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Factors influencing the choice of Travel Mode in Inclement Weather Conditions in Indian cities

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Abstract- Indian roads in medium size cities have witnessed large number of two wheeler users in the recent years. It is observed that their volume varies according to the prevailing weather conditions. Although efficient mode selection in inclement weather conditions is an important issue for the convenience of commuters, their socioeconomic condition is a major governing factor for modal shift. The study aims to understand the relationship of socioeconomic status with mode change in inclement weather conditions with respect to work trips of two wheeler users. It also tries to understand the importance of affordability, comfort, trip duration, reliability and maneuverability across different socioeconomic classes.

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Factors influencing the choice of Travel Mode in Inclement Weather Conditions in Indian cities

Parampreet Kaur [α],Uttam Kumar Banerjee [σ] & Abraham George [ρ]

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I. Introduction

Commuting in inclement weather conditions like rain, fog and extremely hot or cold temperature, is difficult for the two wheeler users. It is observed that people switch their mode or their departure time to avoid any potential inconvenience on their way to work. Inclement weather conditions demand better, convenient and economically affordable traveling modes to different socioeconomic classes.

There have been studies done on inclement weather travel behavior but they mainly focus on car, bus and rail transit system and were conducted in western countries (Khattak & Palma, 1997) (Khattak A. , 1991) (Sumalee, Uchida, & William, 2011). India has a large population of two-wheeler users and in some cities it accounts for more than fifty percentage of modal split. In Indian medium size cities, due to poor public transportation and shorter trip length, commuters naturally depend on personal mode; mainly two-wheelers for their daily commute.

It has been observed that the commuter's behavior changes in adverse weather conditions in search of convenient options. A thorough understanding of their character and behavior is essential for the efficient planning and management of transportation systems under such situations. Studies have shown that socioeconomic conditions are dominant factors for mode selection under normal conditions (Williams, 1978). Mode shifts in inclement weather conditions are more profound across different socioeconomic status. In medium size cities like Raipur and Jamshedpur: two wheelers and pedestrians are mostly affected in adverse situations and have large share of the modal split (Authority, 2008) (JJNURM). The prevalent modal shift takes a toll on traffic and transportation networks and they get heavily affected during inclement weather conditions.

Socio-economic status; (SES) which is a combined score of income, occupation and education, is generally considered in medical, marketing and social science studies. It has been observed that higher SES is associated with higher rates of automobile ownership and greater fuel affordability, especially when income is higher (Giles-Corti & Donovan, 2002). A study done in Adelaide, Australia, indicates that higher level of education is related to higher frequency of transport (Cerin, Leslie, & Owen, 2009). Though the use of SES is new to transport related studies, its components i.e. income, education and occupation have established significance in mode selection. Education governs knowledge, attitude and value system of individual and their socioeconomic growth potential. Occupation determines the income generation capacity and social standing of an individual. Income helps to understand their purchase power and socioeconomic status (Parashar, 2009). In this respect, SES holds great potential to understand mode selection patterns across different socio economic classes. For this study kupuswamy's SES scale is taken and correction were made to the base year 2013. This scale divides the population in five major classes, namely; Upper, Upper middle, Lower middle, Upper lower and Lower.

Fourteen variables are found important in mode selection, which are combined to form five factors, namely, Affordability, Comfort, and Trip duration, Reliability and Maneuverability. Criteria for mode selection are given in table 1.

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Table 1: Criteria for Mode Change

Sl. No	Criteria	Variables
1	Affordability	Fare /cost of travel, (Savage, 2010)
		Time value in terms of money (Horowitz)
2	Comfort (W.Recker & Golob, 1976)	Thermal comfort,
		Convenience ,
		Physical comfort,
		Weather proofing
3.	Trip duration	Walking time, (Khattak & Palma, 1997) (Sumalee, Uchida, & William, 2011)
		Waiting time, (Khattak & Palma, 1997) (Sumalee, Uchida, & William, 2011)
		Transfer time, (Khattak & Palma, 1997) (Sumalee, Uchida, & William, 2011)
		In vehicle time (Khattak & Palma, 1997) (Sumalee, Uchida, & William, 2011)
4	Reliability	Availability of mode, (Lam, Shao, & Sumalee, 2008)
		Regularity, (Sumalee, Uchida, & William, 2011)
5.	Maneuverability	Hindrance to travel, (Rodrıguez & Joo, 2004)
		Terrain impact (Rodrıguez & Joo, 2004)

Inclement weather conditions are classified for this study based on classification given by Indian Meteorological Department, which are further combined to form nine inclement weather conditions for moist sub humid climate in this study. Table 2 indicates the nine inclement weather conditions.

Table 2 : Categorization of Inclement Weather Conditions for Survey Design

Sl. No	Weather description in Study	Scientific description
Summer		
1.	Hot day	Whenever, the maximum temperature remains 40°C or more and minimum temperature is 5° C or more above normal, it may be defined as Hot Day, provided it doesn't satisfy the heat wave criteria given below. (Indian metrological department Pune)
2.	Hot-humid	Relative humidity of 60% or greater.
3.	Heat Wave	Heat wave need not be considered till maximum temperature of a
		station reaches at least 40° C for Plains and at least 30° C for Hilly regions. a) When normal maximum temperature of a station is less than or equal to 40° C. Heat Wave Departure from normal is 5° C to 6° station reaches at least 40° C for

		Plains and at least 30° C for Hilly regions. a) When normal maximum temperature of a station is less than or equal to 40° C. Heat Wave Departure from normal is 5° C to 6° C Severe Heat Wave Departure from normal is 7° C or more b) When normal maximum temperature of a station is more than 40° C, Heat Wave Departure from normal is 4° C to 5° C, Severe Heat Wave Departure from normal is 6° C or more c) When actual maximum temperature remains 45°C or more irrespective of normal maximum temperature, heat wave should be declared. (Indian metrological department Pune)
Monsoon		
4.	Light Rain	include light rain, moderate rain i.e. when rainfall is between (2.5 to 35.5 mm per day) (Indian metrological department Pune)
5.	Heavy rain	Heavy rain. i.e. rainfall between 35.6-124.4mm (Indian metrological department Pune)
6.	Very heavy rain	will includes very heavy, extremely heavy and exceptionally heavy rain with precipitation ≥124.5mm or thunderstorm (Indian metrological department Pune)
Winter		
7.	Cold	In the plains of north India, foggy conditions prevail during winter for several days or weeks. The minimum temperature on these days remains above normal, while maximum temperatures remain much below normal. This creates cold conditions for prolonged period. When maximum temperature is less than or equal to 16°C in Plains (Indian metrological department Pune)
8.	Cold wave	Wind chill factor (WCTn) is taken into account while declaring the cold wave situation.Departure of WCTn from normal minimum temperature is from–5°C to–6 C where normal minimum temperature > 10°C and from –4°C to –5°C elsewhere, Cold Wave is declared. For declaring cold wave etc. WCTn only is used and when it is< 10°C only, cold wave is considered. (Indian

		metrological department Pune)
9.	Cold with precipitation	When cold is accompanied by any type of precipitation which further reduces the temperature.
10. Normal Weather Conditions (Prevailing climate of the region)		

This study aims to understand the relationship between SES and use of two-wheelers in various adverse weather conditions. It also tries to verify the impact of five different criteria namely affordability, comfort, trip duration, maneuverability and reliability on mode selection.

II. The Study

a) Obejectives of the study

The main objective of this study is to find relationship between SES and use of two-wheelers; both motorized and non-motorized, in inclement weather condition. Further the study attempts to find the importance of five factors affordability, comfort, trip duration, maneuverability and reliability in mode selection in normal and inclement weather conditions.

b) Case Study Areas

Two medium size cities; Raipur and Jamshedpur with comparable demographic and climate where chosen for the study. Table 3 summarizes the details of both the cities.

Table 3 : Description of Raipur and Jamshedpur (Authority, 2008) (Jjnurm)

	Raipur AU	Jamshedpur AU
Population	1,122,555	1,337,131
Percentage of work force (%) in urban area, state wise	31.11	25.68
Climate	Tropical Wet and Dry Climate	Tropical Wet and Dry Climate
Elevation (m)	298.15	159
Max temperature (o C)	48	49
Min Temperature(o C)	5	1
Precipitation(mm) annually	1300	1200
Percentage of two-wheeler	66	75

c) Main Survey questionaire

A close end Questionnaire was prepared for data collection. Respondent's demographic profile, general transportation information, their perspective in ten different weather situations on five factors namely: affordability, comfort, trip duration, reliability and maneuverability were obtained in five point Likert scale. Rating of all the weather conditions were also done with respect to its importance in decision making. Subjective explanation of each weather condition and variable were explained to the respondent in order to obtain reliable data.

d) Data Collection

In this study, data were collected through primary survey on 1060 people from Raipur and Jamshedpur. Raipur and Jamshedpur cities have population of 1.12 million and 1.33 million respectively (Authority, 2008) (JJNURM). For the population above 1 million, for 95% confidence interval with 5% margin of error, a sample size of 384 is suggested in sample table. With 80 % response rate 480 responses were collected from each city, in three seasons' winter (February, 2013), summer (May,2013) and monsoon (July, 2013). Out of the 480 responses in each city, 430 in Raipur and 444 in Jamshedpur was found valid for analysis.

After conducting surveys at Raipur and Jamshedpur in three different seasons, data were coded and entered in SPSS19 for analysis. Data on income, occupation and education were collected on SES scale at the time of survey and then SES score was computed to distribute the sample in different socioeconomic classes and analyses were performed.

III. Results

a) Kuppuswamy's SES and mode of travel for work trips

After collation of data it was observed that upper lower has highest number of cyclist for work trips. Apart from motorcycle / automated two wheeler, Raipur's Upper middle and lower middle class uses auto rickshaw and bus for commuting whereas, in Jamshedpur auto rickshaw users were from lower middle and upper lower class. Use of motorcycle/ automated two-wheeler were recorded in every class except lower in both the cities, whereas car usage was observed in upper, upper middle and lower middle class. Lower class people who own a bicycle in both the cities depended on it for daily commute.

Table 4 : Kuppuswamy's Ses and Mode of Travel for Work Trips ,Raipur

Mode	Upper	Upper Middle	Lower middle	Upper lower	Lower (Unit)
Cycle	0	5	54	76	8
Automated two Wheeler	37	145	100	23	0
Car	23	36	1	0	0
Auto rickshaw	3	9	9	5	0
Bus	4	13	15	3	0
Cycle Rickshaw	0	0	0	0	0
Walk	0	0	1	0	0

Table 5 : Kuppuswamy's Ses and Mode of Travel for Work Trips, Jamshedpur

Mode	Upper	Upper Middle	Lower middle	Upper lower	Lower
Cycle	0	3	53	97	10
Automated two Wheeler	15	139	126	22	0
Car	8	43	1	0	0
Auto rickshaw	0	1	6	6	0
Bus	0	1	1	2	0
Cycle Rickshaw	0	0	0	0	0
Walk	0	0	0	0	0

b) *Kuppuswamy's SES and Mode Change in Different Weather Conditions*

When survey was conducted it was observed that people change their mode in inclement weather conditions but after the SES categorization and graph plotting it became evident that mode change varies among different SES classes for same inclement weather conditions. From the Table 7 we can observe that upper class people in Raipur are more inclined to change their mode in adverse weather than Jamshedpur. Upper middle class showed similar modal shift pattern in both the cities where as lower middle and upper lower class of Raipur shift modes more frequently than Jamshedpur. In order to find the association of mode change and SES, Chi - Square test of independence was performed on Kuppuswamy's SES and Mode change in nine given inclement weather situations. For this the null hypothesis and research hypothesis were as follows:

H0 = No relationship exists between Kuppuswamy SES and mode change in the given nine different inclement weather conditions from the normal condition.

H1 = Relationship exists between Kuppuswamy SES and mode change in the given Nine different inclement weather conditions from the normal condition.

Table 6 : Relationship Between Kuppuswamy's Ses and Mode Change in Different Inclement Weather Conditions

Inclement weather conditions	Raipur			Jamshedpur		
	Pearson Chi square value	Phi and Cramer's V value	Relationship	Pearson Chi square value	Phi and Cramer's V value	Relationship
Hot	X2 (4,N=430) =2.87, p=.58	.082	No	X2 (4,N=444) =1.71, p=.789	.062	No relation
Hot humid	X2 (4,N=430) =36.57, p<.001	.292	Fair	X2 (4,N=444) =14.69, p=.005	.182	Little
Heat wave	X2 (4,N=430) =51.99, p<.001	.348	Moderate	X2 (4,N=444) =29.52, p<.001	.258	Fair
Light rain	X2 (4,N=430) =52.592, p<.001	.350	Moderate	X2 (4,N=444) =12.14, p=.016	.165	Little
Heavy rain	X2 (4,N=430) =65.364, p<.001	.390	Moderate	X2 (4,N=444) =34.105, p<.001	.277	Fair
Very heavy rain	X2 (4,N=430) =56.294, p<.001	.362	Moderate	X2 (4,N=444) =36.451, p<.001	.287	Fair
Cold	X2 (4,N=430) =2.096,p=.718	.070	No relation	X2 (4,N=444) =.93, p=.92	.046	No relation
Cold wave	X2 (4,N=430) =18.89, p<.001	.210	Little	X2 (4,N=444) =9.259, p=.055	.144	No relation
Cold with precipitation	X2 (4,N=430) =46.059, p<.001	.327	Moderate	X2 (4,N=444) =37.918, p<.001	.292	Fair

Table 6 list the Chi-square value and outcome of the test performed. In some Socio economic studies correlation of 0.26 to 0.50 are considered high when they occur in multiple regression models where one variable is calculated by the use of more than one variable. Cramer's V value indicates the correlation and p value in Pearson Chi square represent the level of significance. It indicates that in all the cases except hot, cold and cold wave in Jamshedpur, there is significant relation of mode change with SES. Considering other external factors like, availability of other options, willingness to change, and combined effect of all the socioeconomic classes in analysis the small value of association is significant. Raipur has higher value of correlation in every weather conditions as compared to Jamshedpur. It has been observed that maximum positive correlation was found in heavy rain situation in Raipur followed by very heavy rain. Further Table 7 Indicates, SES class wise percentage of modal shift in all inclement weather condition. This indicates that modal shift in any weather condition is maximum in upper class followed by upper middle; lower middle and upper lower. It also indicates that people tend to shift their modes more in very heavy and heavy rain situations. Further, they are more likely to shift their mode in Heat wave condition in Raipur and Cold with precipitation condition in Jamshedpur. Mode shift in hot and cold weather is found to be marginal. From the analysis it is evident that Raipur's modal shift is more sensitive to inclement weather as compared to Jamshedpur. From both the tables it can be concluded that Hot and cold weather does not impact the mode choice decision, whereas hot - humid, light rain and cold wave have moderate impact in both the cities. Heat wave, heavy rain, very heavy rain and cold with precipitation have significant impact on the choice of travel mode.

Table 7 : Percentage of Mode Change in Different Inclement Weather Conditions

Inclement weather conditions	Raipur SES Class					Jamshedpur SES Class				
	Upper	Upper middle	Lower middle	Upper lower	Lower	Upper	Upper middle	Lower middle	Upper lower	lower
Hot	2.7	0.7	0.7	0	0	0	0	0.6	0.3	0
Hot humid	37.8	10.8	8.5	3.2	0	20	12.1	4.9	2.6	0
Heat wave	64.9	24.3	18.3	9.5	0	33.3	26.2	11.6	5.3	0
Light rain	43.2	10.1	7.7	2.1	0	26.7	15.6	8.5	6.1	0
Heavy rain	67.6	27.0	14.1	8.4	0	53.3	30.5	12.8	11.4	0
Very heavy rain	73.0	35.8	24.6	11.6	0	53.3	32.6	12.8	12.3	0
Cold	2.7	1.4	1.4	0	0	0	0.7	0.6	0	0
Cold wave	18.9	3.5	1.1	5.5	0	6.7	5.0	0.6	0.9	0
Cold with precipitation	56.8	27.7	18.3	6.3	0	46.7	27.0	10.4	6.1	0

c) *Importance of five factors in mode change across nine inclement weather conditions.*

Table 8 Indicates the Spearman rho correlation between mode change and five factors namely Affordability, Comfort, Trip duration, Reliability, and Maneuverability in nine different inclement weather conditions. Further the graphs from 1 to 10 indicate the weighted value of all the five factors across Kuppuswamy's Socioeconomic Classes.

Table 8 : Spearman Rho Correlation Between Mode Change and Five Factors in Different Inclement Weather Conditions

Inclement weather conditions	Raipur					Jamshedpur				
	Affordability	Comfort	Trip duration	Reliability	Maneuverability	Affordability	Comfort	Trip duration	Reliability	Maneuverability
Hot	-.103	.101	.071	.002	-.047	.038	.087	.008	-.031	-.023
Hot Humid	-.555	.332	.110	.104	-.002	-.268	.164	.034	-.042	-.107
Heat Wave	-.626	.315	.174	.136	.039	-.365	.095	-.004	.080	-.052
Light Rain	-.557	.389	.259	-.059	.094	-.469	.303	.007	-.001	-.013
Heavy Rain	-.625	.445	.102	-.020	.027	-. 429	.218	.003	.042	-.052
Very Heavy Rain	-.588	.430	.155	.140	.025	-.359	.274	-.015	.069	-.024
Cold	-.164	.186	.110	.032	.001	-.130	.096	-.045	-.042	.004
Cold Wave	-.424	.282	.098	-.067	-.047	-.188	.131	-.006	-.002	.012
Cold with Precipitation	-.644	.376	.214	.151	.118	-.376	.189	-.039	.116	.063

Affordability is found to be correlated with a significance level of 0.05 to mode change in all the nine inclement weather conditions in Raipur and eight in Jamshedpur excluding hot days. The negative sign in the values indicates the negative correlation which states that as the importance of affordability decreases, the number of mode change increases. In Raipur affordability has maximum impact in cold with precipitation whereas, in Jamshedpur it's in light rain conditions. Across the different weather conditions

affordability is observed showing significant influence on the choice of mode change in heat waves, heavy rain, very heavy rain, hot humid and cold wave in Raipur whereas in Jamshedpur it has significant impact in light rain ,heavy rain, cold with precipitation and heat wave conditions.

After affordability, Comfort was found to be the second important factor in mode change in both the cities. It has positive correlation which indicates the increase in the value of comfort factor increases the chances of mode change across nine inclement weather conditions. In Raipur correlation was observed at the significance level of 0.05 in all the inclement weather conditions highest in heavy rain condition. Whereas in Jamshedpur, hot and hot humid conditions were excluded from the impact of comfort on choice of mode change, highest been in very heavy rain condition.

Trip duration is the third important factor in mode change in Raipur except in hot day condition, but it was not relevant in Jamshedpur. In Raipur the highest correlation was observed in light rain and cold with precipitation.

Reliability also seemed to be a deciding factor in Raipur and Jamshedpur but it has very less correlation and only statistically significant at 0.05 level of significance in cold with precipitation, very heavy rain, heat wave and hot humid conditions in Raipur and cold with precipitation in Jamshedpur. An increase in importance of reliability increases the chances of mode change.

Maneuverability was not an important factor in both the cities. It only had small significant correlation in cold with precipitation in Raipur and hot humid in Jamshedpur.

d) Importance of five Factors Across Different Socio-Economic Classes in Normal and Nine Inclement Weather Conditions.

To assess the importance of five factors across socio-economic groups, weighted average method of Likert scale was adopted. In this, the five choices within each factor was given weight from 1 to 5, assuming 1 being 'not at all important' to 5 being 'very much important' with equal interval. Then the weighted value for all the factors were calculated by multiplying the frequencies of responses to their assigned weights and then summing all the value in a factor to get a total score. These scores were then compared to get the importance of different factors according to user in different inclement weather conditions. Though the importance solely doesn't lead to mode change, but provides a perspective towards importance of five factors in respective weather condition according to different socioeconomic classes.

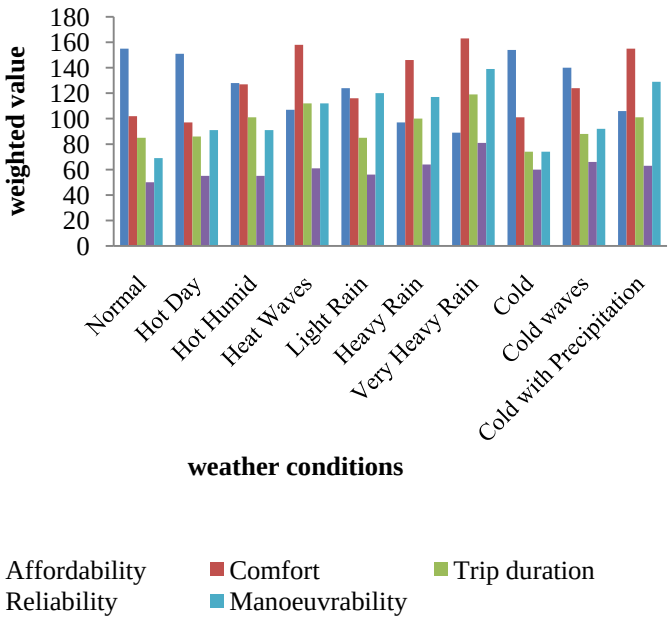

Fig. 1 : Raipur's Upper Class Likert Scale Values of Five Factors in Ten Weather Conditions

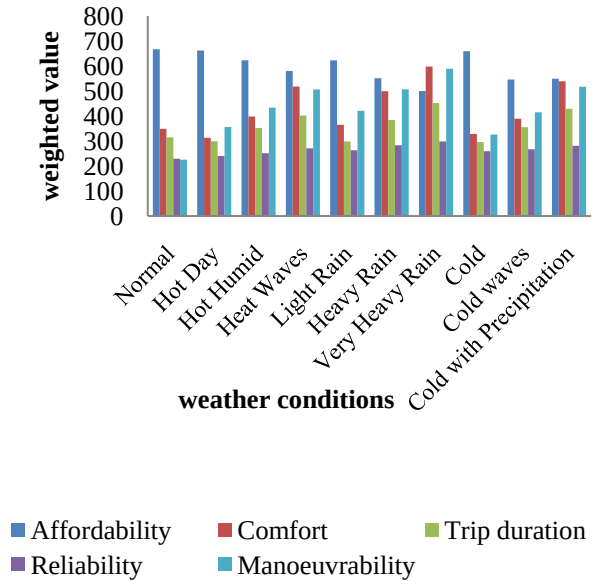

Fig. 2 : Raipur's Upper Middle Class Likert Scale Values of Five Factors in Ten Weather Conditions

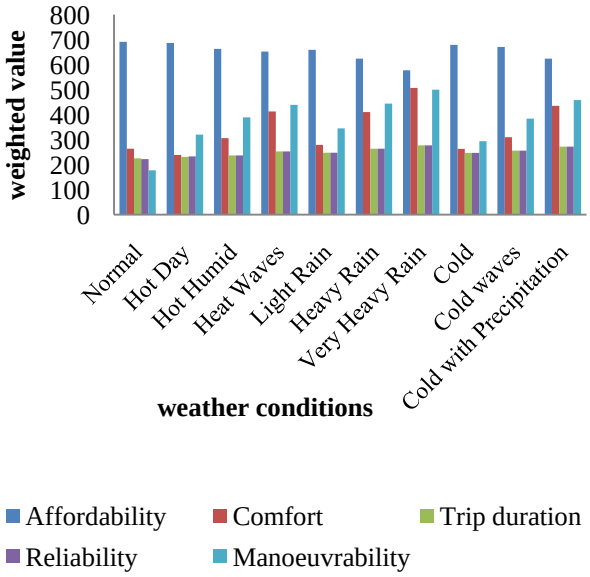

Fig. 3 : Raipur's Lower Middle Class Likert Scale Values of Five Factors in Ten Weather Conditions

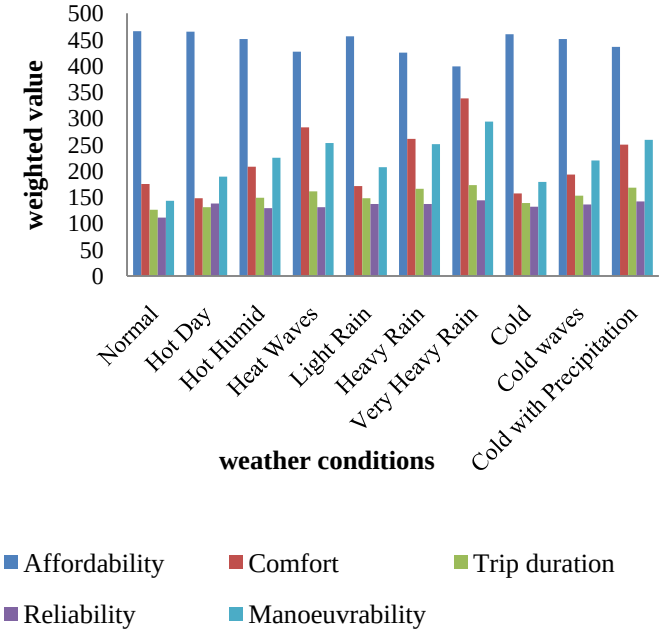

Fig. 4 : Raipur's Upper Lower Class Likert Scale Values of Five Factors in Ten Weather Conditions

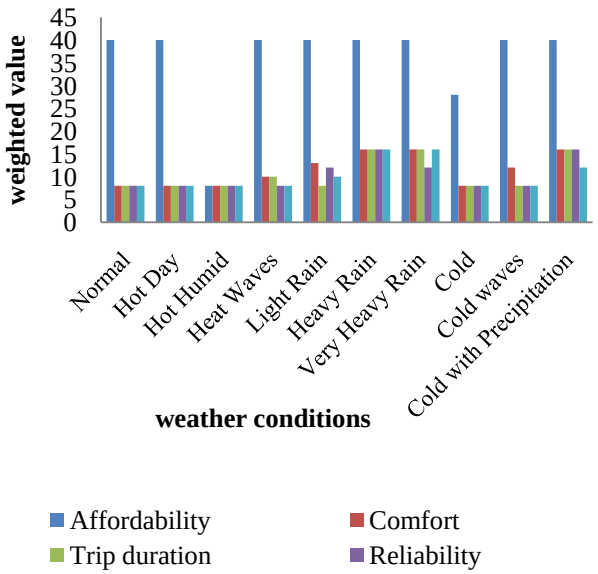

Fig. 5 : Raipur's Lower Class Likert Scale Values of Five Factors in Ten Weather Conditions

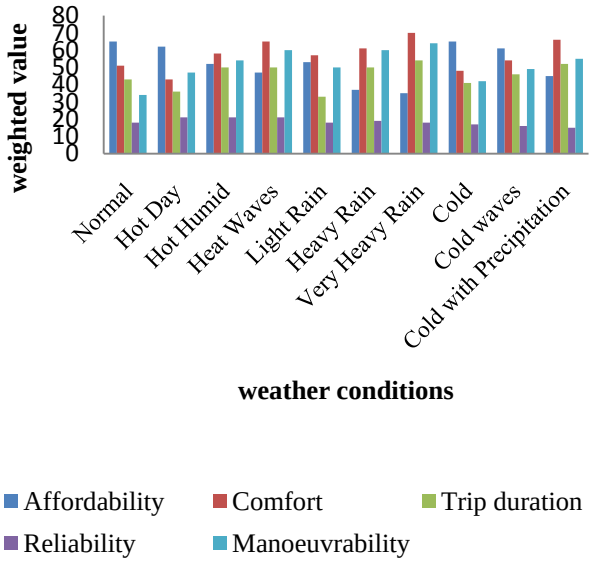

Fig. 6 : Jamshedpur's Upper Class Likert Scale Values of Five Factors in Ten Weather Conditions

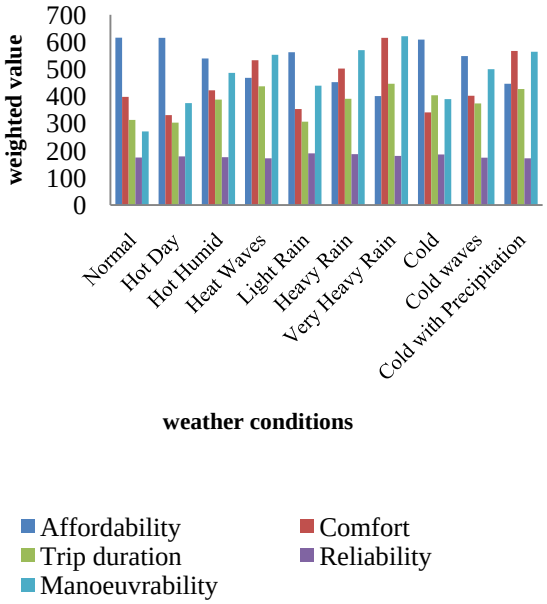

Fig. 7 : Jamshedpur's Upper Middle Class Likert Scale Values of Five Factors in Ten Weather Conditions

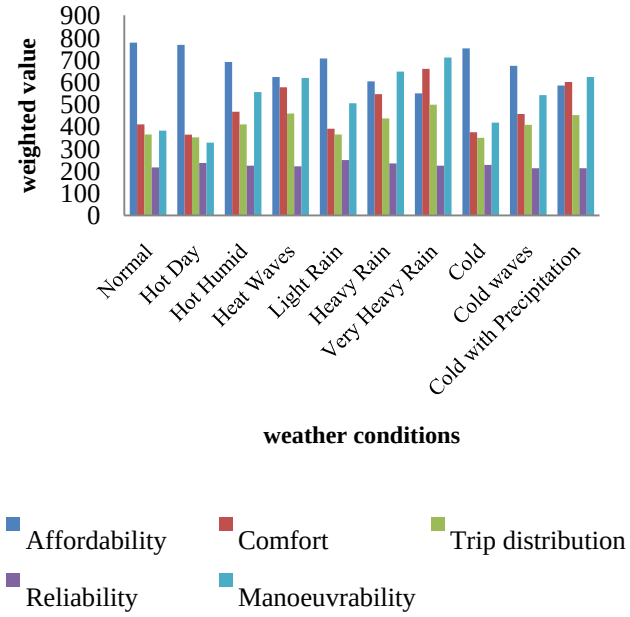

Fig. 8 : Jamshedpur's Lower Middle Class Likert Scale Values of Five Factors in Ten Weather Conditions

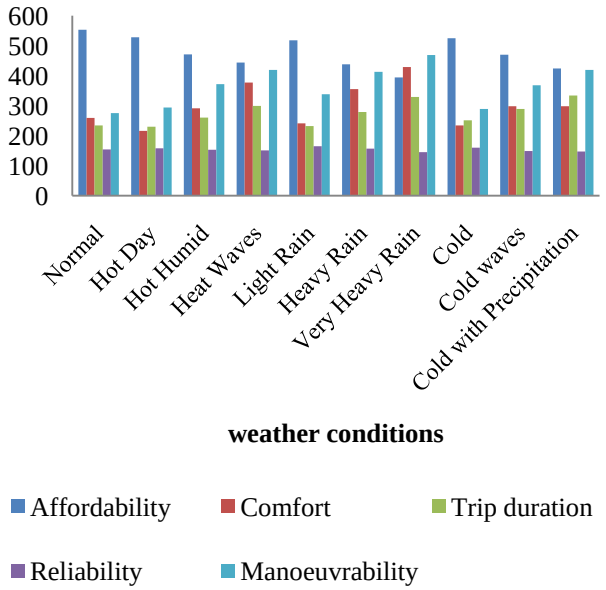

Fig. 9 : Jamshedpur's Upper Lower Class Likert Scale Values of Five Factors in Ten Weather Conditions

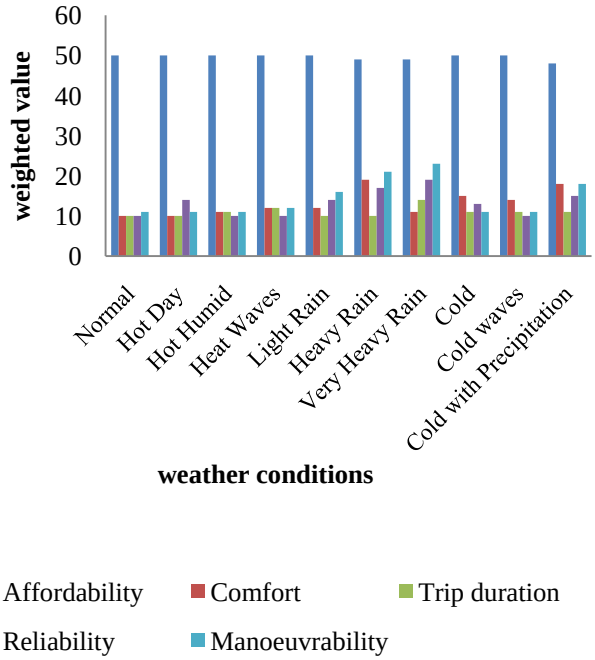

Fig. 10 : Jamshedpur's Lower Class Likert Scale Values of Five Factors in Ten Weather Conditions

It was observed that in normal condition affordability is the most important factor across the socioeconomic classes in both the cities. Comfort stood second in Raipur in all the cases where as maneuverability was seen to be second important concern in Upper lower and Lower classes of Jamshedpur. This may be because, after affordability, it was the second most important concern for these groups as they travel mostly by cycles. Maneuverability was the third important issue of Raipur commuters in Upper, Upper lower, and lower class. Trip duration and then Reliability scored fourth and fifth positions respectively on the scale of importance in Raipur and Jamshedpur in normal weather conditions. In lower class only affordability was most important factor and rest factors were found equally important.

In hot day inclement weather condition, similar trends were observed regarding affordability in both the cities. Comfort was second important factor in Raipur in Upper class, Lower middle and lower class. In Jamshedpur maneuverability was mostly in second position of importance except in lower middle class and lower class where comfort and reliability were second important factor, respectively. Trip duration and reliability stood fourth and fifth, respectively. Lower class in Raipur showed similar preferences like normal conditions, whereas in Jamshedpur affordability was followed by reliability and maneuverability then comfort and trip duration were least important.

In hot humid inclement condition, affordability was again most important factor except in upper class in Jamshedpur where it stood third in the line of importance. Maneuverability was second most important factor except in upper class in Raipur, where it was replaced by comfort which was third important factor in this climate across all the classes. Trip duration and reliability came fourth and fifth, respectively in all classes. Raipur lower class preferred comfort after affordability and then they gave equal importance to trip duration, reliability and maneuverability. In Jamshedpur after affordability comfort, trip duration and maneuverability were found to be equally important and reliability stood last.

In heat wave condition, affordability was perceived to be the most important factor except in upper class in both the cities, where comfort took its place and affordability stood third and fourth in Raipur and Jamshedpur, respectively. In Jamshedpur's upper middle class, maneuverability was most important factor for the commuters, though it was second important factor, across all the classes except in upper middle and lower class in Raipur, where it stood third. Trip duration and reliability came fourth and fifth, respectively.

In light rain conditions, affordability was again the most important factor in all the classes except in upper class in Jamshedpur where it preceded comfort. Maneuverability was second important factor across all the remaining classes in both the cities. In general comfort came third, trip duration fourth and reliability fifth. In lower class comfort was the second most important factor in Raipur followed by reliability, then maneuverability and finally trip duration. Whereas maneuverability is the second important factor after

affordability, and then came reliability, comfort and lastly trip duration.

In heavy rain conditions affordability was still the most important factor in consideration except in upper classes in both the cities. It was also replaced by maneuverability in upper middle and lower middle class in Jamshedpur. Comfort which was the first important factor in upper classes was considered as second important factor in upper lower and lower class in Raipur and upper middle in Jamshedpur, in rest of the classes, maneuverability was voted second important factor. Trip duration was third important factor in upper classes where affordability was fourth important factor. But in rest of the classes, trip duration stood fourth and reliability fifth.

In very heavy rain inclement weather condition again comfort was most important factor across upper class commuters in both the cities, and upper middle class in Raipur in rest of the cases it stood second and affordability was prime factor except in Jamshedpur's upper middle, lower middle and upper lower classes in rest of the cases. Maneuverability stood third, trip duration fourth and reliability fifth.

In cold weather conditions, affordability was the most important factor in user's perspective, followed by comfort in upper class and maneuverability in rest. Trip duration was seen to be the second important factor in case of Jamshedpur's upper middle class. In rest of the classes, trip duration was fourth and reliability stood fifth in importance. In Raipur lower class commuters' perspective only affordability was important and the rest was rated same in the second position. In Jamshedpur, lower class commuter rated comfort as the second important factor after affordability, then reliability, and finally trip duration and maneuverability shared the least importance.

In cold wave condition across all the socioeconomic classes in both the cities, affordability was considered the most important factor followed by comfort in upper class and lower class in both the cities. Maneuverability was the second most important factor in rest of the classes. Trip duration came fourth and reliability, fifth on the importance scale.

In cold with precipitation inclement weather conditions, comfort was the priority factor in upper class in both the cities and in upper middle class of Jamshedpur in rest of cases affordability was still the major factor for consideration, except in lower middle class were maneuverability was a pressing issue. Trip duration came fourth and reliability, fifth on the importance scale.

IV. Conclusion and Inferences

After a thorough analysis it is found that affordability is the most important factor in both the cities except in few conditions like heat wave, rain and cold with precipitation, comfort is the most important factor for upper class. Decrease in the importance of affordability resulted in increase in choice of mode change. It is the key factor in lower class, which prevented any mode change.

Comfort is the second important factor perceived by the commuters, it is found to be slightly more important in Raipur than Jamshedpur. Importance of comfort in choice of mode however decreased down the socio economic groups.

While trip duration seems statistically significant, its impact on mode change is less. This can be contributed to the fact that both the cities are medium size cities with average work trip length in terms of time; 19 minutes and 30 seconds in Raipur and 19 minutes in Jamshedpur. Short delay has considerably less important than other factors.

For this study, private two wheelers are considered, Reliability is statistically significant in some case but not of much importance in users' perspective, because private two wheelers are the prime mode and its predictability and regularity are not issues in most of the cases.

Maneuverability though seemed important in users' perspective is not statistically significant in inclement weather except cold and precipitation in Raipur and hot humid climate in Jamshedpur. This may be due to the fact that two wheelers are easy to manure in heavy traffic and the case study areas are plain sites, with respect to terrain. Though the above criteria are important for good trip, these do not impact choice of mode of travel in these cities.

It is also noted that hot day is treated as normal day in both the cities with minimal changes. Even cold day in Jamshedpur had similar impact as hot day and normal day. Heavy rain has seen to exercise highest influence on the choice of mode change followed by very heavy rain, may be because of the reason that people tend to change other travel decisions like time of travel in extreme weather condition rather than mode. Light rain and cold with precipitation were also important in Raipur. Highest correlation of SES with mode change was observed cold with precipitation conditions in Jamshedpur, followed by very heavy rain, heavy rain and heat waves.

This research consolidates the understanding regarding the factors influencing the choice of mode in transport across different socio-economic groups in inclement weather conditions in medium sized Indian cities. These results after further research can be utilized for forecasting two-wheeler transportation in inclement weather conditions for proper management of traffic.

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