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Mode Choice Modeling for Intercity Travel in Nepal

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Abstract

Economic growth in developing countries generates high transportation demand that needs to be forecasted cautiously. Such demand forecasts are subjected to uncertainties in developing countries. The needs and preferences of users should be studied and demand needs to be tackled strategically to achieve required goals of sustainable and efficient transportation network. Transportation infrastructures are cost intensive in nature. Such infrastructures need to be assessed carefully from technical and economic perspectives since the nature of benefits produced cannot always be monetized directly. The direct time saving to users of transport facility constitute a significant portion of benefits of investment and need to be cautiously assessed. Value of travel time, the monetary value that users place on their time spent travelling from origin to destination, used in appraisal of transportation projects in Nepal is being under-valued and hence has significant effect on appraisal process. Disaggregate mode Choice modeling determines the share of each available mode used by trip makers and also provide estimate of value of travel time. This research uses multinomial logit model for study of mode choice behavior of intercity travellers in Nepal. RP-SP approach is used in data collection to understand the mode choice behavior and shift in mode choice when railway is offered as a new alternative for intercity travel.

Keywords

Intercity Trips, Mode choice, Logit model, Value of travel time

1. Introduction

Demand analysis is one of the most important tasks in transportation planning. In developing countries, public budgetary allocation for capital investment is very low because of demand from many competing sectors. More over the budgetary allocation for transportation sector is even lower. The capital budget of Government of Nepal is about 25% of total budget and share of transportation sector is about 30 % of capital budget. Although the percentage figures seem to be fine, the amount is not enough to convert the vicious cycle into virtuous cycle leading to accelerate growth and economic development. The available budgetary allocations should, therefore, be used for most rightful infrastructures, that have enough demand to generate revenue as well as wider economic benefits. Being capital intensive, under utilization of transportation infrastructures can be a serious wastage of public funding. Hence, estimation of expected travel demand at some future date should be done cautiously.

Economic growth in developing countries generates intercity travel demand in form of increased number of trips or increased trip distance but the infrastructure provisions are not adequate to meet the expected demand levels. The framework of intercity transport is responsible for shaping the spatial structure of a region and eliminating regional imbalance [1]. There are certain differences regarding the approach of handling intercity and urban transportation.

Transportation policy of Nepal adopts a multimodal transportation framework. To capture the benefits of such framework, there must be proper planning to achieve integration of transportation modes. In contrast, multimodal transportation in urban areas where coordination among different modes is required, there is competition among different modes in intercity transport [1]. The interplay of market phenomenon in intercity transport motivates private sector involvement in providing services. If the policy and infrastructures are not in alignment with users' needs and preferences, one or the other mode can face serious sustainability issues and finally break down resulting in wastage and loss of investment.

The mode choice decision of users depends upon system attributes like comfort, reliability, safety; trip characteristics like purpose of trip, time of trip; and user attributes like vehicle ownership, income, age etc. The needs and preferences of users are subject to change with change in any of above mentioned attributes. Discrete mode choice models provide a theoretical framework for analysis of mode choice [2]. The specification and estimation of these models is done based on revealed-preference or stated-preference data.

The model is developed based on revealed preference and stated preference data. Revealed preference data is the outcome of choice made in actual situations while stated preference data results from the choices made in hypothetical situations. Stated preference surveys offer different hypothetical alternatives with same attributes at different level than that of actual alternative and some different attributes as well [3]. Some limitations like insufficient variability in construction of models, difficulty in collecting responses for new alternatives and major dominance of some factors in observed choice, make stated preference methods superior to revealed preference methods [2].

2. Literature Review

Intercity transportation problems may not be visible in short term but in long run these can cause serious damages in structural level. With increasing income and population, the demand for intercity travel grows at rapid rate[4]. The trend of infrastructure development in Nepal cannot support such flow in any way. Some studies have been carried out regarding intercity trips in developed world but the results are not transferable due to differences in socio-economy, infrastructure facilities and travellers' attitude. Hence, it is important to study mode choice behavior for intercity travel in Nepal.

(Morichi and Acharya 2011) has developed a strong argument concerning intercity transportation issues in developing Asian countries, for achieving balanced modal share for intercity transport appropriate policy intervention should be done before the problems affect structural level. The paper hypothesizes two future scenarios for developing countries. The first one relates " incremental response" to transportation demand leading to high mode share of auto and air mode. The second scenario relates " strategic response" to achieve balanced modal share among auto, bus, train, and plane each serving respective market niche[1]. The paper is relevant to situation of Nepal but study based on primary data is a must before drawing conclusions specific to mode choice scenario in Nepal.

An aggregate demand model was developed for intercity trips by public transport modes in Sri Lanka and generalized for use in other developing countries as well. The study has placed an argument that extensive data requirement for dis-aggregate modeling limit its application in developing countries[5]. Although the model can be used well where aggregate data are available, such models are insensitive to system attributes and hence cannot furnish sufficient information for policy formulation.

Aggregate mode choice modeling focuses on study of travel behavior based on data with certain level of aggregation. The geographical area under study is divided into a number of zones and the trips are assumed to have origin and destination at zonal centroids. Oi and Shuldiner(1962), Fleet and Robertson(1968), McCarthy(1969) have analyzed trip behavior using aggregate models and pointed a number of limitations on such models[6].

In case of discrete goods, the consumption occurs at extensive margin i.e. an individual cannot consume little less or more of a discrete good rather shifts his choice of good under changing "economic environment"[7]. Hence application of disaggregate modeling techniques is required in studying mode choice scenario. Disaggregate mode choice modeling is based on principle of maximization of utility. Utility is an abstract concept but provides strong basis for discrete choice analysis. Utility is a parameterized linear function of system attributes, user attributes and trip characteristics. Any individual choose an alternative from mutually exclusive and exhaustive set of alternatives only if the utility of that option is maximum for him[2].

Binary choice models were applied in transportation by Warner, Lave for study of value of time and market share prediction of different modes. Research on discrete choice in 1970's was mainly concerned with mode choice scenario involving more than two alternatives and other trip activities like destination choice, residential location, car ownership [6]. Major revolution in study of discrete goods was brought by

McFadden(1974) when he applied disaggregate choice model for measurement of urban travel demand for commuter trips before and after Bay Area Rapid Transit[8].

A number of research works have been done concerning the theoretical and empirical values of travel time. “A theory of allocation of time” by Gary S. Becker (1965) is one of the pioneering works on valuation of time. Lave (1969) computed one of the early results on value of travel time for commuter travellers to be 42% of wage rate based on ratio of standardized regression coefficients time variable and cost variable[9]. Later studies also estimated value of travel time for commuter trips around 50% of gross wage rate with significant variations with trip purpose[10]. The values of travel time estimated from multinomial logit model were found to be less than those obtained from less restrictive choice model like mixed logit model[11]. Hanssen studied the impact of interview location on value of travel time saving and found significantly higher in-vehicle VTTS for those interviewed during trip and relatively lower value for those interviewed at home[12].

Significant research has been done on mode choice behavior of urban transport but research on intercity transportation is scarce. Research focusing travel behavior in developed countries is not applicable to conditions of a developing country. This study, first of its kind in Nepal, carries a great academic and practical value.

3. Study Area and Sample Size

Nepal is geographically located in South Asian Region between two economic giants- China and India. Its area is $1,47,181 Sq.Km$ and population is $26,494,504$ as per census of 2011. Geographically, Nepal is subdivided into 3 regions viz. Terai, Hilly and Mountainous. Terai region has relatively good accessibility to transportation services. Major mode of transportation is road with strategic road network of 13060 Km(DOR: SSRN) and local roads totaling length of 57632 Km[13]. Apart from road, major cities and places of touristic importance are provided with air transport.

The major portion of intercity trips has Kathmandu- the capital city- as origin or destination. The study area consists of cities in Nepal having road and air connectivity with Kathmandu. The major cities in Terai region, Kathmandu and Pokhara from Hilly region are taken for the study. Data is collected from Gongabu Bus Park, domestic terminal of Tribhuvan International Airport and Kalanki- the exit point from Kathmandu for cities under consideration.

Sampling strategy of the study is choice based sampling. This strategy is in fact stratified sampling with stratification in choice itself. Respondents are selected randomly for interview after they have chosen a particular mode- bus, car or plane. Although bus mode itself consists of a number of options like micro bus,tourist bus, these has been consolidated within a single category due to time and resource constraints in collecting data separately for each category. This method is useful under time, resource constraints and when a subgroup of choice cannot be easily approached under random sampling.

Green (1991) has suggested a rule of thumb for determining minimum sample size for multiple correlations is $50+8m$ where, m is number of factors[14]. For the model to be developed in the study, 20 factors are taken at maximum. Hence minimum sample size is 210. A total of 604 questionnaire are collected and 27 of them indicating choice of motorcycle for intercity travel are rejected. Remaining 577 questionnaire are split into training data with 464 samples and validating data set with 113 samples split using random number generation algorithms.

4. Data Collection

Questionnaires were distributed to intercity travellers to collect information on their current trip. Different questionnaires were made for air mode users and land mode users. The questionnaire mainly differed in travel cost and travel time options of railway mode in stated preference choices. In addition to current trip attributes and user attributes, respondents of survey were asked about their choice of mode for exactly same trip conditions if a railway with given travel time, travel cost and higher reliability were available. Four combinations of railways were made with two level of variation in travel cost and travel time each. The levels of travel time are computed assuming an average operating speed of 60 Kmph and 120 Kmph of conventional railway systems presently in use in Indian region. Levels of cost are determined based on comparative study of railway tickets and air tickets for intercity travel in India. The cost of AC Class-3 tickets in Indian railways are found to vary between

20% and 60% of air ticket. Two levels of travel cost of railway i.e. 30% and 50% of air travel cost in Nepal, are then taken for the study excluding 10% extreme values. Origin and destination pair of trip is selected such that distance is at least 100 km, to keep consistency with standard classification of medium and long route trips in Nepal[15].

5. Data Analysis

Analysis of primary data is done using Multinomial logit model using VGAM package in R statistical software. A number of models with varying specifications will be developed and the one producing best output will be adopted for interpretation of results.

Multinomial Logit Model Formulation

Random utility theory is the theoretical foundation of these models. Indirect utility function depends upon the prices, income and preferences. Utility of any mode is expressed as:

$$U_{iq} = V_{jq} + \varepsilon_{jq}$$

Where,$V_{jq} = \sum_k \theta_{kj} x_{jqk}$ is systematic part of the utility function and ε_{jq} is random part. θ are constant for individuals and vary across alternatives for homogenous market segment. The probability that an individual chooses a mode i equals the probability that the conditional indirect utility of mode i is largest of conditional utility of all other modes.

$$\begin{aligned} P_i &= Pr(V_{iq} + \varepsilon_{iq} \geq V_{jq} + \varepsilon_{jq}) \\ &\quad Where\ i, j = 1, 2, 3, \ldots J, i \neq j \\ &= Pr(\varepsilon_{jq} - \varepsilon_{iq} \leq V_{iq} - V_{jq}) \end{aligned}$$

The difference in error terms is assumed to be independent and identically distributed (IID) Gumbel in case of Multinominal Logit Model (MNL)[2].The probability of choice of any alternative is given by:

$$P_{iq} = \frac{e^{V_{iq}}}{\sum_{A_j} e^{V_{jq}}}$$

Log-likelihood function for simple random sample is not usually applicable for choice based sample but in a condition that the model to be estimated is multinomial with $(J-1)$ alternative specific intercept terms, where J being exhaustive list of alternatives, log-likelihood estimates are consistent for all parameters except for intercept term. The intercept term is modified by subtracting *log* of ratio of sample fraction to population fraction of choice[16]. This modification balances the over sampling and under sampling effects of different alternatives and the modification itself is maximum likelihood estimate[17]. Hence available estimation procedures of multinomial logit model can be applied without any modifications.

It is assumed that the marginal effect on indirect utility of a traveller due to change in travel time or cost of a mode is same for all modes. So, travel time and cost enter the model as generic variables and all other variables enter the model as alternative specific variables[7]. Travel time variable is facing separation effects during model estimation. For a binary response variable Y_i, if a hyper-plane exists in space of covariates such that sample points with $Y_i = 0$ lie in one side of the plane and $Y_i = 1$ on the other[18]. "safeBinaryRegression" package was used to detect the existence of separation of data and hence binary logit model for public transport modes could not be estimated at this point.

Estimation Results from Revealed Preference Data

A number of continuous and categorical variables are used for analysis of multinomial logit model.

Table 1: Description of Variables

Variable	Description
Choices	Bus, Car, Motorcycle, Plane
Purpose	Work, Recreational, Social
Family	Yes, No (If Travel with family)
Child_5	Yes, No (if child$\leq$5yrs in trip)
Travel_Cost	Continuous
Cost_Bearer	Self, Office
Travel_Time	Continuous(in-vehicle)
Frequency	Continuous
Reliability	Low, Medium, High
Age	Continuous
Gender	Male, Female
Marital Status	Married, Unmarried
Family Size	Continuous
No_Income	Continuous
Veh_Ownership	Yes, No
Employment	Business, Service, Unemployed
Income	$\leq$45000, $\geq$45000(Monthly Rs.)
TT_Total	Total Travel Time

Automobile Travel: Automobile trips for intercity travel are highly dependent on vehicle ownership. The log odds of choosing car relative to bus for intercity trip all else constant is 2.4176 times higher when an individual has private car but the utility of car relative to bus is reduced by a factor of 2.6509 at 5% significance level when the trip is being made for work. -1.9569 coefficient estimate for social trips in table 2 shows that users prefer bus to automobile when they are on a social trip. The log-odds of choosing car relative to bus are negative for Low to medium reliability, higher frequency and self-paid cost of trip indicating lower utility of car relative to bus in such circumstances. The utility of choosing car decreases by a factor of 0.0093 relative to bus with a unit increase in trip distance. Travel cost variable has a positive coefficient estimate indicating higher utility of car relative to bus for unit increase in travel cost. The results obtained with this variable are counter-intuitive and indicative of the limitation that no variable has been used in the model to capture comfort, safety , privacy and social prestige on using automobile and air modes for travel. The utility of any mode is found to decrease with increase in travel time as indicated by negative coefficient estimate of travel time variable. User attributes like age, gender, marital status and number of employed persons in family are found to be statistically insignificant in determining choice for mode. If a family is travelling together, car mode is seen to have 1.97 times higher utility relative to bus, with 5% significance level. Table 2 shows lower utility of car travel relative to bus for larger family size. This can be due to lower disposable income of such households available for consumption of transportation services. People employed in service sector are found to have higher log-odds, 2.875 times,of choosing auto mode for intercity travel. This can be due to the fact that such people usually make intercity travel in automobile provided by the employer. Table 4 presents another model based on RP data but with fewer variables for simplicity yet better fit with the data. This indicates the over-fitting of model in table2. This is supported by higher accuracy of second model with 95.6% accurate predictions in validating data set compared to 88.5% accuracy of first model. The results of confusion matrix are presented in table3 and table 5.

Air Travel: The estimation results, although not significant, indicate that the utility of plane relative to bus is reduced with increase in distance. The result is counter intuitive but this must be due to regional effect. The farther areas from Kathmandu like far-western and Karnali Province has considerably lower socio-economic profile and low flight frequency relative to central and western region. The tendency of users using night bus services for long distance travel must have been depicted in the model. Cost bearer is a significant parameter with coefficient estimate of -3.92 at less than 1% significance level for log odds of choosing plane relative to bus. We fail to reject the null hypothesis that the coefficient estimates are not different from zero for purpose of trip, vehicle ownership and family travel implying that these factors do not have significant effect on choice of plane relative to bus. Rejection of null hypothesis for low and medium reliability with negative coefficient estimate suggests that people prefer bus relative to plane when travel time reliability of air mode decreases. The log-odds of choosing air mode relative to bus are found to increase when an individual is employed in service sector. Air mode is found to have less utility relative to bus in case of frequent intercity trips and self paid fare of travel as seen from models in table 4.

Modal Preferences : The constant term for car and plane with bus as reference category indicate that there is very high preference for plane and car, all else constant as seen from model in table 4. The relative preference of car and plane over bus is probably due to higher comfort, safety and perceived social prestige in using such modes.

Value of Travel Time: The value of travel time, calculated as the ratio of coefficients of travel time and travel cost, is found to be RS 97 per hour from table 2. The obtained values are significantly greater than minimum wage rate, Rs 56 obtained from minimum monthly wage rate fixed by Government of Nepal. The obtained values support initial hypothesis that the value of travel time saving, used for transport project appraisal in Nepal, is much below value that people actually place on their saving of travel time. Estimates from table 4 show that value of travel time for lower income group of people in case of car and air travel is higher than that of higher income group people. This counter intuitive result is probably due to the fact that individuals with lower income travel by such modes, mostly in case of urgency while individuals with higher income use car and air mode for regular travel as well.

Table 2: Model:1 from RP Data

Variable	Coefficient	Z Value
Generic Variable		
TT_Total	**-0.5301**(0.151)	-3.509****
Travel_Cost	**0.0055**(0.001)	4.337****
Coefficient:Car		
(Intercept)	**6.2437**(2.533)	2.465**
Distance	**-0.0093**(0.004)	-2.179**
Cost_Self	**-5.412**(1.284)	-4.214****
Frequency	**-0.406**(0.167)	-2.43**
ReliabilityL	**-4.0619**(1.53)	-2.655***
ReliabilityM	**-2.4683**(0.792)	-3.115***
PurposeSocial	**-1.9569**(0.973)	-2.012**
PurposeWork	**-2.6509**(1.177)	-2.252**
Veh_OwnYes	**2.4176**(0.774)	3.125***
Family_Size	**-0.6115**(0.284)	-2.15**
FamilyYes	**1.9718**(0.98)	2.013**
Emp_Service	**2.875**(0.959)	2.997***
Emp_Unemployed	**-0.5266**(1.774)	-0.297
Coefficients:Plane		
(Intercept)	**3.6707**(2.42)	1.517
Distance	**-0.0028**(0.004)	-0.666
Cost_Self	**-3.9257**(1.199)	-3.274***
Frequency	**-0.2228**(0.16)	-1.391
ReliabilityL	**-2.2858**(1.435)	-1.593
ReliabilityM	**-1.2975**(0.761)	-1.705*
PurposeSocial	**-1.4172**(0.98)	-1.447
PurposeWork	**-1.6885**(1.102)	-1.533
Veh_OwnYes	**0.3858**(0.776)	0.497
Family_Size	**-0.4936**(0.272)	-1.818*
FamilyYes	**0.6909**(0.977)	0.707
Emp_Service	**1.7479**(0.995)	1.757*
Emp_Unemployed	**0.1594**(1.582)	0.101
Value of Time = NRs 97 per Hour		
Log-Likelihood = -107.60		
$PseudoR^2 = 0.74$ and $AIC = 271$		

Table 3: Goodness of fit for Model-1

Predictions ⇒			
Observations⇓	Bus	Car	Plane
Bus	66	2	0
Car	2	3	6
Plane	0	3	31
Accuracy of Model = 88.5%			

Table 4: Model:2 from RP Data

Variable	Coefficient	Z Value
Generic Variable		
Travel_Cost	**0.0045** (0.001)	4.69****
Coefficient:Car		
(Intercept)	**2.918** (1.732)	1.86*
Cost_Self	**-2.2519** (0.73)	-3.09***
Frequency	**-0.4779** (0.172)	-2.78***
Veh_OwnYes	**2.3469** (0.592)	3.96****
Family_Size	**-0.54** (0.239)	-2.26**
Coefficient:Plane		
Intercept	**14.9264** (3.609)	4.64****
Cost_Self	**-3.7222** (1.356)	-2.74***
Frequency	**-0.3947** (0.232)	-1.7*
Veh_OwnYes	**1.4909** (0.948)	1.57
Family_Size	**-0.5948** (0.312)	-1.91*
$Income \leq Nrs45,000$		
TT_Car	**-1.2183** (0.367)	-3.32****
TT_Plane	**-3.2376** (0.592)	-5.47****
VOT_Car = Rs 270 and VOT_Plane = 719 Rs		
$Income \geq NRs45,000$		
TT_Car	**-0.5564** (0.12)	-4.64****
TT_Plane	**-3.2319** (0.533)	-6.07****
VOT_Car = Rs 123 and VOT_Plane = Rs 718		
Log-Likelihood = -71.53		
$PseudoR^2 = 0.72$ and $AIC = 173$		

Table 5: Goodness of fit for Model-2

Predictions ⇒			
Observations⇓	Bus	Car	Plane
Bus	67	1	0
Car	2	9	0
Plane	0	2	32
Accuracy of Model = 95.60%			

Estimation Results from Stated Preference Data:

This section presents model with currently available choices along with Rail, a hypothetical alternative presented to the respondents. Model is developed only for rail alternative which has travel time half of bus/car travellers and double for air travellers and travel cost one and half times higher than that of bus, same as that of car and one-third of air travel cost. Access and egress time are same as in current of trip and reliability of railway is set to be high. Figure 1 presents modal share based on stated choice of respondents in different scenario of railway presented to them. Multinomial logit model was developed taking all the attributes as in revealed preference model but only travel time, travel cost and distance and Income were found to be significant. The reference category for model estimation is bus.

Travel time variable has negative coefficient estimate for log-odds of choosing car, plane or rail mode relative to bus. This result is intuitive as the increase in time results in higher dis-utility. Coefficient estimates for Distance are positive for air and rail mode and negative for auto mode indicating higher utility of plane and railway relative to bus for longer trips. Households with higher income are found to have higher preference of auto relative to bus. The positive value of intercept term for rail mode indicates the highest preference for railway for intercity trips other things being constant as seen in table 6. Since the purpose is only to make qualitative explaination of choice behavior for lower and higher speed modes rather than drawing quantative conclusions,the possible biasness in results has been ignored in the study.

Figure 1 presents the share of bus, car, plane and rail in different scenarios presented to the respondents of the survey. The scenarios are associated with travel time and travel cost of rail. Scenario-1 and Scenario-4 represent railway with higher operating speed (120Kmph)and travel cost *half* and *one − third* than that of plane respectively. Similarly Scenario-2 and Scenario-3 represent railway with lower operating speed(60Kmph)and travel cost *one − third* and *half* of bus travel cost respectively. The users do not seem to be sensitive to cost of trip as seen from near similar share of railway for scenario with completely contrasting fare levels. Travel time seem to be very significant factor on determining mode choice as high mode share is seen on faster railway options irrespective of cost of trip. Huge difference is observed in mode share of faster and slower railways. Figure 2 presents mode shift from bus, car and plane to railway in hypothetical scenarios discussed above. The mode shift is significantly and consistently higher for Bus and plane modes than that for car users. This can be an indicative of locked- in effect where users are accustomed to comfort, privacy and flexibility of car in such a way that they cannot shift their choice easily to other modes [1].

Policy Implications

Nepal has envisioned multi-modal transportation model for providing transport needs. This needs integration of different modes to achieve balanced modal share. This study provides an idea on needs and behavior of travellers. This study also provides important indication towards increasing preference of travellers for air travel and auto travel. Although these modes have higher attraction factors for an individual, the overall transportation network steps towards inefficiency in terms of transport cost, safety, emissions and space requirement. Hence, suitable policy can be framed to orient the travel behavior in right direction so that ultimately goal of safe, sustainable and efficient transport network is achieved.

Table 6: Model from SP Data with Rail Alternative

Variable	Coefficient	Z Value
Coefficient:Car		
(Intercept)	**-4.65** (0.889)	-5.23****
Travel_Cost	**0.0063** (0.001)	8.74****
Travel_Time	**-0.2865** (0.094)	-3.04***
Distance	**-0.0102** (0.002)	-4.15****
Income_H	**2.571** (0.806)	3.19***
Coefficient:Plane		
(Intercept)	**-3.047** (2.81)	-1.08
Travel_Cost	**0.0101** (0.001)	9.16****
Travel_Time	**-10.75** (1.981)	-5.43****
Distance	**0.0301** (0.006)	4.9****
Income_H	**0.0485** (1.782)	0.03
Coefficient:Rail		
(Intercept)	**1.819** (0.572)	3.18***
Travel_Cost	**0.0064** (0.001)	8.95****
Trave_Time	**-2.417** (0.218)	-11.08****
Distance	**0.0203** (0.003)	6.01****
Income_H	**0.0023** (0.454	0.01
Log-Likelihood = -195.5		
$PseudoR^2 = 0.84$ and $AIC = 421$		

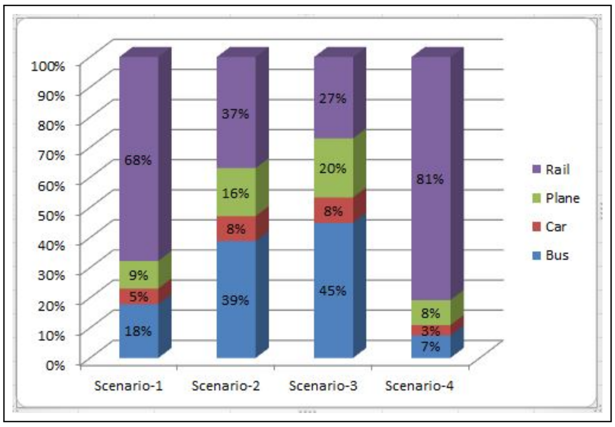

Figure 1: Share of Rail in Different Scenario

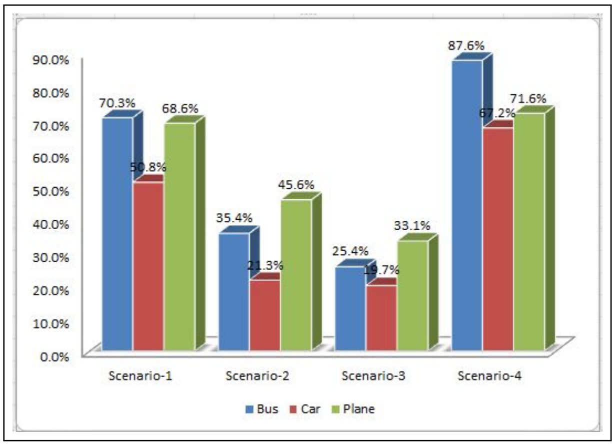

Figure 2: Mode shift to Rail mode in Different Scenario

6. Conclusions

Growing shape of economy places greater demand in transportation. Infrastructure development pattern at present cannot support such huge demand so strategic planning is required for proper form of transport. Mode choice modeling of Inter-city travel provides basic input for demand forecasting and helps understanding the evolving pattern of mode choice with changing scenario of economic development. Results from preliminary analysis of stated preference data suggest that there can be a huge shift in mode choice if a reliable and faster transport mode like railway is introduced. The results from model also suggest that people place more importance on travel time than travel cost. Car ownership is found to increases preference of car trips over public conveyance modes. This can result in inefficient transportation system with low ridership of public modes in longer time frame. Hence suitable policy should be made to orient travel behavior in desired direction.

7. Limitations

The study is carried out within a small time frame with resource constraints. Hence limitation exists in size of sample and design of questionnaire. Similarly, advanced discrete choice models like mixed logit, nested logit can be applied for higher degree of accuracy in model predictability in further studies.

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