The Geographic Profiling of Poverty and Accessibility: The Case of Two Provinces in the Philippines

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This study attempts to relate the poverty problem in the Philippines using spatial accessibility measures. Spatial accessibility is the ease with which one could avail of the social services and economic opportunities laid in geographic space to the individual. Using the provinces of Eastern Samar and Siquijor Island as case studies, a Social Composite Index (SCI) value for the household was derived from the 13+1 CBMS core indicators of poverty, which represents the unmet needs of the household and which was then aggregated at the barangay level. The spatial accessibility values were estimated by measuring how each barangay, specifically households, would avail themselves of the social services (such as schools and hospitals) and economic opportunities in the town center or major economic centers. The ease or difficulty of availing these social services and economic opportunities was estimated using the time variable in order to relate accessibility to the poverty indicators in the barangay. Multiple regression models were developed to relate poverty indicators to spatial accessibility measures and then tested to determine their impact on poverty. The tests showed that expected improvements in accessibility of more elementary schools in Siquijor would redound to a higher SCI or lower poverty levels. The planned merger of hospitals in Eastern Samar, revealed a lower SCI or an increase in poverty levels. Clearly, therefore, the link between poverty and accessibility could be established using CBMS data, and more importantly, could be used to predict the impact of planned social infrastructures on poverty levels.

Key Words: *poverty, spatial accessibility, barangays, social composite index*

Background

One argument why people in the countryside are poor is because of their limited access to social services as well as to economic opportunities. This is also one reason of the high rural-urban migration rate in the Philippines where people in the provinces go to Metro Manila in search of economic opportunities. Though generally true, there is a case for establishing the empirical basis of this assumption in the light of available data from Community-Based Monitoring System (CBMS) regarding poverty especially in the countryside. The CBMS data are based on 13 + 1 core indicators as listed are (a) malnourished children (0-5 years old), (b) child deaths (0-5 years old), (c) women deaths due to pregnancy-related causes, (d) household living in makeshift housing, (e) household who are squatters, (f) household without access to safe water supply, (g) households without access to sanitary toilet facilities, (h) children not attending elementary school (6-12 years old), (i) children not attending secondary school (13-16 years old), (j) household with income below the poverty threshold, (k) household with income below the food threshold, (l) households who experience food shortage, (m) persons in the labor force who are unemployed (15 years old and above), and (n) persons who are victims of crimes.

The main focus of this study is on the CBMS core indicators that could be directly affected by spatial accessibility like for example to avail of social services, such as in the case of accessing a provincial/community hospital, access to school, to access market facilities to sell their farm produce, among others. The CBMS study was conducted in several provinces of the country and it has the objective of covering all the provinces of the country. This study used the CBMS data and relate them to spatial accessibility in the provinces of Eastern Samar and Siquijor island.

Objectives

The following are the objectives of the study: (1) to define and develop accessibility models in the context of the poverty problem of the country, (2) to determine the role spatial accessibility plays in availing of basic social services (focusing on several of the social services, like access to education, to health services, and economic activities), (3) to establish proxy variables that could serve as determinants of the lack of or availability of accessibility variables, (5) to determine the effect of gender on poverty and accessibility relations, and (6) to recommend improvements to the CBMS that would reinforce its future instruments and database on accessibility variables.

REVIEW OF LITERATURE

As defined by Hansen (1959), accessibility is conceived as "the potential for interaction," while Handy and Niemeier (1997) explained that the potential for interaction is influenced by the qualities of the transport system on the one hand and by the qualities of the land-use on the other hand. Straatemeier (2008) measured accessibility using a simple opportunities' measure which counted the number of available spatially dispersed opportunities within a given distance of travel time. Several studies have shown some relation between poverty and access to jobs. Sanchez (2008) reviewed public transportation policies from 1960 to 2000 in the United States to highlight federal policies that affected urban areas during this period, especially in relation to low-income transportation mobility. Kalachek (1968) studied the African-Americans' experience as central city residents and their high unemployment even in times when the overall demand for labor was strong and hiring standards were quite relaxed. The findings of the US General Accounting Office (1998) revealed that existing public transportation systems could not always bridge the gap between where the poor live and where jobs are located. However, the studies by Blackley (1990) and Hughes (1991) showed the relative impacts of employment accessibility resulting from public transportation services, and both recommended

increased public transportation expenditures for addressing urban unemployment problems. Meanwhile, Porter (2007) studied the experiences of women and female children residents in rural areas of sub-Saharan Africa with poor physical accessibility (to services and markets) because of poor roads and inadequate transport (in terms of regularity, reliability and cost). She examined to some detail the following: access to education, access to health services, and access to markets. She concluded that physical remoteness and isolation often compound the effects of poverty and deprivation. Diaz Olvera, Plat, & Pochet (2003) pointed out the major deficiencies in urbanization and transportation systems in Dar es Salaam, Tanzania's largest city, conditions they viewed to be reinforcing patterns of social and urban segregation.

In the Philippines, Barrios (2008) discussed the economic vulnerability of rural households. He proposed that as a starting point to address this problem, there must be a comprehensive improvement in accessibility through public investment in infrastructure, coupled with the use of users' fees for the continuous provision of new infrastructures and maintenance of existing ones. Another recent study termed, Integrated Rural Accesibility Program (IRAP) by the International Labour Organization (2000), defined accessibility as the ease or difficulty for rural folks to satisfy their access-related needs. It comprised a set of planning procedures and techniques that cut across sectors and can be used at the local government level for spatial access planning and at the village level for personal access planning.

THEORETICAL BACKGROUND

Physical Accessibility-Related Variables

With traffic congestion not a concern in the provinces of Eastern Samar and Siquijor, the basic distance-speed-time (s-v-t) equation would be used in order to measure accessibility with time as the independent variable using the equation

$$t = 60S/v \qquad (1)$$

where t is the travel time in minutes, v is the average travel/sailing speed (in kph), S is the road segments/river links/sea lanes, in kilometers, and 60 is the conversion factor of hours to minutes. In the computation of travel time in Eq. (1), there is a need to distinguish the type of road or path network available. When one's residence is in an island barangay, the average sailing speed of the boat is used. Hence, the minimum time to travel from the home origin to a destination whether going to school, to the hospital, to the municipal center or to the market, would be the summation of all the time spent by the individual using a particular transport mode along a particular link. The shortest path in terms of travel time as given in Eq. (2) is

$$T_{ij} = 60 \sum_{k=1, l=1}^{(n,m)} \left[\left((\alpha_l \, S_{kl}) / v_{kl} \right) \right] \qquad (2)$$

where T_{ij} is the minimum travel time, in minutes, from home origin i to the nearest destination j (i.e. school, market, or hospital), and α_l has a value of 1 for a specific transport surface type l (i.e. national, provincial, barangay, river or sea), otherwise it is zero, S_{kl} is the specific segment of the specific transport surface type l using vehicle k (i.e. jeepney, private car, tricycle, inland river boat, sea boat), in kilometers, v_{kl} is the given speed of vehicle k on transport surface type l, in km/hr, and 60 is the conversion of hours to minutes same as in Eq. (1).

The Social Composite Index (SCI) of CBMS

There are many measures and definitions of poverty as discussed by Orbeta Jr. (2002). The CBMS has devised a single composite index to measure poverty which would reflect a representation of unmet needs in the local government unit. The CBMS Composite Indicator is one way of ranking and identifying needy households that may be prioritized as beneficiaries of development interventions. Alternatively, the components of this social composite index (SCI)

reflect living standards in a particular community. The index is measured, using a bottom-up approach, starting at the household level. At the household level, it is derived by counting the number of attained needs out of the 14 CBMS core indicators using a dichotomous choice (0 or 1) decision variable. At the barangay level, the equation form of how SCI is computed is as follows

$$(3)$$

$$SCI = \sum_{i=1}^{14} \left(\frac{\text{Number of } HH \text{ with unmet needs } i \text{ in the Barangay}}{\text{Total number of } HH \text{ in the Barangay}} \right)_i$$

Hence, if all the households in the barangay satisfy a certain poverty indicator i, the numerator would be zero in the above equation for that poverty indicator only and would not contribute any value to the SCI. The higher the number of households with unmet needs the higher would the SCI value, and hence the higher would be the poverty in the barangay.

Accessibility Model

There is no argument that poverty, to some degree, is cause by lack of spatial accessibility: the lack of accessibility to avail of social services, the most important being health services and education, as well as to seek employment in order to achieve economic self-reliance. The socio-economic characteristics, at the barangay level such as income, vehicle ownership, as well as other factors, like presence of support services among relatives and the community may also play a role. Hence a relation, Eq. (4), can be formed such as

Poverty = f(spatial accessibility, socio-economic characteristics, other factors) (4)

Since in this study, poverty could be represented by the SCI value Eq. (5) would then become

SCI = f(Spatial accessibility, socio-economic characteristics, other factors) (5)

Since not all factors that would explain poverty could be captured and hence could be lumped under the error term ε, including error due to data processing as well as biases of the researcher. The ε, the error term, would incorporate all other variables that could not be captured by the accessibility parameter. Since normal distribution is assumed to occur in this relationship, the expected value of the ε = 0. Hence the SCI equation would simply become

$$SCI = f(Accessibility) \qquad (6)$$

Accessibility here in Eq. (6) is assumed to follow a linear model and is the summation of possible variables that pertains to spatial accessibility. The multiple linear regression model form, Eq. (7) would be

$$SCI = \alpha_0 + \Sigma_{i=1}^{n} \alpha_i x_i \qquad (7)$$

where α_0 = the constant coefficient and α_i = the coefficient of significant accessibility variable x_i, $i = 1,..,n$.

ACCESSIBILITY-RELATED CHARACTERISTICS OF STUDY AREAS

In the derivation of accessibility measures, the assumptions used are as follows: (1) The pupil or student in the household is attending the school nearest to his/her house, (2) the sick in the household will seek treatment to the nearest community/provincial hospital, (3) a household member that would either go to school or work will have the first option to use the transport mode available in the household but will use the most common public transport otherwise, (4) following the topography of the land, barangays are connected to other adjacent barangays as well as to town centers when roads are not present and people would walk when going to/from the center of the town when roads are not available, and (5) in the case of island barangays, these were connected to the mainland by considering

the location of the ports or the coast adjacent to the town while using motor boats as mode of transport. Barangays adjacent to inland rivers especially when road access is not present, would also use boats to directly access the town center or disembark on the nearest road link then from there ride a public transport going to the destination.

Road and Other Transport Infrastructure

Table 1 shows the representative and observed travel speeds depending on the road condition one's mode of travel is currently using on both provinces. The problem in Eastern Samar is access from interior towns and hinterland barangays towards the national roads. However, Eastern Samar is blessed with big river systems and the people have taken advantage of this and major inland boat terminals are located in some towns. There are also several island barangays separated from the mainland of Eastern Samar. The province of Siquijor is one of the few provinces in the Philippines whose barangays are all accessible by road and it has no island barangay separated from the main island.

Table 2 provides the estimated time equation as provided previously in Eq. (1), using the representatives speeds of the transport modes given in Table 1 for both land and sea transportation in both provinces.

Table 1
Average Travel Speed of Modes in Eastern Samar and Siquijor

Purpose and destination of travel	Prevalent Transport Mode	Average speed by road type (kph)			Water transport (kph, knots)	
		National Road	Provincial Road	Barangay Road	Inland water	Ocean Water
		Eastern Samar and Siquijor			E. Samar only	
Elementary School	Tricycle	25	20	15	8	12
High School	Tricycle	25	20	15	8	12
Hospital	Private vehicle	40	30	20	8	12
Market/Economic Centers	Jeepney, Minibus	30	25	20	8	12

Table 2
Travel Time Equations for Eastern Samar and Siquijor

Purpose/destination of travel	Prevalent Transport Mode on Land	Travel time equation (min)				
		National Road	Provincial Road	Barangay Road	Water transport	
					Inland water	Ocean Water
		Eastern Samar and Siquijor			E. Samar only	
Elementary School	Tricycle	$2.4S$	$3.0S$	$4.0S$		
High School	Tricycle	$2.4S$	$3.0S$	$4.0S$		
Hospital	Private vehicle	$1.5S$	$2.0S$	$3.0S$	$7.5S$	$5.0S$
Market/Economic Centers	Jeepney, Minibus	$2.0S$	$2.4S$	$3.0S$		
	Walking	$20.0S$				

Sectors Directly Affected by Accessibility

Just like in any typical Philippine town, the municipal public markets of the towns in Eastern Samar and Siquijor islands are located in the municipal center and are in the vicinity of the municipal hall, the police station, the church and in most instances, the schools. There are cases however, in some towns, where the elementary and/or high school campuses are located along national highways which would make them accessible to the students.

The Education Sector. There are 462 public primary and elementary schools as well as 49 public high schools available in Eastern Samar province. In most cases, public elementary schools are located in the populated section of the barangay. In Siquijor island, almost all barangays have its own elementary school. There are 60 public primary and elementary schools and 14 public high schools in Siquijor province.

The Health Sector. The government hospitals in Eastern Samar can be classified as municipal, district, and provincial hospitals and there are 12 of these hospitals. From a discussion with knowledgeable individuals in the Provincial Planning Office of Eastern Samar, some of these hospitals are to be merged and only seven hospitals are expected to continue to operate after the merger. In the case of Siquijor Province, there are only two hospitals serving the health concerns of the province and these are the Siquijor Provincial Hospital, located in the town of Siquijor and the Community Medicare Hospital, located in Calampas, Lazi.

Economic Sector and Related Activities. A typical town in Eastern Samar province has its public market and commercial establishments clustered in the town center. In the whole of Eastern Samar province, the five towns of Borongan, Dolores, Guiuan, Llorente, and Oras are considered the major economic centers because of the vibrant economic activities in these towns. In Siquijor Province, the prime commercial establishments are in the town of Larena and closely followed by the town of Siquijor. These two towns have good port facilities where ships arrive daily with passengers as well as goods. For those coming from or going to Mindanao, the port of access or exit is in the town of Lazi located in the southern portion of the Island.

ANALYSIS OF POVERTY AND SPATIAL ACCESSIBILITY

For each road type, different transport modes could be availed with different travel speeds. Aside from access by land, some remote barangays could only be accessed using inland rivers through the use of boats. Furthermore, island barangays would be using boats whose navigation speed are faster than that of boats serving the inland rivers to access the municipal center. The following variables were considered that may affect accessibility:

a. **Estimated travel time going to the elementary school campus (x_1).** The estimated travel time (in minutes) going to the elementary school campus is the estimated travel time that a grade school pupil coming from a barangay could reach the school campus.

b. **Estimated travel time going to the high school campus (x_2).** The estimated travel time (in minutes) going to the high school campus is the estimated travel time that a high school student coming from a barangay could reach the school campus.

c. **Estimated travel time going to a hospital (x_3).** The estimated travel time (in minutes) going to the hospital is the estimated travel time that a patient coming from a barangay could reach the hospital. When going to the hospital, the prevalent mode is assumed to be the private vehicle if the household owns one or otherwise. But for those whose access

is only through the inland river or the sea, the boat is assumed to be the first mode of transport to reach the port terminal and where transfer to a vehicle-for-hire would be necessary to reach the hospital.

d. **Estimated travel time going to the town center (x_4).** The estimated travel time (in minutes) going to the town center is the estimated travel time that an individual coming from a barangay could reach the center of the town. As observed in both provinces the prevalent mode is the jeepney or minibus when traveling from town to town. Again, for those whose initial access is only through the inland river or the sea, the boat is assumed to be the mode of transport up to the point where the jeepney or minibus would be available.

e. **Estimated travel time going to major markets and economic centers (x_5).** The estimated travel time (in minutes) going to the major markets or economic centers is different from that of the town center since some town centers have no vibrant or significant economic activities. The presence of financial institutions and service-related facilities could also serve as proof. The jeepney and minibus are the prevalent modes when traveling from town to town.

f. **Whether the barangay is in the poblacion (town center) or not (x_6).** This is a dummy variable which has a value of 1 if the barangay is a poblacion barangay and 0 if otherwise.

g. **Location of the barangay with respect to the national road (x_7).** This is a dummy variable which has a value of 1 if the barangay is located along the national highway and 0 if otherwise.

h. **The number of household with phone in the barangay (x_8).** Having a phone would provide the household access to information. This variable may be considered as a 'proxy' variable of accessibility. There was no data gathered for this variable in Siquijor province.

i. **Whether the barangay is an island barangay or not (x_9).** This is a dummy variable which has a value of 1 if the barangay is an island barangay or part of an island located not from the mainland, and 0 if otherwise.

j. **Number of household (hh) with vehicles in the barangay (x_{10}).** It is the total number of household who owns a vehicle in the barangay. It is expected that the more number of household who owns a vehicle the more mobile and accessible the barangay would be to social services and economic activities.

k. **The number of household with phone and computer in the barangay (x_{11}).** With internet access being prevalent nowadays, the availability of a phone and computer in the household means the household has access to the internet. With internet access, the household has access to information.

The descriptive statistics of these variables are provided in Table 3 while Figures 1 and 2 provides a comparison between the SCI of barangays in Eastern Samar and Siquijor located in the poblacion and not in poblacion as well as those barangays located along the national road and not along the national road, respectively. Pearson's correlation analysis was then done on the accessibility measures to know the relationships between variables. The results are shown in Tables 4 and 5, for Eastern Samar and Siquijor Island, respectively. In the case of Eastern Samar, all the travel time variables, x_1, x_2, x_3, x_4, and x_5, have positive signs which would mean that the further the barangay is from the social services and economic centers, the higher would be the poverty level in the barangay. While negative correlation would mean lower SCI which translates to lower poverty. The dummy variables, x_6, x_7, and x_9, the "proxy" accessibility variables x_8 and x_{11}, as well as x_{10}, which is the number of households

Table 3

Description of Important Parameters Related to Accessibility

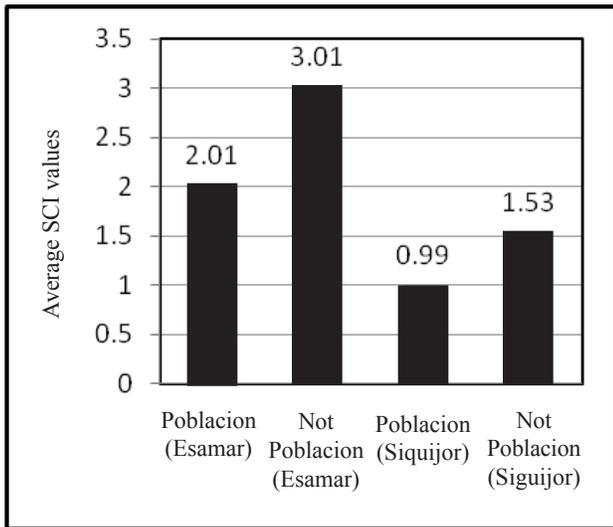| Parameter	Eastern Samar		Siquijor	
	Population mean	Standard Deviation	Population mean	Standard Deviation
x_1 (in min)	7.32	5.86	5.08	4.15
x_2 (in min)	32.07	43.67	8.79	5.05
x_3 (in min)	43.17	57.07	15.11	7.53
x_4 (in min)	37.74	66.54	11.25	6.06
x_5 (in min)	63.82	79.15	16.13	7.84
x_{10} (veh)	15.60	22.52	40.18	30.94
x_8 (no. of phones)	28.97	39.42	-	-
x_{11} (no. of both phone & computer)	2.87	6.66	-	-

Figure 1. Comparison of average SCI values whether the barangay is a poblacion barangay or not (x_6)
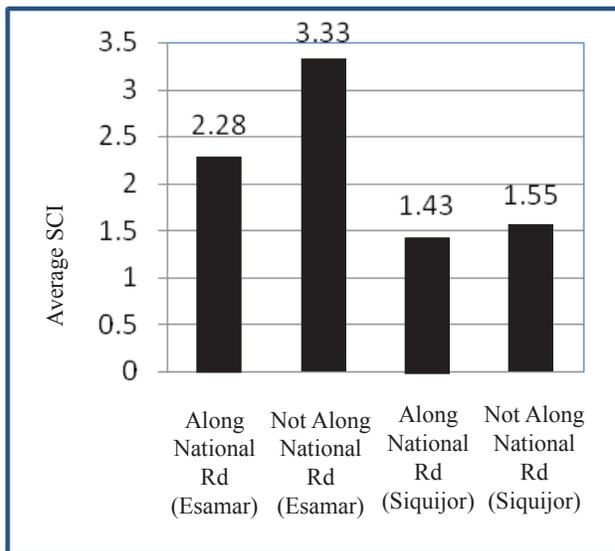

Figure 2. Comparison of average barangay SCI values with respect to the national road (x_7)

with vehicles in the barangay, is a good measure of mobility, are all negatively correlated to SCI. The distance variables x_2, x_3, x_4, and x_5 are highly correlated with each other with values higher than 0.70. In the case of Siquijor, the number of households with phones (x_8) and households with a phone and computer (x_{11}) were not asked in the questionnaire survey and there are no island barangays separate from the main island (x_9). The signs of the variables in relation to the SCI are also consistent similar to that of Eastern Samar though the distance variables x_1, x_2, x_3, x_4, x_5, and

x_6 have lower positive correlation to the SCI. The reason may be due to the extensive road network system of the island and hence better accessibility and lower poverty in the island.

Poverty and Accessibility Models by Province

The multiple linear regression equation model of accessibility for the barangay poverty measure, *SCI*, of Eastern Samar is given in Eq. (8) in Table 6 while for Siquijor, it is given as Eq. (11). The coefficient of determination, R^2, of

Table 4
Pearson's Correlation of Variables for Eastern Samar

	BRGY_SCI	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}
BRGY_SCI	1											
x_1	.1521	1										
x_2	.4022	.1828	1									
x_3	.5031	.2917	.7366	1								
x_4	.3296	.1396	.9388	.7080	1							
x_5	.4400	.2162	.8197	.8479	.8427	1						
x_6	-.4409	.0471	-.3452	-.2900	-.3348	-.2253	1					
x_7	-.5032	-.1646	-.5406	-.5706	-.5228	-.4879	.4954	1				
x_8	-.5000	-.0882	-.3158	-.3493	-.2940	-.3310	.2825	.4298	1			
x_9	-.0167	-.0516	.2685	.0407	.3559	.2103	-.1287	-.2349	-.0299	1		
x_{10}	-.4048	-.1016	-.2127	-.2640	-.1742	-.2446	.1474	.2872	.8667	.0574	1	
x_{11}	-.4064	-.0626	-.2052	-.2282	-.1978	-.2807	.2409	.2780	.8421	-.0680	.7881	1

Table 5
Pearson's Correlation of Variables for Siquijor

	BRGY_SCI	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_{11}
BRGY_SCI	1								
x_1	.1907	1							
x_2	.2709	.4839	1						
x_3	.3620	.2169	.3910	1					
x_4	.2176	.0107	.2648	.3081	1				
x_5	.4645	.0637	.4911	.6860	.4142	1			
x_6	-.2657	-.0174	-.1722	-.0962	-.3703	-.1426	1		
x_7	-.1237	-.2328	-.3598	-.1703	-.4997	-.1042	.2892	1	
x_{10}	-.4455	-.3251	-.4722	-.4229	-.3636	-.4611	.5071	.3515	1

Table 6
Summary of Regression Models Developed Relating Poverty and Accessibility in the Barangay Level

| Regression Models	R²	Eq. No.
Eastern Samar Models		
$SCI = 3.0040 + 0.0073x_2 + 0.0022x_3 - 0.0102x_4 + 0.0040x_5 - 0.5952x_6 - 0.3047x_7 - 0.0072x_8$ *t-value* 40.109 4.298 2.424 -7.009 4.511 -7.495 -3.511 -8.173	0.486	(8)
$SCI = 2.2581 + 0.1579\,ln\,x_2 + 0.1307\,ln\,x_3 - 0.1792\,ln\,x_4 + 0.1592\,ln\,x_5 - 0.2865\,ln\,x_7 - 0.4781\,x_6 - 0.0063\,x_8$ *t-value* 12.000 3.566 2.213 -2.650 3.544 -4.946 -2.961 -6.717	0.447	(9)
$SCI = x_5^{\ 0.0712} \bullet e^{\left(0.9491 - 0.1936\,x_6 - 0.0535\,x_8\left(\frac{1}{2}\right)\right)}$	0.463	(10)
Siquijor Models		
$SCI = 0.9755 + 0.0197x_1 + 0.0277x_5 - 0.4112x_6$ t-value 9.889 2.149 5.655 -2.694	0.282	(11)
Integrated Models		
$SCI = 2.5167 + 0.0094x_2 + 0.0029x_3 - 0.1068x_4 + 0.0049x_5 - 0.5198x_6 - 0.0130x_{10}$ *t-value* 47.570 5.334 3.237 -7.054 5.266 -7.165 -10.986	0.464	(12)
$SCI = x_2^{\ 0.0622} \bullet x_3^{\ 0.0604} \bullet x_4^{\ -0.0717} \bullet x_5^{\ 0.1416} \bullet e^{\left(0.4198 - 0.2210\,x_6 - 0.0546\,x_{10}^{\ 0.5}\right)}$	0.463	(13)
$SCI = x_5^{\ 0.1716} \bullet e^{\left(0.4984 - 0.2185\,x_6 - 0.0588\,x_{10}^{\ 0.5}\right)}$	0.448	(14)
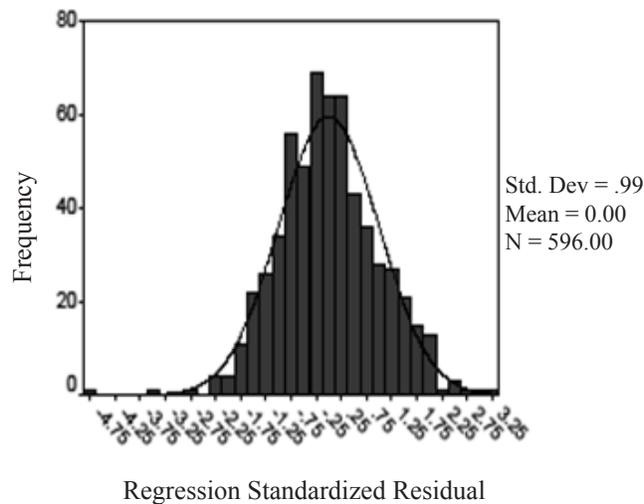
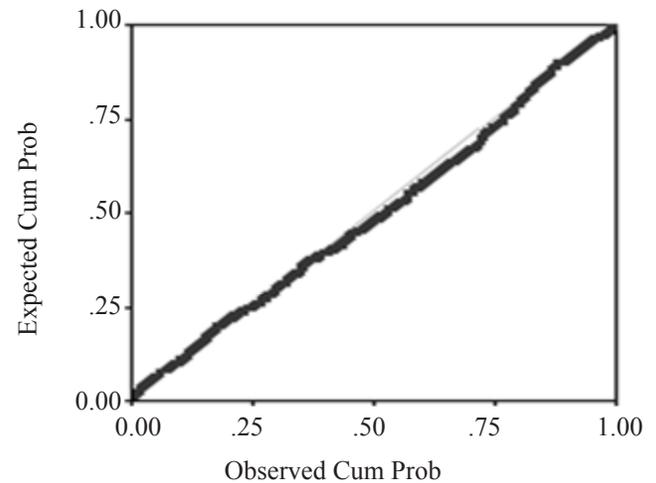**Figure 3.** Histogram of the residuals of Eq. (9)

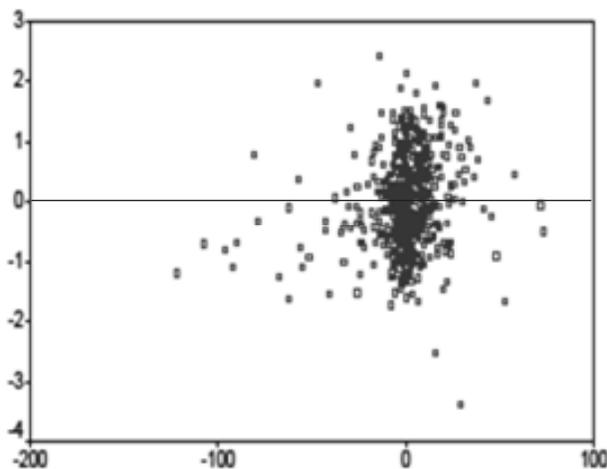**Figure 4.** Normal probability plot of the residuals of Eq. (9).

Figure 5. Partial regression plot of the regression residual with x_2 Eq. (12)
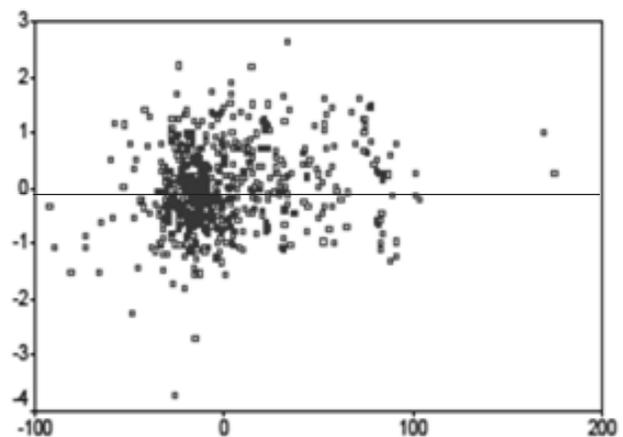

Figure 6. Partial regression plot of the regression residuals with x_5 Eq. (12)

the Eastern Samar model is known to be 0.486 while the t-statistics of its individual variables are significant at 95% level of confidence. Although the travel time variables x_2, x_3, x_4, and x_5 are highly correlated, the individual variables are still significant. However, the x_4 variable in the equation has a negative sign which has to be treated with caution especially the range of values this was derived, and while considering x_4, one also needs to consider the x_2, x_3 and x_5 variables. The coefficient of determination, R^2, of the Siquijor model is 0.2819 while the t-statistics of its individual variables are significant at

95% level of confidence. However, a thorough evaluation of the significant variables of the Easter Samar accessibility equation would show that the variables x_2, x_3, x_4, x_5 and x_8 do not behave normally and may need to be transformed. In the case of Siquijor, there is no need to transform the variables since the variables behave with some normality.

The simplest method to determine whether there is normality in the error term is through the use of the histogram of the regression standardized residuals as shown in Figure 3. As Figure 3 would show, there is normality in

the error term of the distribution. The normal probability plot in Figure 4 would also confirm this where the plotted residuals closely follow a straight diagonal line. Another test to check the assumption that the errors are approximately normally distributed with constant variances is to plot the residuals of the regression model against the independent variables. Considering the variable x_2 and x_5 in the case of Eq. (8), Figure 5 and 6 give the plots between the residuals and the x_2 and x_5 variables, respectively. The data plots should be evenly spread along the zero line for the normality assumption to be met. In the case of the partial regression plot in Figure 5, there is more or less equal dispersion along the zero line, For Figure 6, the points above the zero line a quite numerous compared to the points below. Hence, there may be a need to transform the x_5 variable to minimize this violation of normality. After the transformation of some of the variables, the resulting poverty and accessibility model for Eastern Samar is now developed. The first transformed equation, for Eastern Samar, labeled as Eq. (9) is shown in Table 6. Although the *SCI* variables of Eastern Samar barangays behave quite normally, the transformation of the SCI into its natural logarithmic scale and to improve the normality of x_8, its square root was used. The variables x_2, x_3, and x_4 became insignificant in Eq. (10), which is acceptable since x_5 is highly correlated to the three variables. The variable x_7, to some degree is also correlated to x_2, x_3, x_4, and x_5, and hence also became insignificant when the *SCI* variable was transformed. There was a small reduction in the R^2 value of Eq. (10) due to the transformation of the variables but this is acceptable considering that now each individual variable in the equation behave with some normality. However, Siquijor province, having a good network of roads compared to Eastern Samar, the poverty-accessibility model (Eq. 11) of the former has a lower R^2 compared to that of the latter. There was no need to transform the variables because of their normality behavior. Combining the data of both provinces resulted to regression models (Eqs. 12, 13, and 14) whose

variables are quite similar to those found in the equations of both provinces. Regardless of the different geography in the two provinces, the treatment of accessibility measures would still be the same since it would depend on the type of transport network and transport mode available.

ROLE OF GENDER ON POVERTY AND ACCESSIBILITY

In Philippine culture and tradition, women are usually assigned to do the tasks inside the household like taking care of the children while the men are usually the ones who are expected to find work outside the house and bring food to the table. The current set of CBMS data would help unravel whether these attached roles are being practiced early in life and whether accessibility has some influence on these roles.

Eastern Samar. As shown in Table 7, more than 50 percent of barangays (307 out of 596) in Eastern Samar have their elementary schools within five minutes from the barangay center where most of the household are located. On the average, 25.36 percent of boys in elementary school age are not in school compared to only 22.26 percent of girls. Between the two sexes, the average difference is 3.11 percent more boys are not in elementary school compared to girls. Considering the location variable in terms of travel time to the nearest elementary school between the genders, in general, more boys are not in school compared to girls except for the travel time between 15.01 to 30 minutes. In Eastern Samar, it is safe to conclude that more boys of elementary school age are not in school compared to girls regardless of the accessibility, in terms of travel time, to the elementary school.

In the case of boys and girls of high school age in Eastern Samar, the population average would show that 53.83 percent of boys are not studying compared to only 38.40 percent of girls which translates to a difference of 15.44 percent between the two sexes. It is a well known fact that children around these ages, the boys more

Table 7

Population Percentages of Males and Females who are not in Elementary School in Eastern Samar

Estimated travel time to nearest elementary school (in minutes)	No. of Barangays	Proportion not in elementary school		Difference
		Male	Female	
<=5	307	24.22	21.64	2.58
5.01<=10	210	26.76	22.4	4.36
10.01<=15	47	26.43	23.54	2.89
15.01<=20	17	23.59	24.24	- 0.65
20.01<=30	8	24.04	24.45	- 0.41
30.01<=60	5	28.44	26.32	2.12
>60	2	40.9	36.55	4.35
Total	596			
Population Average		25.36	22.26	3.11

Table 8

Population Percentages of Males and Females who are not studying in High School in Eastern Samar

Estimated travel time to nearest high school (in minutes)	No. of Barangays	Proportion not in high school		Difference
		Male	Female	
<=5	84	39.66	24.85	14.81
5.01<=10	108	40.59	26.68	13.91
10.01<=15	97	47.81	32.89	14.92
15.01<=20	71	52.05	34.45	17.60
20.01<=30	55	57.98	41.62	16.36
30.01<=60	93	66.48	48.6	17.88
>60	88	75.74	62.16	13.58
Total	596			
Population Average		53.83	38.40	15.44

than the girls, help the family in the farm or doing odd jobs elsewhere to help put food on the table. Regardless of the high school location from the barangay center, in terms of travel time, more boys are not in school more than the girls. The difference between the sexes ranged from 13.58 to 17.88 percent as shown in Table 8.

If we are to look at the unemployed individuals in Eastern Samar with respect to the barangay center location from the municipal center or from a major economic center, we could see the opposite trend in which more males are employed compared to their female counterparts. More females are unemployed compared to its male counterparts regardless of the estimated travel time to the nearest municipal center or the major economic center. To distinguish the municipal centers from the major economic centers, the municipal center is the center of each town where most of the social, institutional, and economic

activities of the town are located while as previously discussed, the major economic centers in Eastern Samar are the towns of Borongan, Dolores, Guiuan, Llorente, and Oras.

Looking at the population averages of unemployment between both sexes, only 13.74 percent of males are unemployed compared to 30.88 percent of females which translates to a difference of 17.14 percent between the sexes.

Except when the town center or the major economic center is within five minutes of travel time, as provided in Tables 9 and 10, female unemployment is always more than double that of the male unemployment.

Siquijor Island. In the case of Siquijor Island province, the 60 elementary and primary schools scattered all over the island can be accessed within 20 minutes from the 134 barangay centers.

Table 9

Population Percentages of Males and Females that are unemployed in Eastern Samar in relation to Nearest Town Center

Estimated travel time to nearest town center (in minutes)	No. of Barangays	Proportion unemployed		Difference
		Male	Female	
<=5	130	19.68	29.03	-9.35
5.01<=10	120	15.68	32.55	-16.87
10.01<=15	79	13.84	31.95	-18.11
15.01<=20	32	11.72	32.85	-21.13
20.01<=30	53	9.40	31.45	-22.05
30.01<=60	78	8.91	28.86	-19.95
>60	104	10.44	31.04	-20.60
Total	596			
Population Average		13.74	30.88	- 17.14

Table 10

Population Percentages of Males and Females that are unemployed in Eastern Samar in relation to the Nearest Major Economic Center

Estimated travel time to nearest major economic center (in minutes)	No. of Barangays	Proportion unemployed		Difference
		Male	Female	
<=5	64	20.15	29.06	-8.91
5.01<=10	37	12.67	28.16	-15.49
10.01<=15	31	12.72	28.85	-16.13
15.01<=20	58	16.58	38.62	-22.04
20.01<=30	70	15.01	35.98	-20.97
30.01<=60	157	12.58	27.25	-14.67
>60	179	11.43	31.12	-19.69
Total	596			

Table 11

Population Percentages of Males and Females who are not in Elementary School in Siquijor in relation to Travel Time to Nearest Elementary School

Travel time to nearest elementary school (in minutes)	No. of Barangays	Proportion not in elementary school		Difference
		Male	**Female**	
<=5	74	19.26	18.68	0.58
5.01<=10	39	16.6	17.36	-0.76
10.01<=15	18	21.37	16.78	4.59
15.01<=20	3	10.4	45.33	-34.93
Total	134			
Population average		18.57	18.64	-0.07

Table 12

Population Percentages of Males and Females who are not in High School in Siquijor in relation to Travel Time to the Nearest High School Campus

Travel time to nearest high school (in minutes)	No. of Barangays	Proportion not in high school		Difference
		Male	**Female**	
<=5	35	29.72	24.18	5.54
5.01<=10	48	34.46	26.9	7.56
10.01<=15	34	32.88	26.25	6.63
15.01<=20	14	39.96	24.57	15.39
20.01<=30	3	40.8	42.27	-1.47
Total	134			
Population Average		33.54	26.12	7.42

Since the subgrouping of that of Eastern Samar in terms of travel time going the elementary school was followed there was a big difference between females not in school compared to males under the - 15.01<=20 minute travel time category which does not reflect the overall situation of the province. Under the mentioned category, only three barangays belong to this group as given in Table 11. Overall, 18.57 percent of boys of elementary school age are not in school compared to a slightly higher percentage of 18.64 percent for girls. Hence, a very small difference of only 0.07 percent between the two sexes was observed.

The nearest of the 14 public high schools in the island province of Siquijor is accessible within 30 minutes among the barangay centers of the province although the case of high school students among sexes not in school in Siquijor follows the same trend of that of Eastern Samar high school students. Except for the 20.01<=30 minute travel time category, more males are not in high school compared to females which does not reflect the overall condition in the province since only three barangays are in this category. As given in Table 12, 33.54 percent of males of high school age are not in school compared to only 26.12 percent for

Table 13

Population Percentages of Males and Females that are unemployed in Siquijor in relation to Travel Time to Nearest Town Center

Travel time to nearest town center (in minutes)	No. of Barangays	Proportion unemployed		Difference
		Male	**Female**	
<=5	22	18.39	22.8	- 4.41
5.01<=10	38	13.47	22.87	- 9.40
10.01<=15	42	14.17	25.23	-11.06
15.01<=20	16	8.08	14.77	- 6.69
20.01<=30	16	8.83	19.98	-11.15
Total	134			
Population Average		13.30	22.29	- 8.99

Table 14

Population Percentages of Males and Females that are unemployed in Siquijor in relation to Travel Time to Nearest Major Economic Center

Travel time to nearest major economic center (in minutes)	No. of Barangays	Proportion unemployed		Difference
		Male	**Female**	
<=5	11	20.22	20.94	-0.72
5.01<=10	22	12.31	23.84	-11.53
10.01<=15	29	14.14	25.44	-11.3
15.01<=20	27	11.04	17.85	-6.81
20.01<=30	40	12.67	21.96	-9.29
30.01<=60	5	14.74	26.66	-11.92
Total	134			
Population average		13.30	22.29	- 8.99

females or an overall difference between the sexes of 7.42 percent.

Again, just like in Eastern Samar, in the case of unemployment of males and females with respect to estimated travel time to the nearest town center or major economic center in Siquijor province, females have higher unemployment levels compared to males no matter what the distance to the town center or the major economic center. In the case of Siquijor province, the major economic centers are the towns of Siquijor, Larena, and Lazi. As shown in Tables 13 and 14, in the island

province of Siquijor, only 13.30 percent of males of working age are unemployed compared to 22.29 percent of females or a difference of 8.99 percent between the sexes.

POLICY IMPLICATIONS ON POVERTY AND ACCESSIBILITY

The developed equations on accessibility were used to test accessibility-related development plans and programs. The first application was on

the proposed road improvement in Eastern Samar while the second application is on the proposed consolidation of hospitals in Eastern Samar, and in the case of Siquijor, was on the proposed elementary school in every barangay.

Road Improvements in Eastern Samar Province

Based from the road development network plan of the Department of Public Works and Highways (DPWH) for Visayas, there is a plan to extend the road from Barangay Sohutan in Samar up to the national road passing through the town of Borongan towards the coastal areas of Eastern Samar. Hence, there would be travel time improvements along the areas affected by this road development. This could be reflected in the road network being modeled by changing the access mode and type of road passing through the affected areas. With the proposed all-weather road, it is assumed that public transportation would now be available to use the road.

Considering the term $0.0712 \ln (x_5)$ in Eq. (10) to measure the effect of the propose road on poverty levels in the area, Table 15 would show that only six barangays in Borongan would be directly affected. In Eq. (10), considering $x_6 = 0$, since the six affect barangays are not poblacion barangays and $x_8 = 0$ (zero number of household with telephones), the total aggregated decrease in the SCI value in the six barangays equaled 0.354. This is a 1.79% decrease in the SCI before the presence of the road.

Consolidation of Hospitals in Eastern Samar

According to Eastern Samar's Provincial Planning and Development Coordinator, one of the plans of the Province of Eastern Samar under its health program is to lessen the number of community hospitals in the province to reduce operating costs. Out of the 12 government hospitals currently in operation, five of these municipal and community hospitals would be closed. By removing these five hospitals in the

Table 15

Impact of Road Development on Poverty through Access to Major Economic Markets in Eastern Samar using Eq. (11)

Barangays in Borongan	SCI Values due to access to major economic markets (x_5)		Difference in SCI values
	Before road development	**After road development**	
Pinanag-an	3.799	3.517	0.282
Campesao	2.293	2.277	0.016
San Gabriel	3.138	2.973	0.165
San Juan	3.104	2.994	0.110
Sohutan	2.657	2.502	0.155
Surok	2.962	2.931	0.031
Total	17.953	17.194	0.759
Average	2.992	2.866	0.127
% Decrease = [(Total SCI$_{before}$ − Total SCI$_{after}$)/Total SCI$_{before}$] x 100 = 4.32 %			

Table 16

Impact of Hospital Consolidation in Eastern Samar on Poverty

Municipality	Impact of travel time to the nearest hospital on poverty through the SCI variable		Change in SCI
	Current Available Hospitals	With Hospital Consolidation	
Arteche	0.60	0.76	- 0.16
Balangiga	0.44	0.44	0.00
Balangkayan	0.53	0.63	- 0.10
Borongan	0.47	0.47	0.00
Can-avid	0.50	0.62	- 0.12
Dolores	0.53	0.68	- 0.15
Gen. Macarthur	0.50	0.50	0.00
Giporlos	0.51	0.59	- 0.08
Guiuan	0.40	0.40	0.00
Hernani	0.56	0.58	- 0.02
Jipapad	0.92	0.94	- 0.02
Lawaan	0.54	0.54	0.00
Llorente	0.32	0.66	- 0.34
Maslog	0.90	0.91	- 0.01
Maydolong	0.63	0.64	- 0.01
Mercedes	0.45	0.45	0.00
Oras	0.59	0.60	- 0.01
Quinapondan	0.40	0.56	- 0.16
Salcedo	0.57	0.58	- 0.01
San Julian	0.57	0.57	0.00
San Policarpio	0.52	0.55	- 0.03
Sulat	0.56	0.56	0.00
Taft	0.43	0.43	0.00
Total	12.44	13.66	- 1.22
Average	0.54	0.59	- 0.05
% Decrease = [(Total SCI$_{before}$ – Total SCI$_{after}$)/Total SCI$_{before}$] x 100 = -9.81%			

network model, barangays who are initially in the influence area of these hospitals need to find the next nearest hospital to avail of health services. Table 16 provides the effect per municipality which are the results of the average effect on the barangay level. Due to the hospital consolidation in Eastern Samar, the effect on poverty through the SCI value would be an estimated aggregate total increase of around 1.22. Hence, the potential effect of the consolidation of hospitals in Eastern Samar would be a 9.81% increase in the poverty level of the province.

Table 17

Impact of an Elementary School in every Barangay on Poverty in Siquijor

Municipality	Impact of travel time to the nearest elementary schools on poverty through the SCI variable		Change in SCI
	Existing elementary schools	**Elementary school in every barangay**	
Enrique Villanueva	0.121	0.040	0.081
Larena	0.137	0.039	0.098
Lazi	0.042	0.025	0.017
Maria	0.146	0.083	0.063
San Juan	0.056	0.034	0.022
Siquijor	0.089	0.034	0.055
Total	0.591	0.255	0.336
Average	0.100	0.042	0.056
% Decrease = [(Total SCI_{before} − Total SCI_{after})/Total SCI_{before}] x 100 = 56.85%			

Proposed Elementary School in Every Barangay in Siquijor Province

In the current situation, only 58 out of the 134 barangays in Siquijor province have elementary schools. Consider the term, $0.0197x_1$ in Eq. (11), where x_1 is the estimated travel time (in minutes) to the nearest elementary school. By comparing the effect of the x_1 variable on the change in SCI with the current available elementary school in place and with the proposed elementary school in every barangay, Table 17 provides the total and aggregated effects. By having an elementary school in every barangay, the estimated effect on poverty through the SCI would be an estimated aggregate total decrease of 0.336. The decrease is 56.85% in the aggregate total of the SCI of all the barangays in the current situation.

SUMMARY OF FINDINGS AND CONCLUSION

Multiple regression models of the linear and nonlinear varieties that related poverty to spatial accessibility were developed separately for the provinces of Eastern Samar and Siquijor as well as composite regression models using the combined data from both provinces. In the case of Eastern Samar, the important exogenous variables that could explain poverty in the barangay level are the estimated travel time to a high school campus, the estimated travel time to the municipal center, the estimated travel time to a hospital, the estimated travel time to major markets in the province, and dummy variables - whether the barangay is a barangay in the poblacion or not and whether the barangay is located along the national road. In the case of Siquijor, the important exogenous variables that could partly explain the poverty in its barangays are the estimated travel time to an elementary school campus, the estimated travel time to the major economic centers, and the dummy variable - whether the barangay is a barangay in the poblacion or not. Among the spatial accessibility measures, the most significant indicator of spatial accessibility is the access to major economic centers. Data would show that access to the major economic center in terms of travel time, is highly correlated to the SCI as well

as to other poverty indicators like the percent of household living below the poverty threshold. The mentioned variable is also highly correlated to other travel time accessibility measures, namely the travel time going to elementary or high school, travel time going to the hospital and travel time going to municipal centers.

Looking at the effect of gender on some of the CBMS poverty indicators, especially on the education of the youth in the elementary and high school levels, in the case of Eastern Samar, more males are not going to elementary school than females. But in the case of Siquijor, there is reason to believe that the percentages of males are no different from females of those not going to elementary school. Regarding access to the nearest high school, regardless of distance from the nearest school campus more females are going to high school than males in both provinces. In the case of unemployment, more females of working age are unemployed than males regardless of distance to the nearest town center or major municipal market in both provinces. These results would show that as the children gets older and with most available jobs are in agriculture, the males are needed to help the family work in the field in order to put food on the table on a daily basis rather than study now and prepare for the future.

One of the main applications of the developed regression models relating poverty and accessibility is to predict the impact of proposed infrastructure and social projects of the government on poverty levels in the affected area. In the case of Eastern Samar, the proposed road infrastructure project and proposed hospital consolidation were tested and the direct impact of these proposed projects on poverty levels were measured. For Siquijor province, the proposed establishment of an elementary school in every barangay as being one of the major policies of the National Government to address poverty was tested. As long as the proposed programs and projects could be directly expressed through the significant accessibility variables, the poverty and accessibility models developed here could then be used.

RECOMMENDATIONS

The lowest unit of analysis done on poverty was at the barangay level. The CBMS data was done at the household level. In order to conduct an accessibility analysis in the household level, the household locations have to be properly located in space in order to obtain accurate accessibility measures from the household going toward the points of destination of the members of the household. With the advent of more advanced spatial locator gadgets like the handheld Global Positioning System (GPS), a more exact location of the household as well as the social services and economic centers could be obtained. Distance and travel time functions that would express the accessibility measures would also become more accurate but the data gathering would be quite tedious if all households would be included in the study. This is where the proper sampling procedures of households would be necessary.

The CBMS survey instrument only captures the household profile at a point in time, it does not ask about the behavioral decisions of the household in order to address poverty on a short term or long term basis. It would be interesting to know how the household decides on which concerns would be prioritized on a short term basis like weekly or day to day activities as well as on a long term, say on an annual or seasonal basis. A more detailed questionnaire survey has to be developed that could capture these behavioral decisions and characteristics that could be included in the CBMS survey instrument.

Considering the cost of travel in the accessibility measure and when cost is combined with travel time, a generalized measure of cost could be used to express accessibility. However, the cost of time of the individual has to be estimated in order to develop the generalized cost function. The CBMS questionnaire survey may need to consider the cost variable to make the analysis of accessibility more robust. The frequency of travel to avail of social services or to involve in economic activities could also be determined to evaluate its impact on poverty.

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