RURAL TRANSPORT IN BANGLADESH : IMPACT OF NON-MOTORISED TRANSPORT ON HOUSEHOLDS' ACTIVITY-TRAVEL PATTERNS

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abstract : The paper examines the impact of non-motorised transport (NMT) on rural households' activity-travel patterns in Bangladesh. The paper also examines the suitability of the Household Activity-Travel Simulator (HATS) in a developing country, like Bangladesh, for investigating the daily household activity-travel patterns and for evaluating the impact of transport policy. NMT has an enormous potential in addressing transport related problems of rural Bangladesh. However, its impact is not as straightforward as commonly perceived; rather depends, *inter alia*, on the social, cultural, economic and geographical characteristics of the area concerned. HATS has been found useful for the purpose but only with modification of the method used in developed countries.

1. INTRODUCTION

Over 70% of the people in developing countries live in rural areas (Beenhakker H L *et al.*, 1987). Adequate, reliable and economic means of transport is a prerequisite for the overall rural development and for access to essential facilities by rural residents. Dawson & Barwell, 1993 and Hoyle, 1973 argued that the development patterns of transport facilities in the developing counties were dependent *inter alia* on the extent of : (a) availability of primary product for European and North American markets; (b) urbanisation and the need to facilitate movement of foods from the hinterland to the growing urban centres; and (c) the need for judicial and administrative control by the colonial powers. Road and rail networks and the ports inherited by previously colonised nations were built to serve the above needs. In particular, the transport networks in those areas well endowed with good primary commodities were developed at the expense of other areas.

Following independence, the Governments of those countries invested heavily in transport infrastructure. One estimate found that, in developing countries, about 20-25% of the public sector investment went to the transport sector overwhelmingly for investment in roads, mainly national and arterial (Edmonds & Relf, 1987). In the mid 70's, emphasis shifted to secondary and feeder roads (Dowson & Barwell, 1993). Huge investments were made and

continue to be made in the rural transport sector. As an example, by 1977, 93% of the total road lengths in World Bank projects were rural roads (Dowson & Barwell, 1993).

The basis for such optimistic investment in roads was the classical assumption and model applied in the developed countries that if the public sector built the infrastructure, the private sector would provide the vehicles and operate the services. In turn, the assumption goes on, that, as a result of the "improved access" to facilities in the rural areas the rural economy would respond and thrive. The role of the motor vehicle in meeting the resulting increased transport demand was taken for granted. Until the early 80's this model was widely accepted by transport and development planners. At that time different observations and studies around the world identified the limitations of the approach (Kaira, 1983; Carapetis S *et al.*, 1984). One of the limitation of this approach is its failure to respond to the transport demands of the majority of inhabitants who eke out their living through subsistence agriculture. The majority of rural trips are within the villages and rarely warrant the use of motor vehicles. Even if the motor vehicle could respond to the transport needs, it would be a long, slow process at current level of investment. For example, : (a) In India 70 per cent of the villages are yet to be connected with all weather road (Edmonds & Relf, 1987); and (b) Another 150 years would be required to make initial investment on the rural and feeder roads in Brazil at the current rate of investment (Carapetis S *et al.*, 1984).

Having identified the shortcomings of the traditional planning approaches, several researchers advocated the development and promotion of Intermediate Means of Transport (IMT)/Non-Motorised Transport (NMT)[1] to help meet transport needs of the rural population (Carapetis S *et al.*, 1984; Hasan & Barwell, 1992; Riverson & Carapetis, 1991; Howe, 1994). Several studies had been made in the rural areas of developing countries directly or indirectly concerning IMT/NMT (Sheladia Associates, 1992; Malmberg-Calvo, 1992a; Srisakda & Chivasant, 1992; Malmberg-Calvo, 1992b; Planning Commission of Bangladesh & Overseas Development Group, 1978; Airey & Howe, 1991). The general consensus emerges that there is tremendous potential for the use of IMT/NMT. However, these studies did not quantify the impact of IMT/NMT on the activity-travel patterns of the rural population.

The author, Farhad Ahmed is carrying out a research project which, among other things, will try to assess the impact of the IMT/NMT on the activity-travel patterns of the rural households in Bangladesh. The general nature of the rural transport situation in Bangladesh is consistent with the comments made above. The author is aiming to provide a better basis for policy formulation and assessment in rural transport planning in Bangladesh particularly related to the introduction and promotion of IMT/NMT. This paper throws some light on the impact of IMT/NMT on activity-travel patterns in rural Bangladesh which will in turn help in understanding similar problems in other developing countries. An additional purpose is to explain the pros and cons of the use of the Household Activity-Travel Simulator (HATS) in conducting the study. The following sections: (i) review in brief the current literature related to IMT/NMT in rural areas of developing countries and literature related to the activity based travel framework approach and HATS; (ii) explain the methodology

[1] IMT is defined as the transport of "intermediate technologies" between the "traditional" (human portage with zero investment but low efficiency) and the "modern" (motor vehicle with high investment and high efficiency), like wheelbarrow, bicycle, single axle tractor etc. NMT can be defined as the IMTs which are powered by human or animal, for instance, bicycle, cart etc.

adopted for conducting this study; and (iii) present the results and some of the research findings.

2. LITERATURE REVIEW

2.1 IMT/NMT in Rural Areas of Developing Countries : Recent Literature

The importance of IMT/NMT as a means of effective transport services in the rural areas of developing countries has been receiving increasing recognition recently. Kaira (1983) was the one of the first to point out the limitations of motorised transport services in addressing the transport demand of the rural population through an empirical study done in Kenya. Kaira (1983) argued that conventional motor vehicles were inflexible in addressing the transport demands of the rural population which were characterised by short trips and movement of small loads over short distances. Kaira (1983) identified two main factors responsible for the underdevelopment and under-utilisation of IMT/NMTs, first, the attitude of policy makers which was heavily biased towards the construction of transport infrastructure suiting motorised vehicles neglecting the simpler and cheaper means of transport; and, second, the custom and lifestyle of the rural society which mitigated against the adaptation of such technologies which were successfully used in other places.

Under the Sub-Saharan Africa Transport Programme (SSATP) of the World Bank several studies were made on IMT addressing issues ranging from, assessing the potential of use of IMTs in relieving the transport burden of the rural population to, determining the reasons for the success of some IMTs in a particular area. These are well documented in Riverson & Carapetis, 1991; Leyser, 1992; Malmberg-Calvo, 1992a; Urasa, 1990; Malmberg-Calvo, 1992b; Srisakda & Chivasant, 1992; Sheladia Associates & Consultant, 1992; and Anderson & Dennis, 1992.

Riverson & Carapetis (1991) confirmed the importance of off-road transport and also the inadequate understanding and lack of attention, on the part of the policy makers, to this essential factor of production and rural day-to-day survival. Riverson & Carapetis (1991) argued that large amount of time, energy and drudgery could be saved, particularly for women, by the use of IMT. Riverson & Carapetis (1991) also commented that the introduction of IMT would require a clear understanding, by the Government and local officials, of the policy issues involved and a clear commitment to pursue solutions to local situations. Leyser (1992) identified the range of IMTs available, their use and factors that restricted their wider use. Leyser (1992) noted that a combination of environmental, economic and cultural factors prevented the wider use of those vehicles. It had been argued by Leyser (1992) that wider use of IMT was constrained by the limited supply of IMT and components; lack of access to credit and therefore inability to raise enough cash for purchase; and, cultural restriction on the part of women for use of certain IMTs like bicycles.

In reviewing rural transport in Uganda, Malmberg-Calvo (1992a) noted that : (i) bicycles in Eastern Uganda served two purposes; first, personal transport; and second, as a means of income generation; (ii) ownership of bicycles was influenced by household's economic status, cultural background, terrain and transport infrastructure; (iii) bicycles conferred social prestige and were mainly used by men for making journeys outside the village; women who used bicycles were regarded as behaving like men; (iv) a minority of women

would be benefited from wider use of IMT due to technical, cultural, educational and economic factors; (v) bicycles could be seen both to complement and supplement motor vehicles; and (vi) contrary to conventional belief, women were eager for change and were willing to adopt IMT. Urasa (1990) confirmed (iii) and (vi) of the abovementioned findings. It has been argued by Urasa (1990) that although intermediate technology intervention had the potential for improving the accessibility and mobility of the rural women, its introduction involved complex interaction between different factors and hence required thorough and careful analysis. Malmberg-Calvo (1992b) argued that even if the time and energy resources of the rural women in Africa were freed up by transport or non-transport intervention it was unlikely that women would use that time for leisure; rather they would prefer to use time savings for social reproduction tasks like agriculture and income-generation.

Two case studies, one in northern Thailand and another in the west of India, looked at the use of two popular IMTs - "Itaen" in Thailand and "Motorised Three Wheelers" in India (Srisakda & Chivasant, 1992; and Sheladia Associates & Consultants, 1992). Evidence from those studies suggest that the chance of adaptation of IMTs was high in areas which were economically successful - in Thailand and India those were popular in agriculturally productive and industrially successful areas respectively.

Smith & Howe (1986) argued that there were considerable reluctance in many countries to consider vehicles other than motorised vehicles as 'transport'. They concluded that changes in the use of non-motorised transport could not be expected to take place simply because the technology existed and was successfully used elsewhere. Howe (1994) proposed two avenues for enhancing the supply and use of NMT in Africa; first, mass production of NMTs for the poor and second, changing the investing practices (not only for physical infrastructure) of the development banks and organisations so that they could intervene directly in the low-cost mobility and access enhancements.

Bryceson & Howe (1992) were highly critical of the transport technology interventions undertaken by the international agencies in Africa ostensibly to enhance mobility of the rural population and to indirectly increase agriculture productivity while they accepted without challenge, the cultural preferences of the community. Bryceson & Howe (1992) argued that existing cultural preferences caused interventions to increase the already serious inequities in the transport burden between the sexes. Bryceson & Howe (1992) opined that, with similar transport interventions, men would get increased mobility with few household responsibilities while women with little or no access to IMT, would continue to be responsible for the onerous household transport tasks..

2.2 The Human Activity Approach in Understanding Travel Behaviour

As information from travel related surveys are increasingly being used as empirical evidence for policy and decision making purposes, more emphasis has been placed now-a-days on attitudes and behaviour of different groups of people than network flows and detailed spatial movement (Taylor M A P *et al.*, 1992). On the backdrop of the above, there has been an increasing search for a more realistic representation of the travel decision making behaviour (Clarke, 1979). Heggie & Jones (1978) argued that the response to transport policy changes differ in degree and kind depending on the nature and severity of the change

and the type of people affected. Spatio-temporal and/or inter-personal linkages play a governing role in the categorisation of the response patterns. Heggie & Jones (1978) identified four response domains for the categorisation of the response patterns (Figure 1). Out of the four response domains, domain IV, represents full interdependence - ie. decisions are dependent on the inter-personal linkages (intra and inter household) as well as spatio-temporal linkages. Heggie & Jones (1978) argued that the majority of responses to policy changes would fall within domain IVa, ie. intra-household inter-personal linkages and spatio-temporal linkages. It has been argued by Jones (1975) and Jones (1979b) that domain IV level linkages can be studied by analysing the travel behaviour under the activity-travel framework ie. viewing travel as a part of the human activities. This line of thinking has been strengthened by the conceptual work done by Hagerstrand (1970), as cited in Jones P M *et al.* (1983), using the idea of a space -time prism.

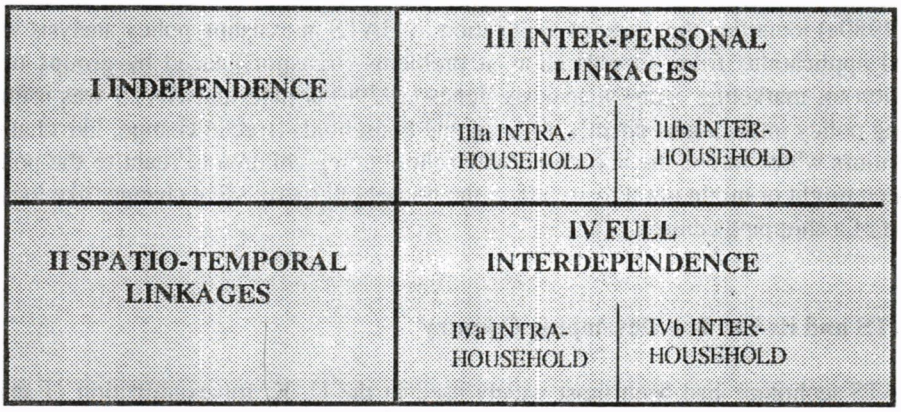

Figure 1 : Response Domain Model (Heggie & Jones, 1978)

2.3 The Household Activity-Travel Simulator (HATS) Approach

The Household Activity-Travel Simulator (HATS), developed in 1976, is an interactive household based survey technique that uses display equipment as a part of a group in-depth interview (Jones, 1980a). It applies the concept of a human-activity based travel framework approach to the investigation of the formation and structure of existing household activity-travel patterns, and examines the way households adjust their behaviour to natural changes as well as to external policy based changes (Jones, 1979b). "Attitudinal" and "engineering" approaches are brought together by HATS, enabling preferences and choices to be studied in the context of subjective and objective constraints (Jones, 1980a). Interested readers should refer Jones(1982), Jones (1980b), Jones (1979a), and Jones (1980a) for complete description of HATS survey equipment and procedure.

The HATS equipment consists of a set of display boards and a component box. Each board consists of some form of map of the local area, beneath which are three time scales for recording one person's in-home, travel and out-of- home activities. Colour coded activity blocks are used to construct a representation of the daily activity-travel pattern on the board. The activities at a particular time of day and place of the activity respectively are represented by the blocks and location markers. The boards depict travel as a part of the

daily activity in time and space and thereby help to identify the role of travel in daily life and the linkages between travel and non-travel activities.

The advantages of the HATS technique for investigation of daily household travel-activity pattern and evaluation of policy impact are summarised by Jones (1980a) as follows: (i) daily activity patterns are better represented compared to the conventional diary approach in time and space context; (ii) it is dynamic in nature; (iii) it helps identify the major constraint or option; key linkages between different events and other members of the family are better conceived due to the visual format; (iv) any logic flaw can easily be identified; (v) display of the activity on the board paves the way for in-depth interviews and reduces, if not eliminates, the nervousness on the part of the interviewee; (vi) interviewees are better able to discuss the activity travel pattern because it is simulated on the board; and (vii) it is as suitable for large households as for small households.

Jones (1980a) identified the range of application of HATS in assisting policy analysis which included applications from, identification of problems (transport) faced by groups of the population to, marketing decision analysis. Jones (1979b) argued that HATS was useful in analysing policy implications directly affecting the households (forced change, like changing school hours which forced the household with school going children to react to the policy) and which might or might not directly affect the household (permissive change, like location decision of a shopping centre).

2.4 HATS and its Use in a Developing Country

The HATS technique had been most widely used in the U. K. for examination of several policy implications which ranged from, school hour revisions to, identification of problems of access to a regional hospital; it had also been used in other developed countries (Jones, 1980b). Other than one occasion, the use of HATS in developing countries has not been reported so far. The HATS technique has been used in China to investigate person trip rates in urban, quasi-urban and rural China as well as to assess its suitability of use in China (Black & Song, 1990). Black & Song (1990) found the method with some modification to the conventional interview procedure suitable in China in terms of measurement of household and individual trip generation rates and in getting insight into family travel patterns. The modification made, were:

(i) An oral presentation on the scope and purpose of the survey due to the interviewee's unfamiliarity with the technique;

(ii) Substitution of a sketch map in place of a detailed map (topographical map or street map) due to the lack of map reading skills of the population;

(iii) Omission of in-home activity due to unfamiliarity with such survey and due to the political structure in China; and

(iv) Filling up of response by the interviewer due to illiteracy and irresponsibility of the interviewee.

3. RESEARCH METHOD

Finding the impact of non-motorised transport on the rural households' activity-travel pattern is one of the objectives of the research project titled "Integrated Rural Accessibility Planning in Bangladesh" conducted by Farhad Ahmed. First, the general areas for the study were selected. Due to their special nature, hilly areas were excluded. The rest of the country was then divided into three areas based on the predominant transport features - mainly land transport, mainly water transport and mixed land and water transport. The areas selected for study were those with mainly land and mainly water transport. Secondly, a representative Thana was selected in each area, and within those, two villages were identified, one relatively close to developed transport infrastructure and one remote from transport infrastructure. Thirdly, in each village, 25 households were randomly selected for Household Travel and Transport Survey (HTTS), a total of 100 households. In each household, all persons over 10 years of age[2] were interviewed - a total of 309 persons of whom 154 were male and 155 were female. Two types of questionnaire were used : (a) Household; and (b) Individual. The "individual" form was used for trip data for a range of purposes. During the individual interview, the interviewers helped to complete a travel-activity diary recording detailed information on the activities undertaken and trips made by the respondents the day before the interviews. The data included, where and when the activity started and finished; type of activity; and, if the activity was travel, distance, weight carried, mode of transport, infrastructure used, fare and purpose of travel.

After the household questionnaire and individual questionnaire forms were completed all the household respondents were gathered together and were prompted to discuss how their activity-travel patterns would change if the household were provided with a bicycle. The bicycle was chosen as the example of a non-motorised transport for the purpose of this hypothetical intervention because: (a) it is one of the cheapest and therefore affordable means of non-motorised transport; (b) it can operate on a fairly narrow road/path and can be carried across obstructions and stream crossings; (c) it has the potential to have a significant impact on the activity-travel patterns due to its flexible use in passenger as well as small load carrying purpose (with simple or no modification); (d) it is universally accepted as a form of transport all over the world hence less likely to be rejected due to cultural difference; (e) comparative ease of use and operation; and (f) the potential for identifying gender bias to the use of IMT/NMT, because in Bangladesh, bicycles are rarely, if ever used by women. This part was conducted by using HATS. The HATS survey method adopted in Bangladesh is depicted in Figure 2. Modifications (i) and (iv) proposed by Black & Song (1990) as described in section 2.4 were adopted. In Bangladesh sketch maps were omitted altogether as they were found to be unsuitable during a pilot survey due to the very poor map reading skill of the overwhelming majority of the rural people. This omission was compensated for by using interviewers who were familiar with the study areas. Recording in-home activity was not found to be a problem in Bangladesh. Modifications to the activity-travel patterns were made based on the current set of activities not on the probable activities; for instance, use of bicycle for current business related travel had been accepted but not for a prospective business venture in which the respondent might engage in future. The activity-travel diaries of all household members were revised based on the responses only after consensus was reached among the household members. The impact

[2] Children below the age of ten years were not interviewed as found unsuitable for interviewing during pilot survey

of non-motorised transport on the activity-travel patterns was assessed by comparing the original with the revised activity travel diaries.

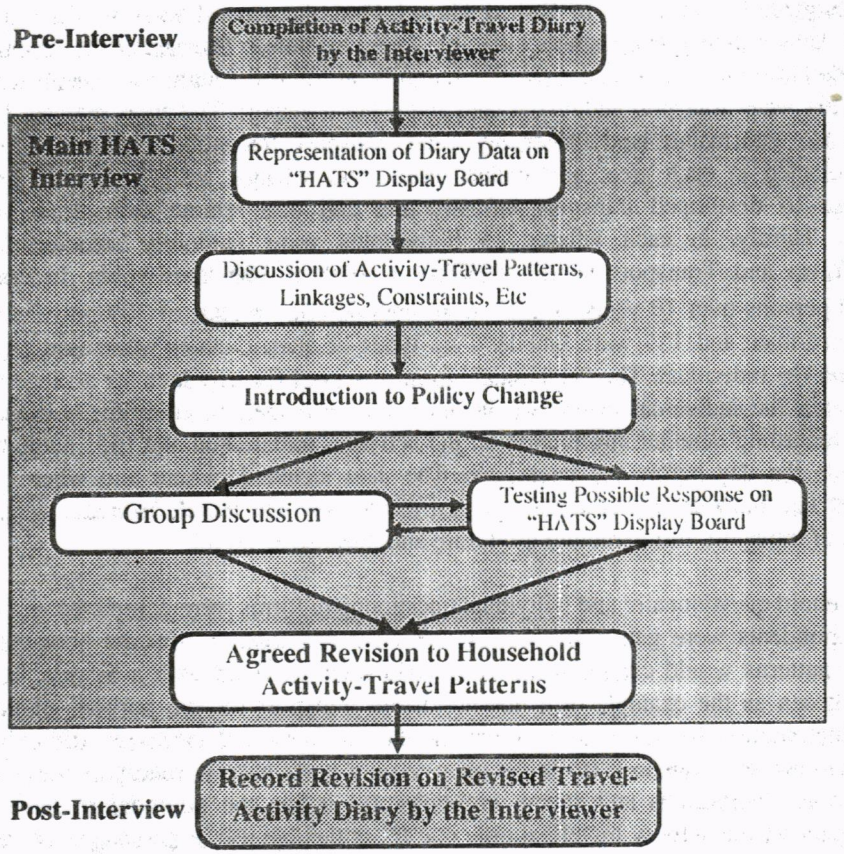

Figure 2 : HATS Interview Procedure Adopted in Bangladesh

4. RESEARCH FINDINGS

4.1 Result

The summary of the original activity-travel pattern is presented in Table 1. The table shows that, other than sleep, males and females spent most of the day for work and domestic work respectively [3].

[3] To capture the work within household and outside household work has been differentiated into two type domestic task (activities related to household work, like cooking, water collection etc.) and work (activities which are directly related to earning or production, like crop production, business, trading etc)

Table 1 : Summary of the Original Activity-Travel Pattern (Hour/Person/Day)

	Dhaparkahti			Guria			Manthana			Gangber			Overall		
	Male	Female	Overall	Male	Female	Overall	Male	Female	Overall	Male	Female	Overall	Male	Female	Overall
Education	2.3	1.2	1.7	1.2	1.1	1.2	1.2	1.1	1.1	1.1	0.8	0.9	1.4	1.0	1.2
Social/Leisure	2.9	2.9	2.9	3.0	2.4	2.7	3.2	3.9	3.5	3.2	5.0	4.0	3.1	3.6	3.3
Domestic Task	1.8	5.0	3.6	3.1	7.4	5.3	1.1	6.8	3.9	0.6	6.1	3.2	1.6	6.3	3.9
Eating	1.5	1.7	1.6	1.4	1.8	1.6	0.7	0.6	0.7	0.7	0.7	0.7	1.0	1.2	1.1
Personal Care	1.2	1.5	1.4	1.4	1.1	1.2	1.0	1.0	1.0	0.9	1.1	1.0	1.1	1.2	1.1
Work	4.0	1.9	2.8	2.8	0.8	1.6	5.2	1.2	3.3	6.1	0.8	3.6	4.7	1.1	2.8
Personal Business	2.1	2.3	2.2	1.6	2.1	1.9	0.8	0.5	0.7	0.4	0.3	0.3	1.1	1.3	1.2
Shopping/Marketing	0.1	0.0	0.1	0.7	0.0	0.3	0.8	0.0	0.4	0.7	0.0	0.4	0.6	0.0	0.3
Travel	0.8	0.2	0.5	1.2	0.2	0.7	0.9	0.3	0.6	1.8	0.4	1.2	1.3	0.3	0.8
Sleeping	7.1	7.3	7.2	7.7	7.2	7.4	9.1	8.6	8.8	8.3	9.0	8.6	8.1	8.1	8.1
Total	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24

No significant difference of total activity duration was found between males and females for activities like, education, eating, personal care, personal business and sleeping (Table 2). In other cases (leisure/social, domestic tasks, work, shopping and travel) there were significant differences in activity duration between males and females. Females spent more time than males for social/leisure activities and domestic tasks and on the other hand males spent more for work, shopping and travel. On average males spent 0.6 hours for shopping but for females it was zero. In case of the two main productive activities of males and females, work and domestic tasks respectively, there were significant inter-village differences. In case of work, work duration of male members of Dhaparkhati was significantly lower than Gangber and that of Guria was significantly lower than both Manthana and Gangber[4]. No significant difference was found in work duration of male members between Dhaparkhati and Guria. Significant differences of domestic task duration of female members were found between Dhaparkhati and Guria, as well as between Dhaparkhati and Manthana.

Table 2 : Comparison of Activity Times for Different Purposes by Males and Females

Type of Activity	Significance Level[5]	Type of Activity	Significance Level
Education	0.300	Work	0.000
Leisure/Social	0.004	Personal Business	0.130
Domestic Task	0.000	Shopping/Marketing	0.000
Eating	0.260	Travel	0.000
Personal Care	0.390	Sleeping	0.190

Of the total 309 respondents, the activity-travel patterns of only 24 (23 male and 1 female) respondents were changed after the introduction of the hypothetical intervention (hereinafter referred as "intervention"). Activity-travel patterns of two respondents each from Manthana and Dhaparkhati (most accessible and remotest) villages and ten each from

[4] Manthana is most accessible, Dhaparkhati is the least accessible and both Guria and Gangber have similar level of access to necessary facilities

[5] Significance level of comparison of means of daily activity times by males and females. Due to non-normal distribution and inequality of variances Mann-Whitney U-Wilcoxon Rank Sum W test was performed

Guria and Gangber (accessibility indicator close to median) were changed after the introduction of the intervention. Economic and travel characteristics of the households, members of which responded positively to the intervention, along with the characteristics of the overall sampled households, are summarised in Table 3.

Table 3 : Average Economic and Travel Characteristics of the Households, Member of Which Responded Positively to the Intervention

	Overall Sampled HH[6]	Positively Responded HH
Operated Land Area	1.9 Acre (.77 hectare)	2.85 Acre (1.15 hectare)
Cash Income	26,782 Taka (670 US$)	32,317 Taka (808 US$)
Cash Income from Agriculture	7,785 Taka (195 US$)	12,224 Taka (306 US$)
Cash Income from Job/Service	7,483 Taka (187 US$)	3,336 (83 US$)
Cash Income from Business	3,528 Taka (88 US $)	5,300 Taka (133 US $)
Trip/Annum/HH	11,718	14,849
Time Travelled/Annum/HH (Hour)	1615	2337
Transport Effort/Annum/HH (Tonne-Km)	244	396
Access Time (Minute)[7]	608	647

The average household operated land area and cash income of the respondents who responded positively to the intervention were about 50% and 21% higher than compared to the overall average. In case of average cash income from agriculture and from business the figures were 57% and 50% respectively. Only income from job/business was found to be lower in the case of households which responded positively. Travel characteristics of the households, members of which responded positively to the intervention, were substantially different from the average households. Those households which responded to the intervention were found to be making 27% more trips, spending 45% more time for travel and shouldering 62% more transport effort. Considering the access time, the households which responded positively were marginally less accessible compared to average households.

Of the individuals who responded positively, 38% were involved in trading/business or service, 21% were students and 29% were involved in agriculture farming. Household heads formed 58% of the individuals who responded positively and the rest 42% were sons and daughters of the household head. A Summary of changes in time allocations to different activities is presented in Figure 3. Figure 3 shows that total travel time would be reduced by 10.29% after the intervention. The percentage re-allocation of the overall saved time is shown in Figure 4. It is to be noticed that about 44%, 27% and 18% of the time saved from mainly travel (96% of the total time saved) would be reallocated for work, domestic task and social/leisure respectively. It is worth mentioning here that in some cases, although there was a potential for the use bicycles for some activities, the physical infrastructure was inadequate to support such use.

[6] HH is the acronym of household

[7] Total travel time to access to the necessary facilities using the best available modes of transport

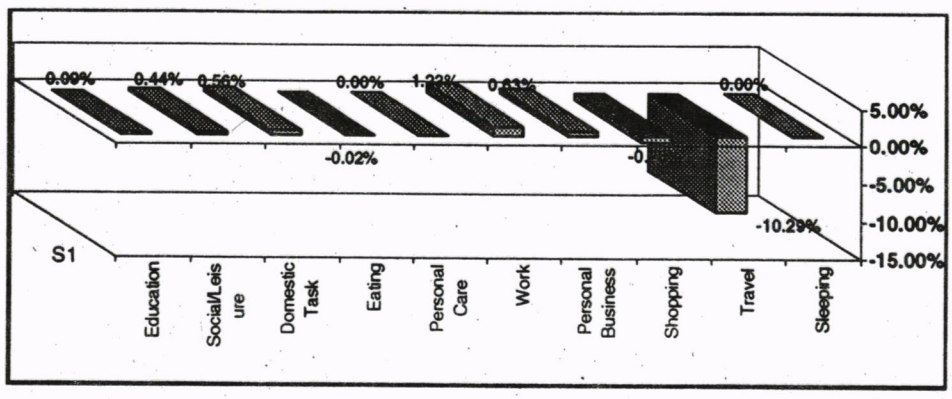

Figure 3: Activity-wise Percentage Change in Time Allocation After Introduction of Intervention

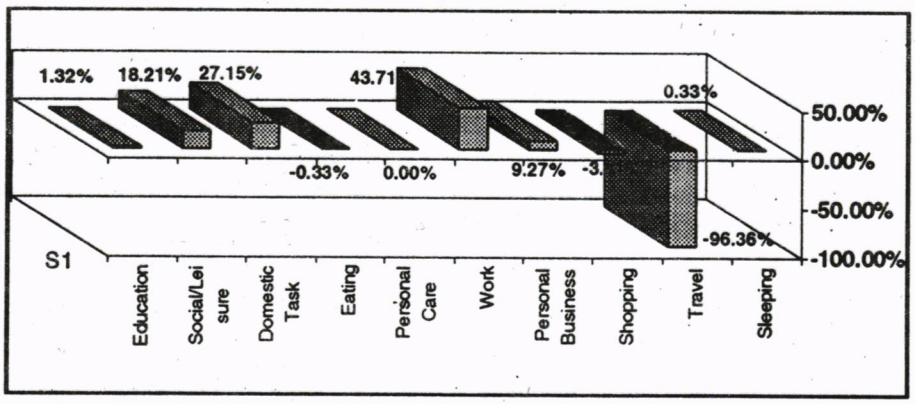

Figure 4 : Activity-wise Percentage Re-allocation of Saved Time After Introduction of Intervention

It was found that the sampled households consumed 62% of agriculture produce and sold 38%. Later in the season, the sampled households bought back additional food for their own consumption equivalent to 40% of their original agricultural production. Of the sample of 100 households, no households had any motorised vehicles, only 12% had bicycle and 4% had boats, ie. only 16% of the households had any means of transport. For each household interviewed the best available mode of transport or combination of modes was recorded for each of the household's separate activities. An analysis was then carried out on the various combinations of modes so recorded (Table 4). Motor vehicles, as a single mode, were found be the best available to less than 1% of the activities of the sampled households; NMT, as a single mode, were found to be the best available to 13% of activities and walking was the best available single mode to 41% of activities. The best available modes for 31% of activities was a combination of NMT and walking while for the remaining 15%, the best mode was a combination that included motor vehicle of some type. When asked whether the household could afford to hire emergency vehicles 69% responded with "yes" and 31% with "no". When asked about what type of vehicle the household could hire, the responses were 4% car, 16% autorickshaw/ mechanised boat and 80% non-motorised transport like rickshaw, boat etc.

Table 4: Access of Households to Range of Necessary Facilities Using Different Modes of Transport[8]

	Nos. and Percentage of Facility									
Villages →	Dhaparkhali		Guria		Manthana		Gangber		G. Total	
Mode or combination of modes ↓	Nos.[9]	%[10]	Nos.	%	Nos.	%	Nos.	%	Nos.	%
Mechanised Vehicles Only	1	<1%	1	<1%	0	0%	0	0%	2	<1%
Human/Animal Driven Vehicle only	0	0%	1	<1%	49	12%	149	37%	199	13%
Walking Only	190	50%	100	27%	127	32%	223	56%	640	41%
Combination of mech. & human/animal driven vehicle	10	3%	24	6%	150	38%	28	7%	212	14%
Combination of human/animal driven vehicle & walk	163	43%	249	66%	74	19%	0	0%	486	31%
Combination of mechanised vehicle & walk	14	4%	0	0%	0	0%	0	0%	14	1%
Combination of mech., human/animal driven veh. and walk	0	0%	0	0%	0	0%	0	0%	0	0%

When asked whether there existed any restriction on the use of any particular mode of transport, more than 90% of the females responded "yes" compared to less than 1% of males. All female respondents identified that mode of transport as bicycle. Females were fearful of social backlash if they used bicycles as females using bicycle were regarded as behaving like males. Some female commented "I can ride a bicycle in another area but not in this area". Interestingly, some of females working in a Non-Government Organisation (NGO) were found using bicycles for trips inside the study villages. When questioned it was found that they were from different areas and also would have been unwilling to use a bicycle in their own area.

4.2 Discussion and Conclusion

The above data shows that female members of the households were engaged mostly in activities that rarely demanded they go far outside the house. On the contrary males were mainly engaged in activities related to earning or production which might warrant use of transport. It has also been found that though female members of the household made significantly higher number of trips, they spent significantly less time for travel and shouldered significantly less transport burden - they spent 29% of the total households travel time and contributed only 1% of the transport effort. Surprisingly it was found that the number of trips made by the females were positively (correlation coefficient of 0.4433 with 2-tailed significance of .01) correlated to the transport effort. The conclusion from the above is that trips made by the females tend to be shorter, mostly laden but light loads compared to their male counterparts. Trips made by males were found to be longer and less likely to be made with weight but when they made loaded trips they were with much larger loads.

[8] Best available mode or combination of modes form the household has been considered irrespective of the ability of the households of their use

[9] Represents nos. or households x nos. of facility accessible with particular mode of combination of modes of transport

[10] Represent % of total of respective nos. column

It has been found that work-related activity time of males in Dhaparkhati was significantly less than Gangber and that of Manthana was significantly less than that of Guria and Gangber (section 4.1). It was also found that the cash income from agriculture and business of Manthana and Gangber were substantially higher than Dhaparkhati and Guria. Hence it can be concluded that the more the households are engaged in commercial activities (commercial farming or other activity) the more total time they spend on work.

The above data shows that less than 1% (.1%) of the activities to which the household had to have access could be accessed solely using mechanised vehicle; the rest had to be accessed using either NMT(13%) or walking (41%) or any combinations of modes like motorised vehicle, NMT and walking (46%). Accordingly, there exists enormous potential demand for NMT to carry out households' basic, economic and life enriching activities. The potential for motor vehicles to meet rural households' day to day activities is negligible because they are not affordable (31% of the households ruled out use of any type of vehicle even in case of emergency simply because they are beyond their financial means). Of the other 69% of the households, only 20% have the ability to use mechanised vehicle and the rest 80% could only afford NMT. Hence, considering the nature and scale of economy and affordability, NMTs are more amenable compared to mechanised vehicle and can play a significant role in meeting households' transport demand.

The introduction of NMT could change the activity-travel pattern of only 8% of the respondents. However, this data should be treated with caution as the data collected was only cross-sectional. It did not capture seasonal variations of activity-travel patterns. Despite this shortcoming some of the analysis of the data are still conclusive. Female's activity-travel patterns are less likely to be affected by the introduction of NMT as they are rarely involved with directly productive activities (on average 6.3 hours per day was spent on domestic task compared to 1.1 hours/day for work) and considering the trip characteristics as discussed above. This coincides with the findings of Airey & Howe (1991). NMTs are most likely to favour wealthier classes as the average household income and agriculture land ownership pattern of the respondents who were affected by the intervention were considerably higher than the overall average. This again coincides with the findings of Airey & Howe (1991). It was found that the time saved on travel due to the introduction of the intervention would be used mainly for productive purposes (44% and 23% were used for work and domestic task respectively). This is contrary to the conventional belief that people in rural areas of developing countries do not place the same relative value on time as their developed country counterparts.

It can also be concluded that there existed geographical factors restricting the wider use of bicycles. Cultural factors may play a central role towards the use of bicycle by females in Bangladesh. It was also observed that females were willing to adopt IMTs but cultural factors restricted them from doing so. This corroborates the findings in Africa by Malmberg-Calvo (1992a) and Urasa (1990) regarding the issues related to females and IMT.

The above findings may form useful inputs in the decision making process for formulation of rural transport policy in Bangladesh.

The use of HATS for investigation of daily household activity-travel pattern and evaluation of policy impact was found useful like other developed and developing countries but only

with few modification of the method used in other developed countries. It has been observed during the study that the use of HATS needs qualified interviewers and careful training of interviewers as well as a pilot study before commencing the actual study. As the use of maps had been omitted altogether due to the poor map reading skill of the overwhelming majority of the rural population in Bangladesh, it also needed interviewers who were fairly knowledgeable of the land-use and transport network of the area. Weight of the HATS equipment (a set of particular equipment used in this study weigh about 30 Kg) had been found as a problem for moving from one place to another in Dhaparkhati and Guria (southern part of Bangladesh) where transport services and infrastructure were poor. Improvised equipment with less weight may be of help in remote areas of developing countries which are characteristically poorly served by transport infrastructure and services. Experience during the Bangladesh study demonstrated that it would be preferable for the HATS study to be used alone rather than only as a part of a study with multiple objectives. This is because a HATS study alone would acquire more qualitative data, this would be better for getting improved insight into the intricate inter-personal and spatio-temporal linkages. HATS can be recommended for use in other areas of developing countries but only with some modification of the method used in the developed countries which may depend on the social, cultural and geographic characteristics of the area concerned.

The findings of this study would be more conclusive if longitudinal data could have been collected to capture seasonal variations of activity-travel patterns with a larger sample size. These shortcomings were unavoidable due to time and financial constraints. Further study could be made taking into consideration the above limitations.

Nevertheless, the following conclusion can be made from this study:

1. NMT has an enormous potential in addressing the transport related problems of the rural population of Bangladesh;

2. Impact of NMT on the activity-travel patterns of the rural population is not as straightforward as commonly perceived;

3. Impact of NMT has bias towards males and the wealthier classes;

4. Any intervention to increase mobility of the rural population in a particular area of a developing country using IMT/NMTs needs, *inter alia*, careful investigation of the social, cultural, economic and geographical factors related to use of IMT/NMTs of the area concerned;

5. Rural population of Bangladesh would tend to spend the time saved from the transport intervention for productive purposes;

6. HATS has been found useful for investigation of daily household activity-travel pattern and evaluation of transport policy intervention but only with some modifications of the method used in developed countries and in China.

7. Use of HATS may be recommended for the abovementioned purpose in the rural areas of developing countries but with modification suiting the social, cultural and geographic characteristics of the area concerned.

8. More research is warranted to make more conclusive recommendations on the impact of NMT on rural households' activity-travel patterns.

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