDM approach in decision making have been conducted in the developed countries and there is a scarcity of research in the low- and middle-income countries (LMICs). In Indian context, the

mode choice decision-making process is not well-analyzed by means of MCDM. The present study is the first-of-its-kind attempt to examine how MCDM techniques can be utilized to understand the effect of selected factors on mode choice for commuting in India for an individual based on their gender and work profile.

There are several factors contributing to gender differences in mobility, including modes of transportation, travel behaviours, perceptions, experiences of mobility, etc., found around the globe (Kawgan-Kagan, 2020). In this study, the importance of varied parameters for mode choice was fairly aligned for 'Female workers' and 'Formal workers', and a similar observation can be made as well for 'Male workers' and 'Informal Workers'. In the case of 'Female workers' and 'Formal workers', Travel Time was the most influencing factor, while for 'Male workers' and 'Informal Workers', Travel Cost was the most influential factor. Furthermore, the latter category also did not pay a lot of emphasis on Safety while choosing of mode, which was contrasting in the case of 'Female workers' and 'Formal workers' as Safety had a decent influence (Saxena, 2023b, 2023a).

It is left largely unaddressed how gender influences mobility choices and behaviour, particularly as they pertain to women's perceptions of safety and their mobility choices in public spaces (Hidayati et al., 2020). Women tend to adopt complex commutes and non-work chains than men (Yang et al., 2013). Women in urban areas have specific mobility needs (Kawgan-Kagan & Popp, 2018). An in-depth study on mode choice based on socioeconomic profiles was conducted in India, whose results are consistent with the findings of the present study (Tiwari & Nishant, 2018). In their study, it was also found that the work profile and gender of individuals have a big influence on the mode of travel for commuting. Additionally, female respondents also highlighted their concern about safety in their work (Tiwari & Nishant, 2018). A key factor to consider is the reliance of women on public transportation. The proportion of females who commute via public transport in India is 15%, while the proportion of males who commute via public transport is only 10%. Their work also indicates that for commuting, almost 30% of women walk compared to just 22% of men. In another study conducted by Shah & Viswanath (2017), women use public transportation primarily due to affordability, coverage, frequency, and safety. When women are empowered to commute without fear, safety is one of the focal points that need to be addressed in India. In the same study, nearly three-quarters of the women surveyed pointed out the need for dedicated footpaths, and 57% pointed out that existing footpaths were unusable because of discontinuities or encroachments. This also validates the finding of the present study; women respondents significantly weighed 'Safety' while choosing a mode for travel.

Based on the work profiles of respondents, Gadepalli et al. (2020) and Manoj & Verma (2015) assessed travel behaviour in the Indian context. In their study, Gadepalli et al. (2020) observed a significant and positive correlation between the use of bus transport for commuting among informal workers and a negative and significant correlation between bus usage and formal workers. Manoj & Verma (2015) from their research concluded that marginalised and informal workers rely a lot on walking as a mode for work and recreational trips. Even though nearly 81% of the employed personnel in India are in the informal sector, nothing in the existing literature evaluates the importance informal workers give to factors selected in this study in choosing their mode of transport for commuting. This underscores the relevance of the present study.

## 5. Summary and conclusions

The past research on factors influencing mode choice decision making has emphasized on various contexts, however this article considered work profile and gender of respondents as the key influencing factors for mode choice. The aim was to specifically assess if respondents with varying gender and work profile have different perspectives and priorities while deciding a mode for travelling for

commuting. In this work, we analysed and investigated the importance of selected factors for mode choice decision making based on gender and work profile of commuters. The key insights from the study findings are as follows:

- A significant level of disagreement exists between the participants based on their gender and age while they are deciding the mode of travel for commuting based on selected factors.
- Safety was found to be a significant factor for female and formal workers while making a mode choice for working trips, however, this was not the case with male workers and informal workers.
- Travel Time, Travel Cost, Accessibility, and Convenience were among the major deterministic factors while comfort level and privacy were not weighted highly.
- The level of comfort and privacy for all four groups were the least weighted factors in terms of their influence on mode choice decisions.
- Travel time was the most significant factor for formal workers, while the cost of travel was the most significant factor for informal workers.
- Post-COVID-19, a lot of researchers have empathised on Hygiene and Cleanliness as influencing factors that can affect the mode choice decision-making (Bhaduri et al., 2020; Luan et al., 2021; Scorrano & Danielis, 2021; Tan & Ma, 2021). In this study, it was found that formal workers paid the highest weightage (10%) to this factor against the other three categories.

The study findings will aid policy makers and city planners in understanding the need of different respondents from gender and work profile towards urban transport system, prioritize and develop even more gender sensitive policies. It is more likely that poor decisions in urban transport sector negatively affect low-income and other socially vulnerable groups. This suggests that the need to formulate socially inclusive policies is paramount (Oviedo & Attard, 2022). Additionally, developing countries like India should pay special focus on active travel as a sustainable, resilient, and inclusive form of transportation and to integrate it into the desired future in large and small cities, remote settlements, and islands of all sizes and shapes, and at the same time reduce carbon footprint (Attard, 2022).

## 6. Limitations and Future Scope

Using a MCDM approach, this study attempted to analyse the influence of factors affecting mode choice for commuting based on gender and work profile of participants. Irrespective of the strengths and contributions of the present study, few limitations are also present. Although focus group discussions (FGDs) can serve as an effective tool to carry out such studies, there is still the fact that not everyone participating in a FGD expresses their opinions equally and frequently. Apart from the selected eight parameters, there can be multiple factors that could influence mode choice decision-making in real-life scenarios. Furthermore, the present study did not consider the geographical distribution of locations for FGDs. Participants residing in places with better connectivity and accessibility may not have given enough weight to that factor or may have given more weight to that factor, implying that the results may be generalized. Further studies should consider other factors, such as parking fees, vehicle ownership, transfer time from one vehicle to another, etc. Moreover, the mode of travel for commuting can be influenced by an individual's behaviour. The use of behavioural economics models and theories of planned behaviour may provide useful insights in the future. There can also be a comparative study conducted to assess the importance of the factors related to the mode choice in the pre and post-COVID scenarios (Saxena and Yadav, 2022).

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## CRedit authorship contribution statement

**Aditya Saxena:** Conceptualization, Methodology, Data curation, Formal analysis, Writing – original draft. **Ankit Kumar Yadav:** Visualization, Validation, Writing – review & editing.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## References

- Agarwal, A., Ziemke, D., Nagel, K., 2020. Calibration of choice model parameters in a transport scenario with heterogeneous traffic conditions and income dependency. *Transportation Letters* 12 (7), 441–450. <https://doi.org/10.1080/19427867.2019.1633788>.
- Almasri, E., Alraee, S., 2013. Factors Affecting Mode Choice of Work Trips in Developing Cities—Gaza as a Case Study. *Journal of Transportation Technologies* 03 (04), 247–259. <https://doi.org/10.4236/jtts.2013.34026>.
- Attard, M., 2022. Active travel and sustainable transport. *Communications in Transportation Research* 2, 100059. <https://doi.org/10.1016/j.commtr.2022.100059>.
- Bari, C., Chopade, R., Kachwa, S., V. Navandar, Y., & Dhmaniya, A. (2021). Impact of COVID-19 on educational trips—an Indian case study. *Transportation Letters*, 13 (5–6), 375–387. doi: 10.1080/19427867.2021.1896064.
- Basheer, M.A., van der Waerden, P., Kochan, B., Bellemans, T., Raheel Shah, S.A., 2019. Multi-stage trips: An exploration of factors affecting mode combination choice of travelers in England. *Transp. Policy* 81, 95–105. <https://doi.org/10.1016/j.tranpol.2019.06.007>.
- Bhaduri, E., Manoj, B.S., Wadud, Z., Goswami, A.K., Choudhury, C.F., 2020. Modelling the effects of COVID-19 on travel mode choice behaviour in India. *Transportation Research Interdisciplinary Perspectives* 8 (November), 100273. <https://doi.org/10.1016/j.trip.2020.100273>.
- Buijs, R., Koch, T., Dugundji, E., 2021. Applying transfer learning and various ANN architectures to predict transportation mode choice in Amsterdam. *Procedia Comput. Sci.* 184, 532–540. <https://doi.org/10.1016/j.procs.2021.03.067>.
- Chen, M.A., 2016. Technology, informal workers and cities: insights from Ahmedabad (India), Durban (South Africa) and Lima (Peru). *Environ. Urban.* 28 (2), 405–422. <https://doi.org/10.1177/0956247816655986>.
- Ciesla, M., Sobota, A., Jacyna, M., 2020. Multi-Criteria decision making process in metropolitan transport means selection based on the sharing mobility idea. *Sustainability (Switzerland)* 12 (17), 1–21. <https://doi.org/10.3390/su12177231>.
- Cingel, M., Drlicak, M., Celko, J., 2021. Morning modal split model of economically active people in Zilina region. *Transp. Res. Procedia* 55, 1065–1072. <https://doi.org/10.1016/j.trpro.2021.07.077>.
- Dang, V.T., Wang, J., Van-Thac Dang, W., 2019. An integrated fuzzy AHP and fuzzy TOPSIS approach to assess sustainable urban development in an emerging economy. *Int. J. Environ. Res. Public Health* 16 (16), 1–21. <https://doi.org/10.3390/ijerph16162902>.
- de Palma, A., Picard, N., Waddell, P., 2007. Discrete choice models with capacity constraints: An empirical analysis of the housing market of the greater Paris region. *Journal of Urban Economics* 62 (2), 204–230. <https://doi.org/10.1016/j.jue.2007.02.007>.
- Devika, R., HariKrishna, M., Anjaneyulu, M.V.L.R., 2020. Influence of psychological factors in mode choice decision making: A structural equation modeling approach. *Transp. Res. Procedia* 48 (2018), 2821–2830. <https://doi.org/10.1016/j.trpro.2020.08.236>.
- Dill, J., Wardell, E., 2007. Factors affecting worksite mode choice findings from Portland, Oregon. *Transp. Res. Rec.* 1994, 51–57. <https://doi.org/10.3141/1994-07>.
- Ding, H., Wang, J., Liao, W., Liang, T., Dai, H., 2021. Site selection of self-driving and recreational vehicle camps in China: An investigation using analytic hierarchy process and entropy. *Journal of Traffic and Transportation Engineering (English Edition)* 8 (5), 762–777. <https://doi.org/10.1016/j.jtte.2021.09.003>.
- Ding, L., Zhang, N., 2016. A Travel Mode Choice Model Using Individual Grouping Based on Cluster Analysis. *Procedia Eng.* 137, 786–795. <https://doi.org/10.1016/j.proeng.2016.01.317>.
- Dobrovolskienė, N., Tamosiūnienė, R., 2016. An index to measure sustainability of a business project in the construction industry: Lithuanian case. *Sustainability (Switzerland)* 8 (1), 1–14. <https://doi.org/10.3390/su8010014>.
- Duleba, S., Moslem, S., 2018. Sustainable urban transport development with stakeholder participation, an AHP-Kendall model: A case study for Mersin. *Sustainability (Switzerland)* 10 (10). <https://doi.org/10.3390/su10103647>.
- Gadepalli, R., Tiwari, G., Bolia, N., 2020. Role of user's socio-economic and travel characteristics in mode choice between city bus and informal transit services: Lessons from household surveys in Visakhapatnam, India. *J. Transp. Geogr.* 88 <https://doi.org/10.1016/j.jtrangeo.2018.08.017>.
- Hasnine, M.S., Habib, K.N., 2018. What about the dynamics in daily travel mode choices? A dynamic discrete choice approach for tour-based mode choice modelling. *Transp. Policy* 71, 70–80. <https://doi.org/10.1016/j.tranpol.2018.07.011>.
- Hatamzadeh, Y., 2021. Working commuters' tendency toward a travel pattern with potentially more walking: Examining the relative influence of personal and environmental measures. *Res. Transp. Econ.* 86 (February), 101060 <https://doi.org/10.1016/j.retrec.2021.101060>.
- Heinen, E., Chatterjee, K., 2015. The same mode again? An exploration of mode choice variability in Great Britain using the National Travel Survey. *Transp. Res. A Policy Pract.* 78, 266–282. <https://doi.org/10.1016/j.tra.2015.05.015>.
- Hidayati, I., Tan, W., Yamu, C., 2020. How gender differences and perceptions of safety shape urban mobility in Southeast Asia. *Transport. Res. F: Traffic Psychol. Behav.* 73, 155–173. <https://doi.org/10.1016/j.trf.2020.06.014>.
- International Labour Office, 2018. Women and Men in the Informal Economy: A Statistical Picture. In *International Labour Office*. <https://doi.org/10.1179/bac.2003.28.1.018>.
- Jain, S., Aggarwal, P., Kumar, P., Singhal, S., Sharma, P., 2014. Identifying public preferences using multi-criteria decision making for assessing the shift of urban commuters from private to public transport: A case study of Delhi. *Transport. Res. F: Traffic Psychol. Behav.* 24, 60–70. <https://doi.org/10.1016/j.trf.2014.03.007>.
- Jochem, P., Lisson, C., Khanna, A.A., 2021. The role of coordination costs in mode choice decisions: A case study of German cities. *Transp. Res. A Policy Pract.* 149 (July 2020), 31–44. <https://doi.org/10.1016/j.tra.2021.04.001>.
- John, A., Yang, Z., Riahi, R., Wang, J., 2014. Application of a collaborative modelling and strategic fuzzy decision support system for selecting appropriate resilience strategies for seaport operations. *Journal of Traffic and Transportation Engineering (English Edition)* 1 (3), 159–179. [https://doi.org/10.1016/S2095-7564\(15\)30101-X](https://doi.org/10.1016/S2095-7564(15)30101-X).
- Kawgan-Kagan, I., 2020. Are women greener than men? A preference analysis of women and men from major German cities over sustainable urban mobility. *Transportation Research Interdisciplinary Perspectives* 8, 100236. <https://doi.org/10.1016/j.trip.2020.100236>.
- Kawgan-Kagan, I., Popp, M., 2018. Sustainability and Gender: A mixed-method analysis of urban women's mode choice with particular consideration of e-carsharing. *Transp. Res. Procedia* 31, 146–159. <https://doi.org/10.1016/j.trpro.2018.09.052>.
- Krahl, D. (1999). Proceedings of the 1999 Winter Simulation Conference P. *Simulation*, 188–195.
- Krishnapriya, M.G., Soosan George, T., 2020. Mode choice behaviour of students, integrating residential location characteristics: A study from Kochi City, India. *European Transport - Trasporti Europei* 79, 1–17. <https://doi.org/10.48295/et.2020.79.5>.
- Kumar, C., Mangaraj, B.K., Vijayaraghavan, T.A.S., 2015. Mode choice for urban work-based daily trips: A multi-criteria decision making model using the analytical hierarchical process. *WIT Trans. Built Environ.* 146 (September), 627–638. <https://doi.org/10.2495/UT150511>.
- Lamba, D., Yadav, D.K., Barve, A., Panda, G., 2020. Prioritizing barriers in reverse logistics of E-commerce supply chain using fuzzy-analytic hierarchy process. *Electron. Commer. Res.* 20 (2), 381–403. <https://doi.org/10.1007/s10660-019-09333-y>.
- Leung, S.C.H., Lai, K.K., 2002. Multiple objective decision-making in the mode choice problem: A goal-programming approach. *Int. J. Syst. Sci.* 33 (1), 35–43. <https://doi.org/10.1080/00207720110067430>.
- Li, X., Liu, Y., Wang, Y., Gao, Z., 2016. Evaluating transit operator efficiency: An enhanced DEA model with constrained fuzzy-AHP cones. *Journal of Traffic and Transportation Engineering (English Edition)* 3 (3), 215–225. <https://doi.org/10.1016/j.jtte.2016.05.004>.
- Li, X., Zhang, S., Wu, Y., Wang, Y., Wang, W., Chen, X., 2021. Exploring Influencing Factors of Intercity Mode Choice from View of Entire Travel Chain. *J. Adv. Transp.* 2021, 1–13.
- Liu, S., Zhu, J., Easa, S.M., Guo, L., Wang, S., Wang, H., Xu, Y., Velaga, N.R., 2021. Travel Choice Behavior Model Based on Mental Accounting of Travel Time and Cost. *J. Adv. Transp.* 2021, 1–21.
- Lu, X.S., Liu, T.L., Huang, H.J., 2015. Pricing and mode choice based on nested logit model with trip-chain costs. *Transp. Policy* 44, 76–88. <https://doi.org/10.1016/j.tranpol.2015.06.014>.
- Luan, S., Yang, Q., Jiang, Z., Wang, W., 2021. Exploring the impact of COVID-19 on individual's travel mode choice in China. *Transp. Policy* 106 (March), 271–280. <https://doi.org/10.1016/j.tranpol.2021.04.011>.
- Manoj, M., Verma, A., 2015. Activity-travel behaviour of non-workers belonging to different income group households in Bangalore, India. *J. Transp. Geogr.* 49, 99–109. <https://doi.org/10.1016/j.jtrangeo.2015.10.017>.
- Márquez, L., Cantillo, V., Arellana, J., 2021. How do the characteristics of bike lanes influence safety perception and the intention to use cycling as a feeder mode to BRT? *Travel Behav. Soc.* 24 (January 2020), 205–217. <https://doi.org/10.1016/j.tbs.2021.04.005>.
- Masoumi, H.E., 2019. A discrete choice analysis of transport mode choice causality and perceived barriers of sustainable mobility in the MENA region. *Transp. Policy* 79 (March), 37–53. <https://doi.org/10.1016/j.tranpol.2019.04.005>.
- Matowicki, M., Pribyl, O., Pecherkova, P., 2021. Carsharing in the Czech Republic: Understanding why users chose this mode of travel for different purposes. *Case Studies on Transport Policy* 9 (2), 842–850. <https://doi.org/10.1016/j.cstp.2021.04.003>.

- Matthies, E., Kuhn, S., Klöckner, C.A., 2002. Travel mode choice of women: The result of limitation, ecological norm, or weak habit? *Environ. Behav.* 34 (2), 163–177. <https://doi.org/10.1177/0013916502034002001>.
- Mayo, F.L., Taboada, E.B., 2020. Ranking factors affecting public transport mode choice of commuters in an urban city of a developing country using analytic hierarchy process: The case of Metro Cebu. Philippines. *Transportation Research Interdisciplinary Perspectives* 4, 100078. <https://doi.org/10.1016/j.trip.2019.100078>.
- Mazúrová, B., Kollár, J., Nedelová, G., 2021. Travel mode of commuting in context of subjective well-being—Experience from Slovakia. *Sustainability (Switzerland)* 13 (6). <https://doi.org/10.3390/su13063030>.
- Mirzaei, E., Kheyroddin, R., Mignot, D., 2021. Exploring the effect of the built environment, weather condition and departure time of travel on mode choice decision for different travel purposes: Evidence from Isfahan. *IranCase Studies on Transport Policy* 9 (4), 1419–1430. <https://doi.org/10.1016/j.cstp.2021.05.002>.
- Mishra, S.S., Muduli, K., Dash, M., Yadav, D.K., 2018. PROMETHEE-based analysis of HCWM challenges in healthcare sector of Odisha. *Smart Innovation, Systems and Technologies* 77, 163–170. <https://doi.org/10.1007/978-981-10-5544-7-17>.
- Moradian, M., Modanloo, V., Aghaiee, S., 2019. Comparative analysis of multi criteria decision making techniques for material selection of brake booster valve body. *Journal of Traffic and Transportation Engineering (English Edition)* 6 (5), 526–534. <https://doi.org/10.1016/j.jtte.2018.02.001>.
- Nassereddine, M., Eskandari, H., 2017. An integrated MCDM approach to evaluate public transportation systems in Tehran. *Transp. Res. A Policy Pract.* 106 (August), 427–439. <https://doi.org/10.1016/j.tra.2017.10.013>.
- O.Nyumba, T., Wilson, K., Derrick, C. J., & Mukherjee, N. (2018). The use of focus group discussion methodology: Insights from two decades of application in conservation. *Methods in Ecology and Evolution*, 9(1), 20–32. doi: 10.1111/2041-210X.12860.
- Oviedo, D., Attard, M., 2022. Making equity work: Implementing socially-targeted urban transport policies. *Res. Transp. Bus. Manag.* 42, 100800.
- Palma, A.D., Rochat, D., 2000. Mode choices for trips to work in Geneva: An empirical analysis. *J. Transp. Geogr.* 8 (1), 43–51. [https://doi.org/10.1016/S0966-6923\(99\)00026-5](https://doi.org/10.1016/S0966-6923(99)00026-5).
- Patel, S.J., Patel, C.R., 2020. A stakeholders perspective on improving barriers in implementation of public bicycle sharing system (PBSS). *Transp. Res. A Policy Pract.* 138, 353–366. <https://doi.org/10.1016/j.tra.2020.06.007>.
- Patterson, Z., Ewing, G., Haider, M., 2005. Gender-based analysis of work trip mode choice of commuters in suburban Montreal, Canada, with stated preference data. *Transp. Res. Rec.* 1924, 85–93. <https://doi.org/10.3141/1924-11>.
- Pawar, D.S., Yadav, A.K., Akolekar, N., Velaga, N.R., 2020. Impact of physical distancing due to novel coronavirus (SARS-CoV-2) on daily travel for work during transition to lockdown. *Transportation research interdisciplinary perspectives* 7, 100203.
- Pawar, D.S., Yadav, A.K., Choudhary, P., Velaga, N.R., 2021. Modelling work-and non-work-based trip patterns during transition to lockdown period of COVID-19 pandemic in India. *Travel Behav. Soc.* 24, 46–56.
- Rahul, T.M., Megha, T.M., Meenakshi, S., Madhavendra, K., Verma, A., 2020. Gender Differences in Work Trip Generation: Evidences from Bangalore. *Transp. Res. Procedia* 48 (2019), 2800–2810. <https://doi.org/10.1016/j.trpro.2020.08.238>.
- Samanta, S., Jana, D.K., 2019. A multi-item transportation problem with mode of transportation preference by MCDM method in interval type-2 fuzzy environment. *Neural Comput. & Applic.* 31 (2), 605–617. <https://doi.org/10.1007/s00521-017-3093-6>.
- Saraswat, S.K., Digalwar, A.K., Yadav, S.S., Kumar, G., 2021. MCDM and GIS based modelling technique for assessment of solar and wind farm locations in India. *Renew. Energy* 169, 865–884. <https://doi.org/10.1016/j.renene.2021.01.056>.
- Saxena, A., 2023b. Texting and crossing : An extended theory of planned behaviour to model the psychological and demographic factors related to pedestrians ' use of cell phone for texting at crosswalks in developing country. *IATSS Research* xxxx. <https://doi.org/10.1016/j.iatssr.2023.01.003>.
- Saxena, A., Choudhury, B., 2022. Internalizing the externalities of urban private transport – A case of Gurugram, national capital Region, India. *Case Studies on Transport Policy*. <https://doi.org/10.1016/j.cstp.2022.08.002>.
- Saxena, A., Shrivastava, B., 2021. Developing a hypothetical scenario for assessing the impact of modal shift towards public transport in Delhi. *International Journal of Enhanced Research in Science, Technology & Engineering* 10 (6).
- Saxena, A., Yadav, A., 2022. Examining the Effect of COVID - 19 on rail freight volume and revenue using the ARIMA forecasting model and assessing the resilience of Indian railways during the pandemic. *Innovative Infrastructure Solutions*. <https://doi.org/10.1007/s41062-022-00929-2>.
- Scorrano, M., Danielis, R., 2021. Active mobility in an Italian city: Mode choice determinants and attitudes before and during the Covid-19 emergency. *Res. Transp. Econ.* 86 (February), 101031. <https://doi.org/10.1016/j.retrec.2021.101031>.
- Sen, A.K., Tiwari, G., Upadhyay, V., 2010. Estimating marginal external costs of transport in Delhi. *Transp. Policy* 17 (1), 27–37. <https://doi.org/10.1016/j.tranpol.2009.09.003>.
- Srinivasan, K.K., Pradhan, G.N., Maheswara Naidu, G., 2007. Commute mode choice in a developing country: Role of subjective factors and variations in responsiveness across captive, semicaptive, and choice segments. *Transp. Res. Rec.* 2038, 53–61. <https://doi.org/10.3141/2038-07>.
- Tan, L., Ma, C., 2021. Choice behavior of commuters' rail transit mode during the COVID-19 pandemic based on logistic model. *Journal of Traffic and Transportation Engineering (English Edition)* 8 (2), 186–195. <https://doi.org/10.1016/j.jtte.2020.07.002>.
- Tiwari, G., & Nishant. (2018). *Travel to Work in India: Current Patterns and Future Concerns*.
- Weis, C., Kowald, M., Danalet, A., Schmid, B., Vrtic, M., Axhausen, K.W., Mathys, N., 2021. Surveying and analysing mode and route choices in Switzerland 2010–2015. *Travel Behav. Soc.* 22, 10–21. <https://doi.org/10.1016/j.tbs.2020.08.001>.
- Wong, M., Farooq, B., 2021. ResLogit: A residual neural network logit model for data-driven choice modelling. *Transportation Research Part C: Emerging Technologies* 126 (February), 103050. <https://doi.org/10.1016/j.trc.2021.103050>.
- Wong, J.K.W., Li, H., 2008. Application of the analytic hierarchy process (AHP) in multi-criteria analysis of the selection of intelligent building systems. *Building and Environment* 43 (1), 108–125. <https://doi.org/10.1016/j.buildenv.2006.11.019>.
- Yang, M., Li, D., Wang, W., Zhao, J., Chen, X., 2013. Modeling gender-based differences in mode choice considering time-use pattern: Analysis of bicycle, public transit, and car use in suzhou. China. *Advances in Mechanical Engineering* 5, 706918.
- Yannis, G., Kopsacheili, A., Dragomanovits, A., Petraki, V., 2020. State-of-the-art review on multi-criteria decision-making in the transport sector. *Journal of Traffic and Transportation Engineering (English Edition)* 7 (4), 413–431. <https://doi.org/10.1016/j.jtte.2020.05.005>.
- Saxena, A., & Gupta, V. (2023). Carpooling: Who is closest to adopting it? An investigation into the potential car-poolers among private vehicle users: A case of a developing country, India. *Transport Policy*, 135(September 2022), 11–20. <https://doi.org/10.1016/j.tranpol.2023.03.007>.
- Saxena, A. (2023a). Assessing the factors affecting the perceived crossing speed of pedestrians and investigating the direct and indirect effects of crash risk perception on perceived crossing speed. *Journal of Transport & Health*, 28(November 2022), 101541. <https://doi.org/10.1016/j.jth.2022.101541>.