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ACCESSIBILITY MEASURES OF.VARIO US MODES OF TRANSPORT IN BANGLADESH

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The contribution of appropriate transportation systems to economic development and growth can be gauged through comparing the performance of a region enjoying such facilities with another region that lacks such facilities. The selection of such regions and collection of the required primary data were undertaken by the author in collaboration with members of the staff of Bangladesh Academy for Rural Development (BARD), Comilla.

Two regions were purposively selected in the survey. These are the Kotwali and Burichong thanas of comilla district. . The former has relatively better transportation facilities with respect to rural networks and m ides of transportation compared with the latter, that is, Burichong which is regarded as a control region. From each region, five villages were selected purposively keeping in mind the outline of the study. In each region four markets were selected; while selecting the markets care was taken to ensure that farmers of at least one selected village generally sold their farm products m each of the markets.

Both regions are located in a rice growing plain. The soil type of both regions is similar and under the same Tippara-Noakhali clay plain. The normal rainfall of the two areas during the whole year ranges from 80 to 90 inches approximately. Attention s7iould be drawn here to an important differential characteristic of the *two* regions. Kotwali region is adequately served by deep tube-well irrigation facilities. In Burichong region, low lift pumps are mainly used for irrigation purposes in the villages located around the river Gumuti and its feeder canals. It is assumed that this difference in the irrigation system is deemed to be less important from the present `study's standpoint.

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TABLE 1 LIST OF SAMPLE VILLAGES AND MARKETS

1. Sample Villages :

Thana					
Kotwali	(p_1)	Sreekamta	(p_2)	Ramchandrapur	
	(p_3)	Sreemantapur	(p_4)	Sreenibush	(p_5) Jorpushkuni
Burichong	(p_1)	Kakiarchar	(p_2)	Barair Jalam	
	(p_5)	Metholma	(p_4)	Abedpur (s)	(p_5) Abedpur

2. Sample Markets :

Thana				
Kotwali	(L_1)	Champar Bazar	(L_2)	Chawara Bazar
Laksham	(L_3)	Rajgonj	(L_4)	Baghmara
Burichong	(L_1)	Abedpur	(L_2)	Barella
Debidwar	(L_3)	Dighirpar	(L_4)	Chandina
Chandina				

Key

P =villages of the two reqgions

L =markets of the two regions

The rural road systems in the area were constructed by a government works programme during the early 1960s under the Rural Works Programme. As a matter of fact, Kotwali region is well furnished with modern infrastructural facilities and its communication network is better developed in comparison with most of the Thanas in Bangladesh. About 15 miles of the Dacca-Chittagong trunk road is within the boundary of the region. The road enters the Thana at the western boundary, runs to the east for about 8 miles, and then south for the rest of the way. Besides the trunk road, three other metalled roads pass through the region ; 8 miles of the Chandpur road, 5 miles of the Kotbari road and 6 miles of the Bibir Bazar road. All villages are connected to the metalled roads

with linking dirt roads. The Dacca-Chittagong railway line passes through the middle of the Thana from north to south. Waterways are almost absent in the region (Rahim 1963).

Among the selected five villages in the region, two are just beside the metalled road and the remaining three are further away. However, these three villages are connected to the metalled road by feeder roads. Among the four markets, three are on the metalled road and one is connected to the metalled road by a narrow road. In the sample villages and markets, cycle rickshaws, bullock carts, tractors and trucks can easily enter for hauling purposes.

By contrast, Burichong Thana, though located adjacent to Kotwali Thana, is furnished with relatively few rural roads and road transportation facilities. For instance, there is only one metalled road, the Comilla-Brahmanbaria road. It runs from south to north and passes through the Thana. But selected villages of this area are not connected with this road through any linking dirt roads. The Dacca-Chittagong railway line passes through the eastern boundary line of the region from north to south. Water transportation is possible during the rainy season in the area. The river Gumuti originating in the Tippera State of India flows directly through the middle of the Thana which causes flooding in each monsoon due to heavy rainfall in the hilly regions of Tippera State. However, in the dry season the main transport mode of goods is human labour (shoulder load and head load). During the monsoon, small two man boats become the only possible mode of transportation in the area.

Among the selected five villages in the area, none is located beside the metalled road. Among the four sample markets, one is on the matalled road. Though this marjet is located on the metalled road, rural feeder roads are almost absent between the market and surrounding villages.

A total of 50 farmers (5 from each village) and 40 traders (5 from each market) were interviewed in the two regions. Farmers selected for interview were the ones with marketable surplus in the village. The procedure for selecting traders was that on the weekly market day the sample traders were contacted and approached through some persons known to them so that they might not hesitate to supply data from their books of account.

Two separate interview schedules were used for the two groups, i.e. farmers and traders in the two sub-samples. This resulted in building case studies of farmers and

traders from the selected villages and markets in each region. All the information collected related to the 1972-73 production and trading year for rice. Finally, selected farmers and traders in both regions were grouped on the basis of the variables deemed to be important in the present study.

Relevant Agro-economic Characteristics of the Study Area

Generally speaking, these factors in the case of farmers should include the size of land holding, the number of land parcels as well as their shape and location, yield characteristics, the mix of different rice varieties, the pattern of use of the product, i.e. family consumption, amounts reserved as seeds, gifts and payment in kind, and the quantity sold or to be sold, etc. However, we will concentrate here on the size of land holding, pattern and intensity of cropping in the study area as revealed by the sample and on the volume of traders' transactions in the two regions. The reason for this concentration is that these characteristics are helpful in verifying or otherwise our hypotheses.

Size of Operational Land Holdings

Size of operational holdings is an important determinant of the economies of scale, income distribution, marketable surplus and the adoption of improved practices in agriculture. In the Kotwali region, among the sample growers, 56 per cent of the farmers had land holdings within the range of 0 to below 5 acres of land but in the Burichong region, 84 per cent of the sample growers had land holdings within this range. The remainder (44 per cent and 16 per cent of the farmers of both regions respectively) had land holdings within the reange of 5 to below 10 acres of land. The skewness is distinctly marked in the latter case.

Cropping Pattern

In both regions, rice is the principal crop. In the Kotwali region, paddy, potato and winter vegetables are the main field crops with paddy as the principal crop. Additionally, Boro as a winter paddy crop with proper irrigation facilities is cultivated as the HYV paddy in this area. In the Burichong region, paddy, jute and lentils are the main field crops. Paddy (Aus and transplanted Aman) is produced as the principal crop. Jute comes next in importance among the crops grown there.

Cropping Intensity

Increasing the intensity of cropping is perhaps the major means of increasing total cropped area. However, this is mainly determined by the extent of irrigated area and

TABLE 2 CROPPING INTENSITY OF EACH SAMPLE VILLAGE IN THE TWO REGIONS

Kotwali Region			Burichong Region		
Village	Total Land Operation (Acres)	Cropping Intensity (%)	Village	Total Land Operation (Acres)	Cropping Intensity (%)
Sreekamta	52.40	201.54	Kakiarchar	48.00	177.77
Ramchandrapur	51.00	204.00	Barair Jalam	45.50	184.21
Sreemantapur	41.40	200.00	Metholma	24.03	190.71
Sreenibush	29.92	182.21	Abedpur (s)	26.50	182.46
Jorpushkuni	58.50	212.72	Abedpur	23.05	185.29
All villages	233.22	202.23	All villages	167.08	183.12

crop rotational practices. The average intensity of cropping in the Kotwali and Burichong regions is 202.23 and 183.12 per cent respectively (Table 2). The low intensity of the Burichong region is due to the low percentage of irrigated land.

In the Kotwali region, per acre yield and total production are also higher. It is estimated that in the Kotwali region, per acre yield is 31.48 muands while in the case of the Burichong region it is 24.69 maunds. Of the total production among sample farmers in both areas, the former produced 64.03 per cent and the latter produced 35.97 per cent. Again, of the total out- put of the Kotwali region, 50.52 per cent was used for family consumption as food intake, for seeds, wastage and for other uses and the rest had either been sold out or was to be sold. The situation in Burichong was that 56.53 per cent was used for family consumption and 43.47 per cent had been sold or was to be sold.

Volume of Traders' Transactions

From traders' information on the transaction of rice in both regions, the traders of Kotwali operated on a larger amount of capital than the traders of Burichong. It is estimated that, of the total volume of transactions in the two areas, Kotwali traders operated 82.74 per cent while the rest was operated by the Burichong traders. The average operating capital invested by each trader in Kotwali was 69.64 per cent higher than a trader operating in Burichong.

Accessibility Measures of Different Modes

Accessibility measures by different modes of transport reflect the level of service provided by transportation systems to various regions. Accessibility may be described in the present tudy as the ease of movement from one area to another by a specific mode of transport. The following procedure, adopted by Falcocchio and Cantilli (1974), can be fitted to the data to measure the accessibility index of the different modes of transport.

$$x_i = \sum_{j=1}^{n} \frac{E_j}{(T_{ij})^{\alpha}}$$

where,

X_i = Accessibility to market with mode i

E_j = Quantity hauled to market j

T_{ij} = Movement cost charged per maund-mile for mode i to market j

α = Exponent of movement cost

The detailed calculations are shown in Appendices where the transport cost factor is defined as $F_{ij} = 1/(T_{ij})^{\alpha}$.

The accessibility indices resulting from the calculations are useful only when they are compared with each other. It can be stated that accessibility measures are relative values which describe how well one mode compares with another and, in general, how one region compares with another in terms of transport.

From the analysis it can be stated that in the Kotwali region, farmers use tractors as the most efficient mode of transporting rice, whereas in the Burichong region, shoulder load is the most important mode. The farmers of Burichong use human labour extensively as there are no other alternative mechanical methods of transport available in the dry season due to the non-availability of road networks (Appendix A).

Considering the traders' point of view, in the Kotwali region trucks are the most accessible mode, while in Burichong big country boat is the efficient one. Due to lack of roads in the Burichong region, big country boats are used by traders in the rainy season to transport rice ; although their speed is very low they can carry a large amount of rice for a longer distance and more cheaply than any other mode used in the region.

From the above discussion it can easily be seen that the accessibility indices of respective modes for both the sub-categories of the sample show that the Kotwali region is highly accessible from the production centres to the market places using tractor and truck in comparison to the Burichong region which uses shoulder load and boat as the only accessible modes of transport.

Modal Calibration

The impact of transportation accessibility on capacity levels of the different modes of transport can be obtained by relating the two variables through regression analysis.

Altogether, there are fifteen modes of transport used individually and in combination by the farmers and traders of both regions. Accessibility indices were calculated for each mode and combination mode in the same manner as in the illustration given in the Appendices A—C. The volume transported by each mode, together with the accessiblity index of each mode, are given in Appendix C.

The relationship might be described as a positive exponential function of the type,

$$C_i = AX_i^b$$

where,

C_i = Volume transported by each mode

X_i = Accessibility indices of modes

The positive exponential function states that the importance of the accessibility variable on capacity of vehicle increases as accessibility increases for the mode.

For ease of computation, the positive exponential function may be transformed to a linear function, using logarithmic transformation and then fitting the linear function to the data using the ordinary least-squares method. However, to avoid the unrealistic conclusions that result from assuming a linear relationship, the final capacity-accessibility model takes the following form in semi-logarithms :

$$c_i = a + b \log X_i$$

where,

c_i = Volume transported by different modes of transport in maunds

x_i = The accessibility index of different modes

The calibrated form of the model is :

$$c_i = 2.303 + .8880 \log X_i$$

S.E. (.0745)

$\bar{R}^2$ = .9099

From the equation, it may be concluded that the capacity of the different modes of transport increases as accessibility increases. The results of the capacity-accessibility analysis may be summarised as follows :

(a) The capacity-accessibility hypothesis was found valid in the model.

(b) The increase in production that can be expected in an area depends on the increase in capacity of different modes of transport to move the inputs toward production centres and outputs toward consuming centres. This relates to the increase in accessibility programmed for the area and the level of existing transportation services found in the area.

That is, if the accessibility for a certain mode of transport increased in an area, the capacity of that mode for shipments of goods certainly be increased.

To sum up, more an area is accessible through road network system more the capacity and the use of a mechanical mode of transport will be increased. Hence, it is implicit that development of a transportation system both in road network and advance mode of transport is one of the preconditions for commercialization of agriculture.

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APPENDIX A

The following illustration will show the use of the accessibility measure equation using the information collected from the farmers of two regions :

Kotwali Region : Transportation Cost Rate Charged by Each Mode in Each Village per Maund-Mile

Mode of Transport Used (i)	Production Village (n)				
	p_1	p_2	p_3	p_4	p_5
Rickshaw (X_1)	.16	—	—	—	.25
Tractor (X_2)	.05	.05	—	—	—
Bullock Cart (X_3)	—	—	.25	.10	—

The volume transported from each village (p) is :

$p_1=623$, $p_2=651$, $p_3=920$, $p_4=628$, $p_5=747$

The transportation cost factors (F_{ij}) associated with each mode are defined as $F_{ij}=\frac{1}{(T_{ij})\alpha}$ and are calculated considering .45 as the exponent of transport cost following Falcocchio and Cantilli (1974).

Transport Cost (Maund-Mile) (T_{ij})	Transport Cost Factor (F_{ij})
.05	3.85
.10	2.82
.16	2.28
.25	1.87

The accessibility for each mode (X_i) may then be calculated as follows :

X_1 (Rickshaw) = $(p_1)(F_{1-1}) + (p_5)(F_{1-5}) = 3{,}795.44$

X_2 (Tractor) = $(p_1)(F_{2-1}) + (p_2)(F_{2-2}) = 7{,}411.25$* *=Most Accessible Mode

X_3 (B. Cart) = $(p_3)(F_{3-3}) + (p_4)(F_{3-4}) = 3{,}491.36$

Burichong Region : Transportation Cost Rate Charged by Each Mode in Each Village per Maund-Mile

Mode of Transport Used (i)	Production Village (n)				
	p_1	p_2	p_3	p_4	p_5
Boat (X_1)	—	—	.37	—	—
Shoulder Load (X_2)	.59	.75	.43	.73	.82
Shoulder Load and Rickshaw (X_3)	.45	.50	—	—	—

The volume transported from each village (p) is :

$p_1 = 610$, $p_2 = 508$, $p_3 = 227$, $p_4 = 335$, $p_5 = 163$

The transport cost factors (F_{ij}) associated with each mode are defined as $F_{ij} = \frac{1}{(T_{ij})\alpha}$ and are calculated considering .45 as the exponent of transport cost following Falcocchio and Cantilli (1974).

Transport Cost (Maund-Mile) (T_{ij})	Transport Cost Factor (F_{ij})
.37	1.56
.43	1.46
.45	1.43
.50	1.37
.59	1.27
.73	1.15
.75	1.14
.82	1.09

The accessibility for each mode (X_i) may then be calculated as follows :

X_1 (Boat) $= (p_3)(F_{1-3}) = 354.12$

X_2 (Sh. Load) $= (p_1)(F_{1-2}) + (p_2)(F_{2-2}) + (p_3)(F_{2-3}) + (p_4)(F_{2-4}) + (p_5)(F_{2-5}) = 2,248.16$*

X_3 (Sh-Load & Rickshaw) $= (p_1)(F_{3-1}) + (p_2)(F_{3-2}) = 1,568.26$

*Most accessible mode

APPENDIX B

The following illustration will show the use of the accessibility measure equation by using the information collected from the traders of two regions :

Kotwali Region : Transport Cost Rate Charged by Each Mode to Each Market per Maund-Mile

Mode of Transport Used (i)	Local Markets (j)			
	L_1	L_2	L_3	L_4
Rickshaw and Truck (X_1)	.08	.10	.08	—
Truck (X_2)	.08	.04	—	.03
Tractor (X_3)	.05	—	.08	—
Tractor and Truck (X_4)	.06	.04	.06	—
Bullock Cart and Truck (X_5)	.04	—	—	—

The volume transacted in each market is : $L_1 = 8,650$, $L_2 = 20,200$, $L_3 = 16,200$, $L_4 = 75,800$.

The transport cost factors (F_{ij}) associated with each mode are defined as $F_{ij} = \frac{1}{(T_{ij})\alpha}$ and are calculated considering .45 as the exponent of transport cost following Falcocchio and Cantilli (1974).

Transport Cost Maund-Mile (T_{ij})	Transport Cost Factor (F_{ij})
.03	4.85
.04	4.26
.05	3.85
.06	3.55
.08	3.12
.10	2.82

$X_1 = 123,588$, $X_2 = 480.670$*, $X_3 = 83,846.5$ $X_4 = 174,269.50$
$X_5 = 36,849$

* Most accessible mode.

Burichong Region : Transport Cost Rate Charged by Each Mode to Each Market per Manund-Mile

Mode of Transport Used (i)	Local Market (j)			
	L_1	L_2	L_3	L_4
Shoulder Load, Rickshaw and Truck (X_1)	.18	—	—	—
Boat (X_2)	.02	.02	.03	—
Shoulder Local and Boat (X_3)	.22	—	—	—
Truck (X_4)	—	—	—	.06

The volume transacted in each market (L) : $L_1 = 4{,}190$, $L_2 = 6{,}425$ $L_3 = 7{,}300$, $L_4 = 6{,}886$

The transport cost factors (F_{ij}) associated with each mode are defined as $F_{ij} = \frac{1}{(T_{ij})\alpha}$ and are calculated considering .45 as the exponent of transport cost following Falcocchio and Cantilli (1974).

Transport Cost (Maund-Mile) (T_{ij})	Transport Cost Factor (F_{ij})
.02	5.81
.03	4.85
.06	3.55
.18	2.16
.22	1.98

The accessibility calculated for each mode is :

$X_1 = 9{,}050.40$, $X_2 = 97{,}078.15^*$, $X_3 = 8{,}296.2$

$X_4 = 24{,}445.30$

* Most accessible mode.

APPENDIX C

CAPACITY-ACCESSIBILITY MODEL

Sample Group		Mode of Transport	Accessibility Index (in 000)	Volume Transported in Maunds
Used by Farmers of Two Regions :				
	1.	Rickshaw	3.80	288
Kotwali	2.	Tractor	7.41	564
	3.	Bullock Cart	3.50	354
	4.	Boat (Small)	.35	112
	5.	Shoulder Load	2.25	750
Burichong	6.	Shoulder Load and Rickshaw	1.57	572
Used by Traders of Two Regions :				
	7.	Rickshaw and Truck	123.59	15,450
	8.	Truck	480.67	78,800
Kotwali	9.	Tractor	83.85	9500
	10.	Rickshaw and Tractor	174.27	14,100
	11.	Track and Bullock Cart	36.85	3000
	12.	Shoulder Load, Ricksahaw, and Truck	9.05	2250
	13.	Boat (Big)	97.10	16,225
Burichong	14.	Shoulder Load and Boat	8.30	740
	15.	Shoulder Load and Rickshaw	24.45	6886