

AN APPROACH FOR MODELLING TRAVEL DECISION ECONOMICS FOR RURAL AREAS OF DEVELOPING COUNTRIES

Mir Shabbar Ali, Muhammad Adnan*

Dept. of Civil Eng., NED Univ. of Eng. and Technology, Karachi 75270, Pakistan
mshabbar@neduet.edu.pk, adnanres@neduet.edu.pk

Abstract

The transportation planning process incorporates representative travel demand models for making comprehensive travel forecast. Travel demand models incorporating individual level travel decisions are vital for developing countries in conceiving projects aimed at improving accessibility, land use planning, work schedules and transit use. The aim of this paper is to put forward an approach for modelling rural travel behaviour which may be useful in poverty alleviation programs by providing individual oriented planning tools to policy makers and transport planners. Development of conceptual framework is based on detailed analysis of household data, collected from rural areas of Pakistan, in the context of household economics and accessibility conditions. The concept of need threshold is introduced, as a major shift in incorporating travel decision based on different types of household needs, household economics and changes in household needs with time. It has been observed that household economics and accessibility concepts provide a behavioural basis to explain differences in individual responses with reference to their physical environment, affordable price, income and preference. Integration of household economics, role allocation and accessibility within a same framework results in a behavioural approach, which is people oriented and provides a major shift from classical zonal based approach.

Keywords: Household economics; Accessibility; Household role allocation; Need threshold; Rural travel demand modelling; Developing countries

Topic Area: D1 Passenger Transport Demand Modeling

1. Introduction

Adequate transportation planning policies and strategies play major role in alleviating poverty from the rural areas of developing countries. The main problem that results in poverty among the residents of rural areas is their deprivation in the fulfilment of basic needs, which has strong connection with the transportation system (Howe 1997). Over 70% of the population of developing countries lives in rural areas. It is pre-requisite for the development of these rural areas that economical, reliable, accessible and satisfactory transport is provided to every user of the system (Ahmed 1996). It is concluded from past research efforts that conventional transport planning which focused on “motorable roads and conventional motor vehicles” was inflexible in addressing the issues and problems of rural individuals (Ali 2000, Ahmed 1996).

For rural areas of developing countries past research mainly focused on the issues of practical implications of some solutions to reduce transport related problems (Barwell 1997). Very little work has been done so far for developing world in the area of “travel demand modelling”, which is an important dimension and key input to the whole transportation planning process. This paper addresses issues involved in travel decision of

* Corresponding Author: Tel: 09221-9243261-68 /2205

rural individuals by developing an approach for modelling travel decision economics in rural areas of developing countries.

2. Research background

Travel behaviour of an individual is understood by considering the characteristics of an individual as well as its household (Koppelman and Townsend 1987). Household economics play an important role in defining travel behaviour of an individual and helps greatly in projecting future travel demand of households (Button 1975). Travel behaviour demand models developed so far incorporate different household economics parameters as explanatory variables but the proper illustration of household economics is missing in these models. Most of the models conferred high significance to the accessibility (individual time-space), activity attributes, mode available for travel and individual characteristics. These parameters are the effects of household economic conditions, not indicative of the actual in house economic phenomenon on which travel decision of an individual depends. Travel behaviour of the resident of rural areas of developing countries is entirely different from urban localities. Rural people travel only when it is absolutely necessary. Tenet on which travel demand model methodologies developed for urban localities are not best suited for rural areas (Ali 2000, Ahmed 1996), where basic problems are poor economic conditions and lack of accessibility towards their basic needs.

Ali-Nejadfard (1997) found for rural population that, need of transport and travel in these areas is focused around and within villages. An average rural household spent between 60 and 70 hours per week to get access to water, collect firewood, go to grinding mill, get to a clinic, market its produce and take children to school. The difficulties in access are attributed to poor rural infrastructure, location of needed services and limited or lack of access to non-motorised means of transport. i.e. affordable transport facilities. Female members of the household spend 2 to 3 hours carrying 25 litres of water every day and an additional 2 hours waiting to get it. Their dominant mode of transport is walking and head loading; 77% of which is borne by women. Gender dimension, is therefore important in explaining the rural travel phenomenon and also being highly stressed in the literature should be given their due importance in formulating travel demand methodology (Howe 1996, Chinghozu 1999). The two most important factors noted, in shaping rural travel behaviour are,

- (i) Household Economics
- (ii) Accessibility

The above two factors being the key factors in understanding in-house decision phenomenon related to travel and can be used to develop travel demand methodology in accordance with rural conditions. Barwell and Edmonds et al (1985) suggested that it would be irresponsible to propose an approach which was purely social in emphasis and which did not take account of the economic aspects of life.

2.1 Household economics

Theory of household economics provides a sound basis to answers of questions posed related to household behaviour in fulfilment of different domestic needs; namely their budget allocations, their sharing of resources, their lifestyle, their intra-household resource allocation, and their economic well-being. In all, household economics describe the collective economic activities of households (Ironmonger 2001). For rural areas of developing countries, household economics indicators describe in-house economic

phenomena in fulfilment of diverse nature of household needs within their monetary resources, which helps understanding the factors involved in travel decision.

2.2 Accessibility

Accessibility is considered as major factor responsible for deprivation of residents of rural areas (Odoki 1997, Barwell 1996, Ali 2000). The majority of rural population of developing countries does not have direct access to a recognizable road. This renders clear enough indication that transport planning has not been explicitly concerned with people and their transport needs (Barwell and Edmonds et al 1985). Chingozho (1999) concluded regarding access problem in the case study of rural Zimbabwe that access to rural areas is constrained by unavailability of engineered roads. It scares away public transport like buses causing delaying in transporting their goods and services. Where, transport is available for hire, hiring fees are exorbitant. This reduces development, increasing the levels of marginalization.

3. Travel behaviour modelling

The growth of travel behaviour modelling began with aggregate transportation demand models based on pragmatic relation of group of travellers or on average relations at zonal level. Then models shift from aggregate to disaggregate level i.e. Individuals and Households, in order to incorporate real underlying travel decision phenomenon. However, very little efforts have been done so far in development of sound modelling methodology to suit individual travel behaviour of rural areas of developing countries.

Ahmed (1996) in rural Bangladesh found evidences against the postulated hypothesis of application of conventional approaches of transport planning and recommended need for the investigations of social, cultural, economic and geographical characteristics of the rural areas of developing countries in order to address their transport needs.

Activity-based models consider travel as a derived demand by looking at a total activity pattern (activity duration, frequency, and distances of all activities). It is assumed that in this way, the interaction between travel and activities can be modeled, with travel expenditures as an output of the activity pattern. Due to the complex nature, activity-based analysis remained primarily an academic exercise and idiosyncratic to a particular data set (Lawson 1998). Kitamura (1997) concluded gap between current modelling efforts and its practical implications for shaping policies and strategies.

Lawson (1998) used the approach of “new home economics” proposed by Becker (1965) and integrates it with transport component within Activity-based approach to explain the derived demand for travel. The work of Lawson contributes to the understanding of what activity types, times of day, and specific socio-demographic characteristics should be considered for further research. However, the approach is not appropriate in explaining behaviour of rural household and their decision making process for travel as they engaged with stringent cultural norms, poor economics and accessibility settings. Howe (1996) and Ali (2000) suggested need-based approach; suitable for rural transportation planning as in rural environment travel was result of needs. Efforts for developing sound methodology to model rural travel behaviour for shaping transport policies and strategies in agreement with people needs are vital.

It is inferred from the literature of rural travel patterns (Howe 1996, Conerley and Schroeder 1996) that following issues should be incorporated in development for rural travel decision modelling approach.

- Social, economic and Cultural Behaviour
- Neighbourhood Environment
- Lifestyles and,

- Factors that represents their travel decisions hierarchy

The aim of this paper is to put forward an approach for modelling rural travel decision, which reflects the above-mentioned areas and support it by examining rural travel pattern through detailed data analysis.

4. Modelling approach for rural areas of developing countries

Modelling approach presented in this paper sets rural household as basic entity for analysis and incorporates household Economics, Household Role allocation process and Accessibility notions. The sub-sections here explain the framework and its components.

4.1 Conceptual framework layout

The modelling approach for travel decision economics of rural areas of developing countries is described by presenting a conceptual framework shown in *Figure 1*. The framework depicts two levels of travel decision hierarchy and the processes involved in each level. The first or primary travel decision is taken at household level, which is then transformed to individual level. At household level the travel decision are based on the different household needs and their respective need threshold process outcome. Household role allocation process transforms the household level travel decision to individual level in accordance with the role and responsibility of each individual within the household.

Individual activity set is then formed by different type of needs to be fulfilled through the individual. At this stage an individual checks an accessibility criterion for each tasks in relation to his/her time-space prism. Finally an individual takes the decision for travel to fulfil those needs, which satisfy his/ her accessibility criteria by making schedule of a day about executing time of each activity. The conditional aggregation of both level travel decisions gives the population travel demand.

4.2 Rural household needs

The rural household needs are of diverse nature; vary from household to household and highly dependent on household structure. It is recognized from the empirical analysis that rural household members only travel when it is absolutely necessary; most of their travelling is the result of fulfilment of their basic household needs. Once the household members made decision about fulfilment of their need, this need is transformed into activity. Activity here is defined as task requiring travel and time to participate in, for example work. So activities in which people engaged themselves by travelling are the resultant of household needs (Ali 2000). Therefore the main agents behind the concept of derived demand of travel are household needs rather than activities. Howe (1996) for the purpose of transport planning listed core level rural household needs as:

- (i) *Health*
- (ii) *Education*
- (iii) *Markets*
- (iv) *Water*
- (v) *Firewood*
- (vi) *Other subsistence tasks (principally farming)*
- (vii) *Leisure*

Though there is no standard aggregation of wide nature of activities with respect to activity-based data sets. Golob and McNally (1995) aggregated the highly specific activities into three broad categories namely, Work, Maintenance and Discretionary. Lawson (1998) gives a classification scheme for all in-home and out of home activities,

her classification based on two categories which are Work and Non-Work. Non-work category is further divided into Household Production and Leisure.

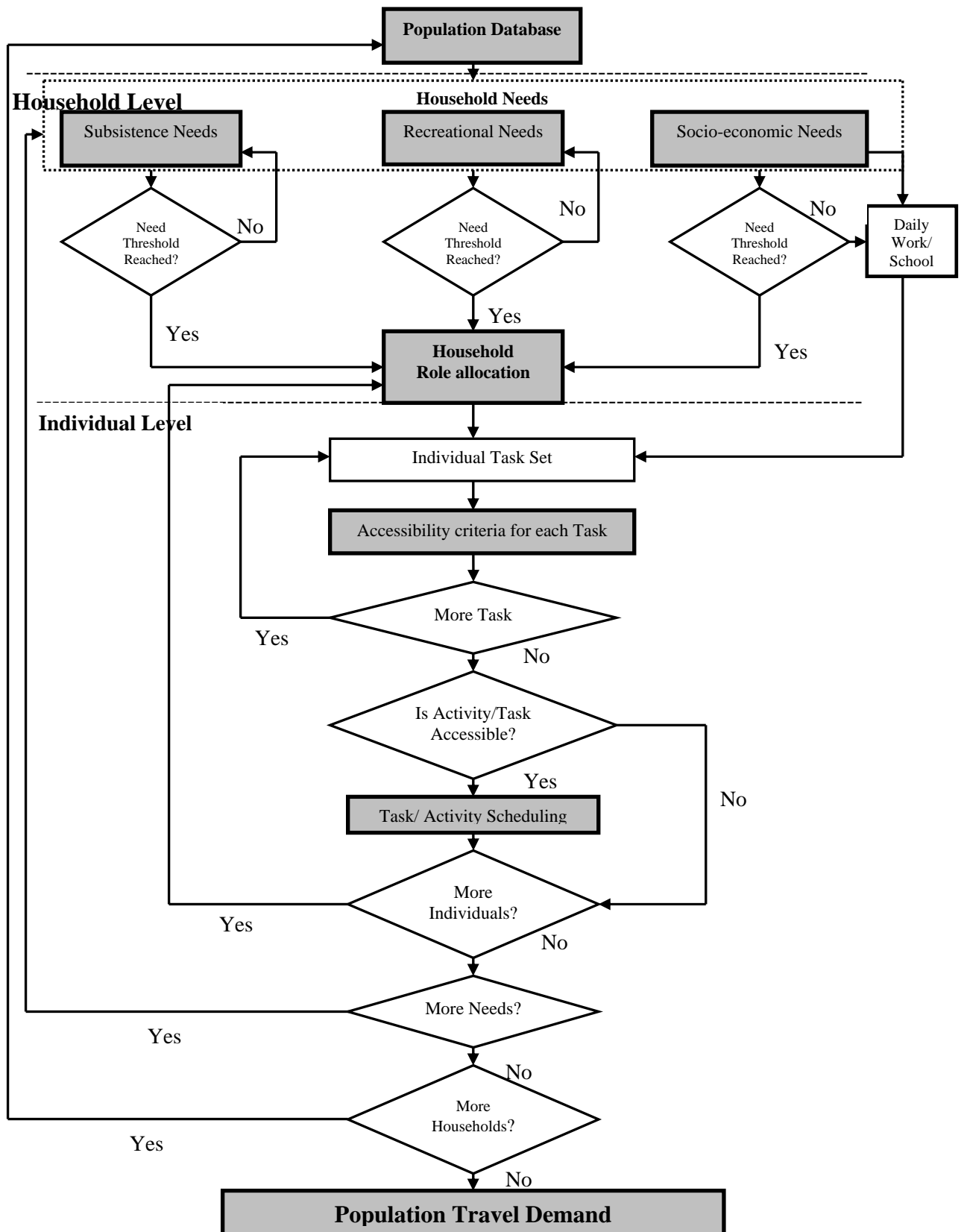


Figure 1: Conceptual Modelling Framework for Rural Travel Demand Incorporating Household Economics, Household Role Allocation, Accessibility and Activity Scheduling

In rural travel behaviour milieu, Ali (2000) combined all rural household needs in three groups, as Primary, Secondary and Tertiary needs. Primary needs are composed of Subsistence nature of needs like Water, firewood and food collection etc. Secondary needs are composed of needs, which have their importance in between Primary and Tertiary needs like Work, School and Market and tertiary needs include Leisure and Sports. In this research the household needs are divided into three broad classes to engross all type of household needs having ability to generate trips. The classes are mentioned as following and their detailed classification scheme is given in *Table 1*

- i) Subsistence needs
- ii) Socio-Economic needs
- iii) Recreational needs

Table 1: Classification Scheme for Rural Household needs having association with travel

Classes	Types of Needs included in Each Broad class (travel associated needs only)
Subsistence Needs	Water, Firewood, Food, Health etc
Socio-Economic Needs	Out of home Work(major and minor sources of livelihood) and School
Recreational Needs	Leisure, amusement related needs etc.

4.3 Need threshold concept

Need threshold concept was introduced by Westillius (1972) and was further developed by Ali (2000) in context of travel demand. Need Threshold is defined as “the stage of the need accumulation process of any need associated to travel at which household takes a decision to fulfil that need”.

This concept is further understood by observing a household consumption process, imagine a typical rural house, which has a full stock level of *Water*. As the time proceeds there is decrease in stock of water due to its consumption in drinking, washing etc, a time comes at which the stock of water is reached at its minimum level as shown in *Figure 2a*. Parallel to consumption process, need of water starts accumulating; need accumulation curve at its minimum level when water stock is full, and as the time proceeds need accumulation curve reached at its maximum level. This level is known as *Need Threshold* level, the stage at which household member must make a journey to accomplish that need. This whole process repeats itself, and continues to be replicated until the household need water. The process diagrams are shown in *Figure 2a and 2b* for clear understanding.

Need threshold concept can pave way for evolving methodology to model travel demand. As this process originates at household level so the output from this process is the household level travel decision. This concept proved helpful in understanding the behaviour of rural travel in more rigorous way and assisted in visualizing the underlying in-house economic phenomenon. The parameters describing the need accumulation process are (i) Consumption rate of the household for particular need, (ii) Household size, household structure, (iii) Household income, (iv) Household capacity to store stock relevant to the need. These parameters are explicitly related to household economic

conditions, thus need threshold concept is proxy to represent household economic phenomenon underlying household level travel decisions.

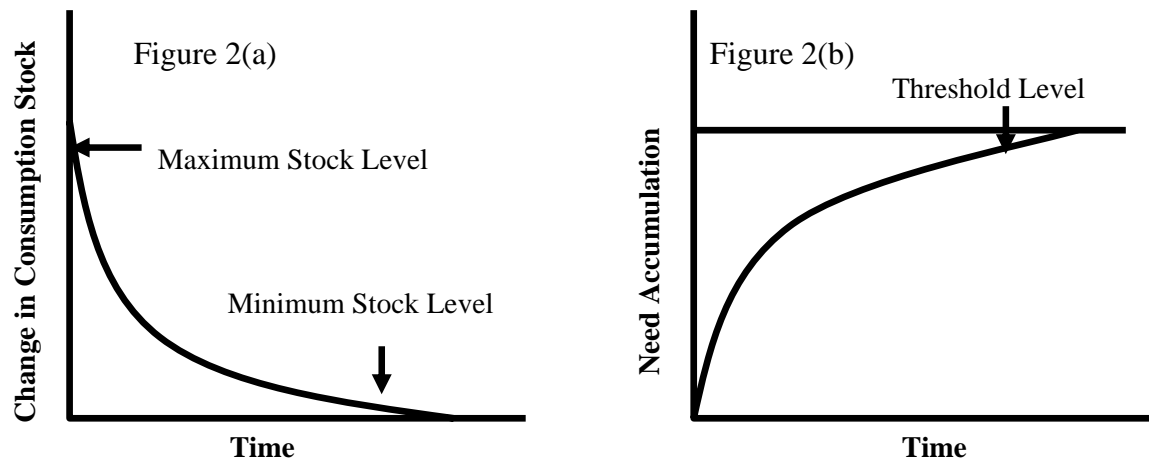


Figure 2(a) & 2(b): Change in Consumption and its corresponding phenomenon of Need Accumulation with Time.

Need Threshold assessing criteria should be different for each class of household needs, as described in section 4.1. In each class, household needs have different consumption pattern and monetary requirements and also their attributes are significantly variants to each other. The modelling approach presented in this paper, therefore assigns different need threshold assessment criteria for each class of household needs.

4.4 Household role allocation

After household level decision to accomplish any type of household need i.e. need accumulated to its Need threshold level, a new process begins about selection of suitable person within a household to fulfil this need. This process is termed as Household Role Allocation Process. Further this process works as an agent in transforming household needs to individual tasks/activities i.e. result in development of Individual Activity set. Lawson (1998) suggested that an individual has two sets of activities, first set characterized as *private activities* and the second set comprised of those activities that influence the utility of other household members termed as *household oriented activities*. The second set of activities is the result of household role allocation process. In rural environment where it is concluded that almost all the trips are the result of household level needs, therefore it is important for rural travel demand modelling approach that it must incorporate this process, as it rendering guidelines regarding “which person in the household capable of fulfilling what types of household needs”.

The engagement of different household members in different type of activities to fulfil household needs also reveals their role allocation within the household (Ali 2000). Koppleman and Townsend (1987) recognized the importance of household role allocation process and depicted various factors from which an individual role commitment is defined such as time and opportunity constraint, past experience, social norms, personality factors and negotiation. The most significant factor explaining household role allocation process is the Life Cycle Stage (LCS) of the household; LCS represents household composition including children and their ages. This factor also addresses the changes in household needs and activity-organization over the life cycle. Over time, roles change for household members as the household evolves through Life Cycles (Townsend 1987). The basic life cycle stages of a household in chronological order are as: Single person, Couple without children, Couple or single parent with dependent children, Couple

or single parent with independent children, Couple of seniors, Senior single person (Papacostas and Prevedouros 1993). Ali (2000) analyzed the household role allocation process by defining four LCS with respect to presence of children and their ages which are as follows.

LCS 1: couple without children,

LCS 2: couple with pre-school children,

LCS 3: couple with school going children and

LCS 4: couple with both types of children.

He found that household head is responsible for most of the out of home activities but household in which older children are present (*LCS 3* and *4*), they sharing the responsibilities of the household head and reduced his burden by participating in out of home activities.

4.5 Accessibility criteria

The definition of the term Accessibility suggested by Jones (1981) encompasses the broad area and is defined as “the measure of potential of an individual to take part in an activity at a particular location”. It comprises of three components, transportation, spatial and temporal (Odoki et al 2000, Ali 2000). Transportation component entails the transportation available to individuals and the speed at which this transportation allows individuals to overcome space. Spatial component engrosses availability of activities in geographical space and the locations of specific activities in which individuals participate. The temporal component involves the availability of activities at different times of the day and the time at which individual participate in specific activities. The Accessibility measure incorporated all three components provides a better tool to envisage individual decision of travel for any activity. The conventional methodologies of rural travel analysis based on transportation system and didn't focus on its users and non-users, thus the missing link in rural travel analysis are the individuals (Barwell 1996). Accessibility notion has ability to explicitly address the individuals both in form of users and non-users of transportation system (Odoki 1999).

Accessibility concept has capability to explain time-space constraint upon individuals and their transportation requirement. It is inferred that lack of accessibility causes the changes in travel pattern of an individual. The framework presented in this paper, fits stage of an accessibility criteria after development of Individual activity set. Accessibility criteria outcome, assist individual to take decision about whether he/she will participate in an activity or not which is included in his/her activity set. After analysing each activity on the basis of accessibility criteria an individual involves in shaping activity participation schedule and activity location choice. This completes phenomenon underlying from household to individual level travel decision. An empirical analysis has also done to investigate the above proposed concepts involved in travel decision.

5. Empirical analysis of household travel behaviour

Data was collected from rural areas of district *Hala* of Pakistan. *Hala* is about 103 Kilometres from Karachi, the major economic centre of Pakistan. *Hala* contains 261 villages each has a population of 200 or more. The village around *Hala* represent typical rural areas of Pakistan while; *Hala* serves as main economic centre for these villages. Sampling strategy is primarily based on accessibility notion, which represents transport, spatial and temporal conditions of the area. Cluster sampling was adopted as it has the ability to address the time-space effects being major determinant of accessibility. This helped in visualizing accessibility problems of the area. Questionnaire for survey was designed in three modules namely Village level, Household level and individual level

information. In village level information, the respondents were asked about total population, availability of basic facilities, past and future development works to be carried out in village etc. In Household level module, respondents were asked about their household needs and its fulfilment pattern, expenditures on different needs, household size, income and its sources, vehicle ownership and income satisfaction level etc. Individual level module comprises of daily activity dairy, information about their role in the household, spatio-temporal budgets and mode of travelling etc.

5.1 Analysis of household economic indicators

Household income is considered to be an important determinant of economic condition within the household. The average household income for the study area has been found to be Rs.5700 per month and the average household size noted as 5.5 per household. So, per capita income comes out as Rs.1036 per month, giving per capita daily income as Rs. 34.5. This per capita daily income is well below poverty threshold set out for rural areas of developing countries which is dollar¹ a day for each individual (World Bank 2001). It is also found from the analysis that presence of male child having age over 15 years, increase the income level of household as these children also engage themselves in income generating activities shown in *figure 3*. This may help setting need threshold assessment criteria for socio economic needs of households.

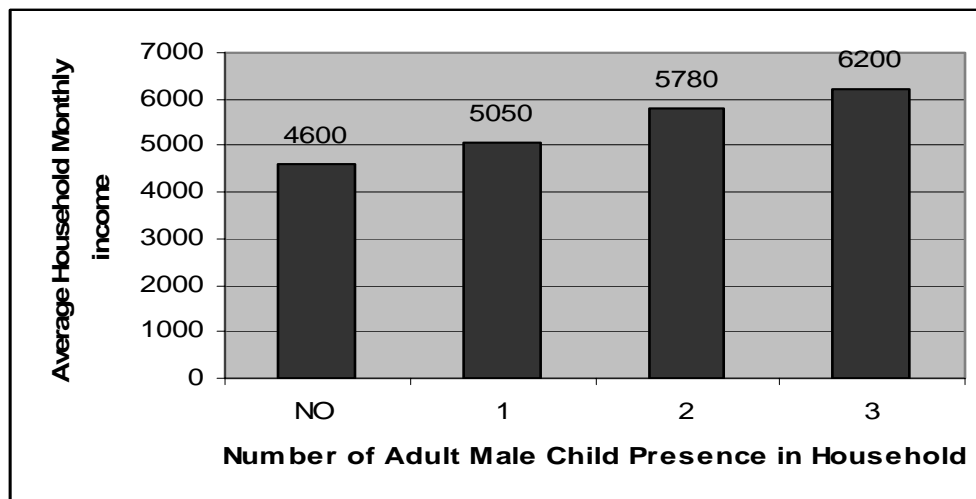


Figure 3: Bar graph shows trend of Household income with presence of Adult male child numbers in Households.

Household Need Index (HNI) and Household Capacity Index (HCI) are formulated to envisage household consumption pattern and setting subsistence needs threshold assessment criteria. Their mathematical function given as

$$HNI = 1 + (aN_{ma} - 1) + bN_w + cN_{fa} + dN_c \text{ ----- (5.1)}$$

Where, HNI = Household Need Index

N_{ma} = Number of male adults in the household

N_w = Number of household wives

N_{fa} = Number of female adults in the household

N_c = Number of children

¹ One US dollar was equivalent to 55 Pakistani rupees, According to currency exchange rate at the time when survey was conducted in July 2003.

a,b,c,d = Resource cost of the above with respect to household head.

$$HCI = \frac{Hi \times Isl}{He} \text{----- (5.2)}$$

where, HCI = Household Capacity Index

Hi = Household Income

Isl = Income satisfaction level

He = Household Expenditures

HNI depends upon household size but not in direct nature, it gives the equivalent household size because of the weights (i.e. a,b,c,d) attached with each type of members of household. These weights are the ratio of resource cost, i.e. ratio of expenditures of respective household member to household head. It is truly accepted fact that strength of household needs is function of household size; hence HNI can be used as measure of strength of household needs. HCI is a measure of satisfaction of household in its circumstances, it implicitly gives the measure of capacity of household i.e. higher the HCI value the economic condition of the household is strong; hence household has high level of affordability. HNI and HCI in combination reveal the consumption phenomenon of household. If household has High HNI and Low HCI value then its need threshold for subsistence type of need occurs frequently. The *Figures 4* and *5* show this situation in which x-axis represents the day at which threshold of subsistence need occurs i.e. water and firewood and y-axis represents the difference of HNI and HCI values. This analysis reveals that both these indices have capability to become a measure of need threshold and provide useful tools for household level decision of travel.

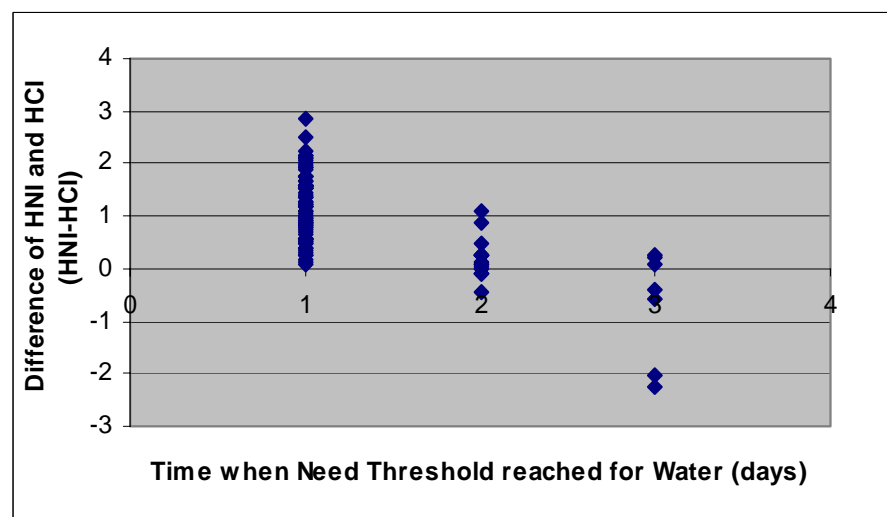


Figure 4: The variation of reaching Need Threshold stage of water with Household Economic indicators

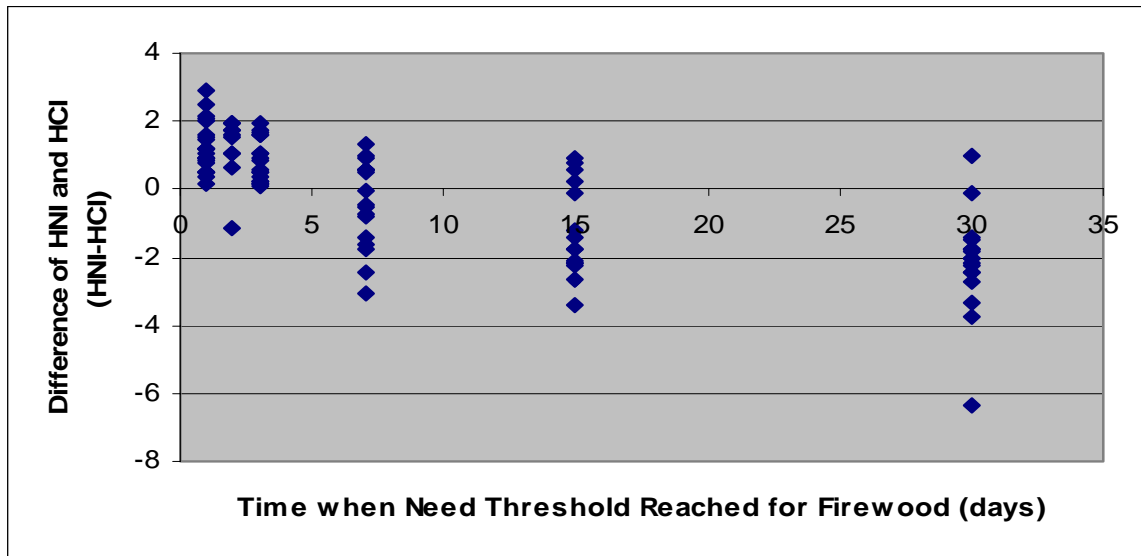


Figure 5: Variations in Need threshold occurring frequency of Firewood with household Economic indicators.

5.2 Household role allocation significance

Figure 6 reveals importance of household role allocation in transforming household level travel decision to individual level. The figure shows that Household head and older male children are responsible for carrying out work activity. Housewife mainly with other in-home activities takes part in water collection. Older female children and dependent children mostly engage themselves in in-home income generating activity, which is one of vital source of earning in villages of Hala. The younger females do not take part in out of home activities mainly due to cultural constraints. Older male children are also responsible for fulfilling food and firewood related needs of the household. To make further insight of the household role allocation process 8 LCS are devised in this research, which are described in Table 2.

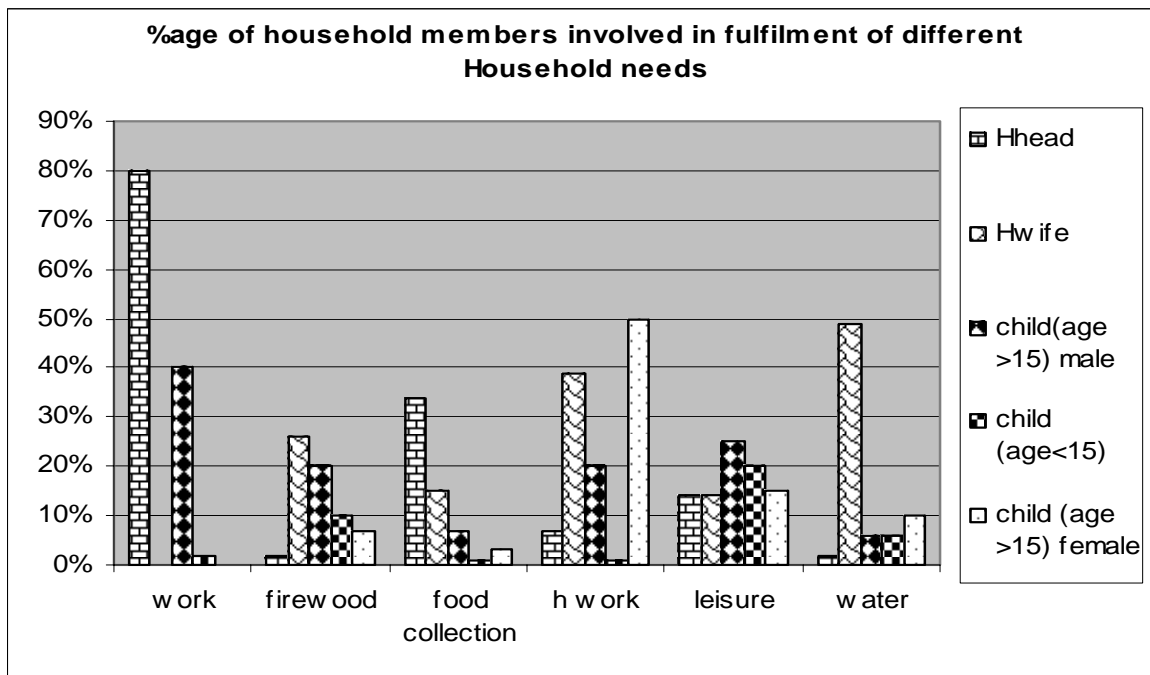


Figure 6: Fulfillment of different household needs by various members in the household

Table 2: Life Cycle Stage Distribution according to household structure and their % Existence in study Area

LCS No.	Household Structure	% Existence
LCS 1	Couple/ Single Parent	5 %
LCS 2	Couple with small children (sc)	29 %
LCS 3	Couple with adult male children (amc)*	12 %
LCS 4	Couple with adult female children (afc)	10 %
LCS 5	Couple with (sc) and (amc)	15 %
LCS 6	Couple with (sc) and (afc)	6 %
LCS 7	Couple with (amc) and (afc)	14 %
LCS 8	Couple with (sc), (amc) and (afc)	9 %

* Adult children are those having age 15 years or more

The households which have older male children shown in *Figures 7a & 7b* (i.e belonged to LCS 3, 5, 7 and 8) earned high income because of this they generated high number of trips related to socioeconomic needs. These figures also reveal one of the cultural norm of the area that older male children (children having age 15 or more) are also responsible for generating income. It is also found that role of the members within household are changing as LCS of the household vary. Figure 8(a) and 8(b) shows this pattern, in LCS 1 and 2, it is the responsibility of Housewife to carry out subsistence tasks but in LCS 5, and 6 these needs are fulfilled by younger and older children. This analysis showed how significantly household role allocation process is important in visualizing who is fit for fulfilment of which household needs.

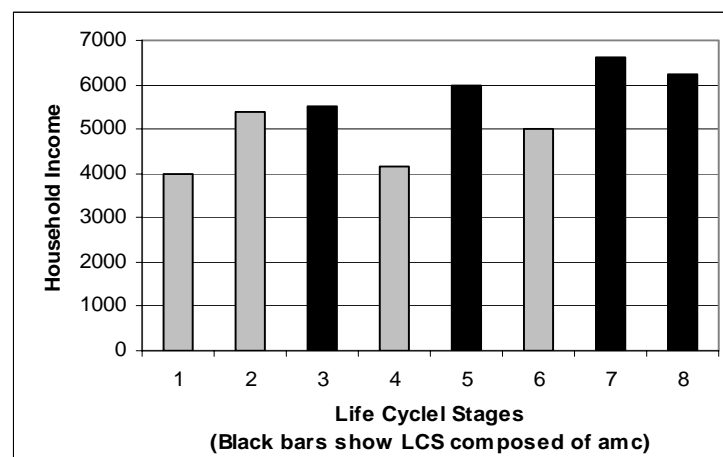


Figure 7(a): Graph represents Household Income Distribution over LCS, Black bars shows LCS composed of adult male child (amc).

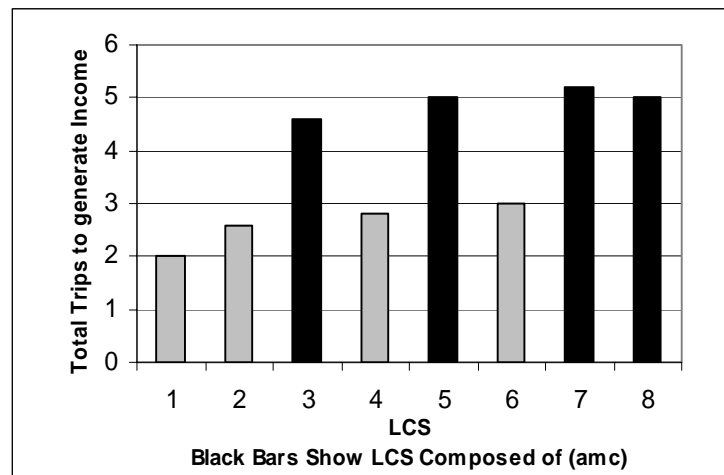


Figure 7(b): Graph represents trip generation for earning income over LCS, Black bars show LCS composed of adult male child (amc).

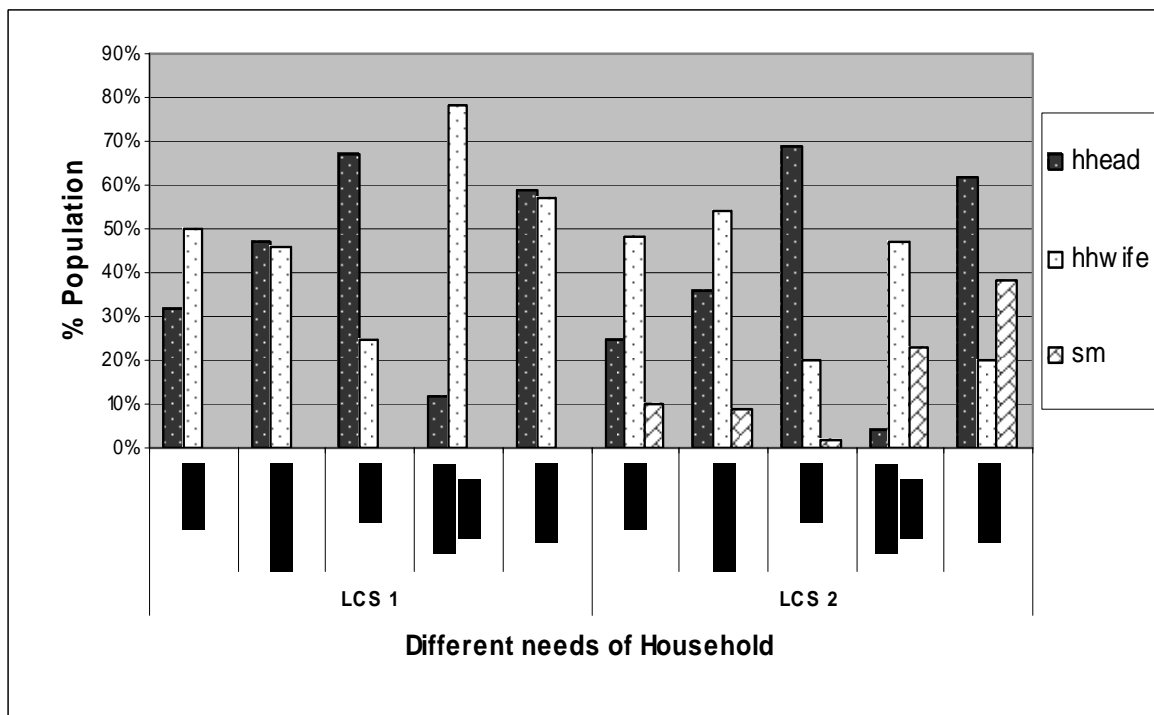


Figure 8 (a): Graph shows household members responsibilities for fulfilling different household needs for LCS 1 and LCS 2

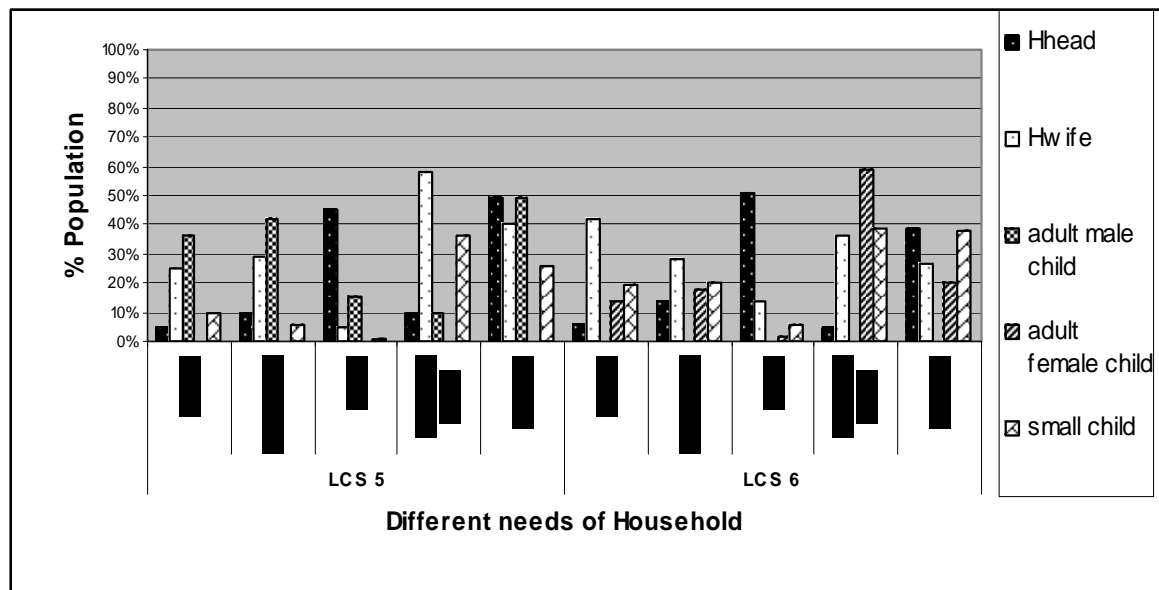


Figure 8(b): Graph shows Household members responsibilities for fulfilling different household needs for LCS 5 and LCS 6

5.3 Accessibility analysis

The village level information is utilized in performing accessibility analysis. In total, five villages were surveyed *table 3(a)* shows the name and population statistics of the villages and *table 3(b)* shows the availability of different facilities within the village. In addition to this, individual level information is also helpful in depicting problems regarding accessibility.

Table 3 (a): Surveyed village names and their Population Statistics

Cluster No.	Name of Villages	No. of Households	Population	Area(Km ²)
1	Hala Old (Qazi)	226	1050	0.3
2	Dhabri Chandia	85	660	0.15
3	Haji Hasan Gahoti	96	580	0.25
4	Tayyab Dahri	59	430	0.10
5	Bagho Rind	67	380	0.15

The *Figures 9* and *10* shows the monetary and time consumption of an individual in fulfilling different household needs. It is revealed from both these figures that subsistence needs require very little monetary resources however, these needs consume large amount of their daily time budget. Poor access and the availability of few facility locations are the main reason behind this as large amount of time is consumed of an individual in waiting of their turn. *Figure 11* shows, modes mostly used for travelling within village and their ownerships, the motorized vehicle ownership is very low, very few household have motorcycle and no one owned car. 20% of the household have bicycles and 10% have animal carts, rural people usually travel long distance by walking. However, car-taxis, horse-carts and rickshaws served as public transit to go from one village to the other. These modes of transport are not available within village mainly because of poor road conditions, which causes high Vehicle operating cost. These issues depicted the severity

of accessibility problems faced by rural individuals and inadequate rural transport planning.

Table 3 (b): Availability of different domestic facilities within village, representing access related problems of residents

Basic Facilities	Hala Old (Qazi)	Dhabri Chandia	Haji Hassan Gahoti	Tayyab Dahri	Bagho Rind
In home water supply	No home supply, 5 location in whole village	No home supply, available at 3 location	No home Supply, 6 points in village	No home Supply, 4 points	No home Supply, 1 point
Health Centers	1 clinic, operates at 8 to 12 am	No health centre	No health Center	No health center	No health center
School	1 primary school 1 high school for each sex	1 Primary School	1 Primary School	1 Primary School	1 Primary School
Electricity	Available to each household	Available to each household	Available to each household	Not Available	Available to each household
Connection to engineered road	2 roads, 1 st at 4km, 2 nd at 10 km	1 road at 4 km	2 roads, 1 st at 3 Km, 2 nd at 6 Km	2 road, 1 st at 9 Km, 2 nd at 6 Km	1 road at 1.5 Km
Firewood centers	4 places around village periphery	1 location	1 location	2 points around village periphery	1 point
Food collection shops	3 small markets each has 3-4 shops	4 shops	7 shops	1 shop	5 shops

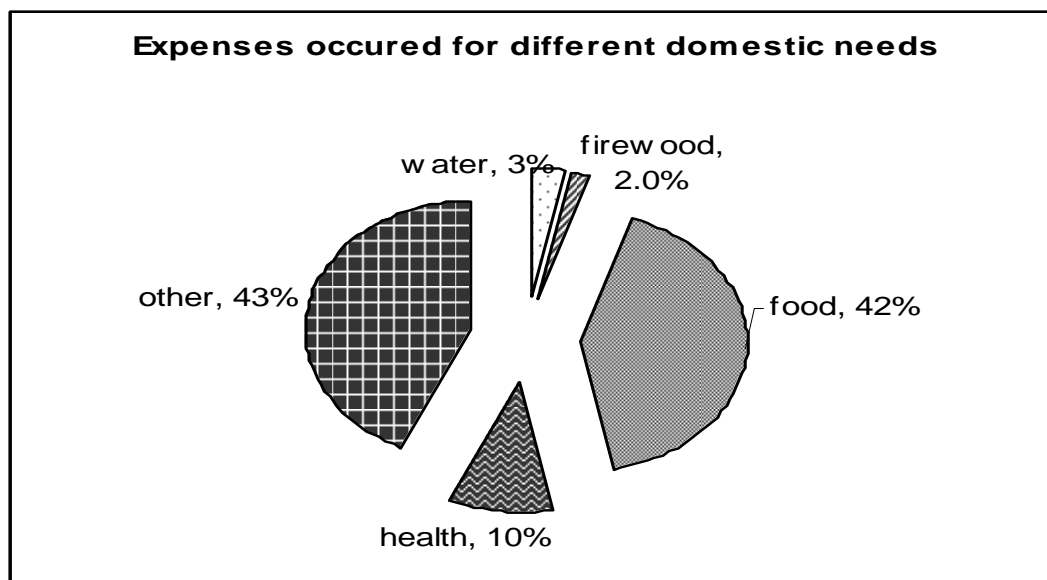


Figure 9: Pie-Chart shows household expenditure on different domestic needs

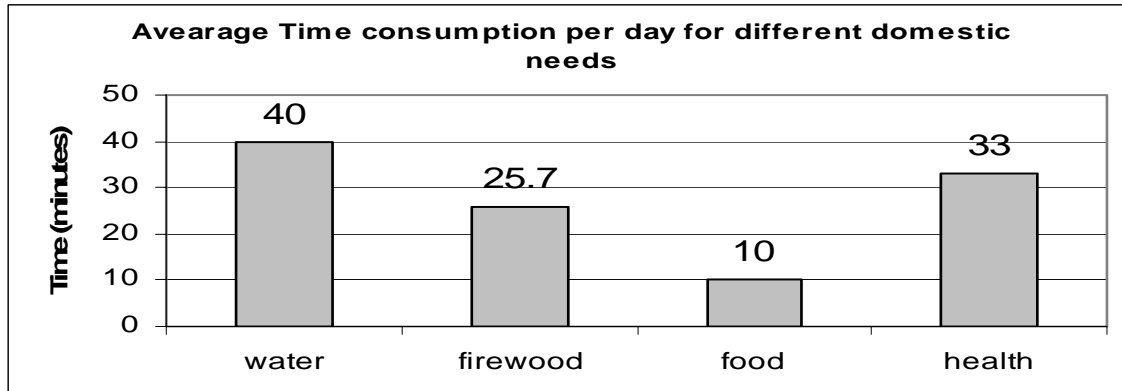


Figure 10: Average Time consumption of household members in fulfilling different domestic needs.

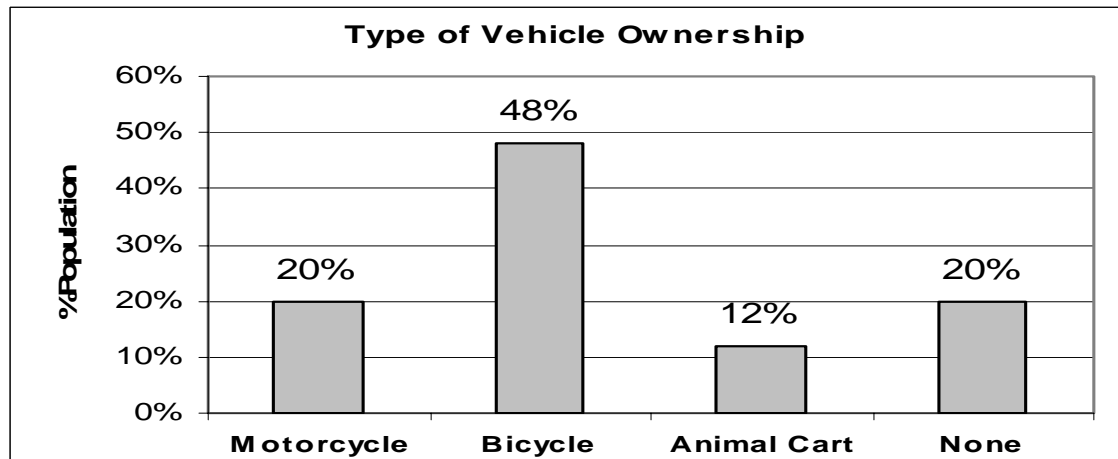


Figure 11: Transport modes used within the village and their ownership

5.4 Activity scheduling

Daily activity diary from the individual level information describes the activity scheduling process, an individual choice for fulfilling different needs in his/her activity set at different time of day. *Figure 12* illustrates this phenomenon, high percentage of people fulfilled subsistence nature needs in earlier part of the day and recreational needs were fulfilled in latter part of the day. However, socioeconomic needs are fulfilled in time gap available between these two classes of needs. The choice of individual in scheduling these activities is constrained by time at which respective needs fulfilment centres were open. i.e. health related needs are only fulfilled in villages between 10 am to 1.00 pm and in few location drinking water is only available from 9.00 am to 10.30 am. The accessibility and activity scheduling analysis revealed the importance of these issues in affecting individual decision to travel and how important their incorporation is necessary in formulating travel demand modelling approach especially in rural areas of developing countries.

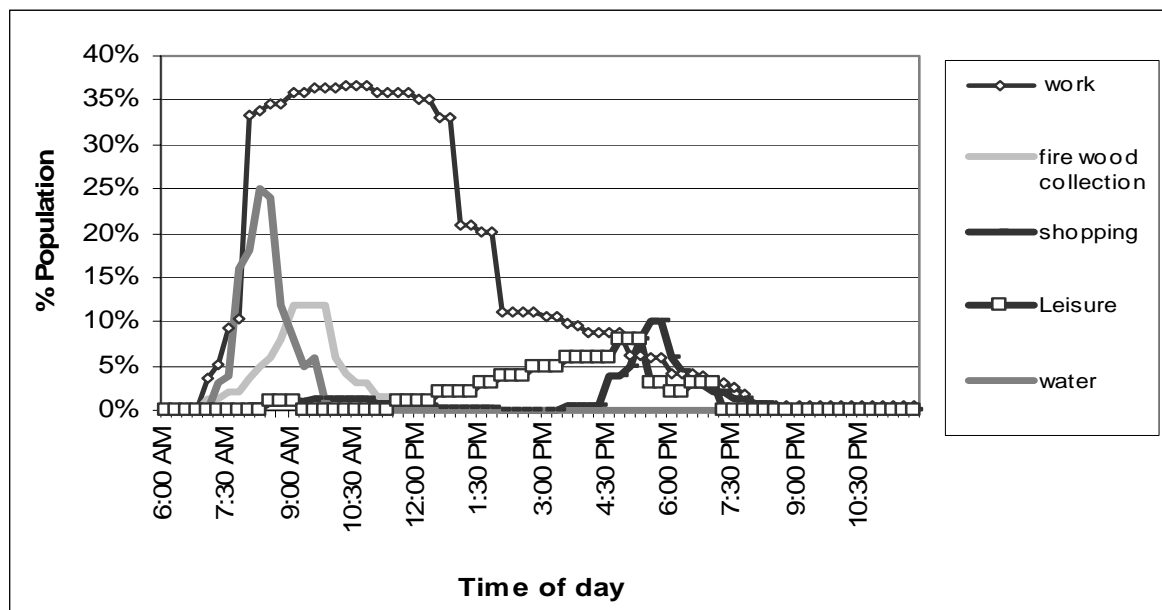


Figure 12: Graph shows different Need fulfillment pattern in different time of a day i.e. Activity Scheduling

6. Conclusion

The research reported in this paper provides an approach for modelling rural travel decision economics. The approach incorporates household needs as main agent of travel decision thus, recognized derived nature of travel. Integration of household needs with need threshold concept represents household economic phenomenon underlying in a travel decision of a household. Household Economics (household needs and need threshold), household role allocation process and Accessibility criteria of individual (spatial and time constraints) put together in a same framework to represent rural travel behaviour and provide help model rural travel demand. Empirical Analysis of household economic indicators, household role allocation process, Accessibility and Activity scheduling provide full support to the travel decision hierarchy along with major processes on which modelling approach is based.

The modelling approach can also be extended to address the trip-chaining phenomenon by enhancing the activity scheduling process. For application of approach in the areas where individual related needs are also important the framework extended on this basis at the stage of Individual Activity Set. The household role allocation process is also capable to cater for gender dimension emphasized in the literature to obtain better understanding of rural travel behaviour.

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