QUANTIFICATION OF ACCESSIBILITY AND PRIORITIZATION OF VILLAGES FOR LOCAL LEVEL PLANNING

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ABSTRACT

Rural development, and its asscociated investment choices, are a major issue for governments of rural areas. Keeping in mind the scarcity of funds and that the needs of the people in rural areas should be given due importance, it is necessary to have an integrated approach to development where all sectors are considered together and then prioritized. An approach, known as Integrated Rural Accessibility Planning (IRAP), for infrastructure and services planning has emerged as a result of a series of studies conducted over the years by the International Labour Organization (ILO), the World Bank and other agencies in a number developing countries of Asia and Africa. The quantification technique for determining accessibility to basic facilities and services is the key to this approach. A number of quantification techniques have been used in various studies conducted so far. This article suggests a modified quantification technique which is simple and more practical, and reports the findings of a case study carried out in a cluster of villages in Neemrana Block in Alwar District of Rajasthan (India) where the technique has been applied.

INTRODUCTION

Poor access is one of the key factors of poverty. At the macro level, the World Bank has shown that access to safe water, electricity and a viable network of roads is directly associated with national per capita income. Nevertheless, access to basic services such as health, water and sanitation is not necessarily reflected by increases in household income, but rather provides the foundation for development. On the other hand, access to economic activities is important for income generation. Basic services and infrastructure should be planned based on equity, whereas economic services need to be planned based on potential and ability to pay (Ghosh and Sarkar 1998). The level of physical accessibility, or the degree of difficulty in physically accessing a particular service, depends on the “level of mobility”, which is defined as the measure of the opportunity cost of transportation of people and their goods, and “the sitting and the quality of the facility”, or the distance, route and travel time of places for dwelling, economics, medical, recreational and similar other activities, all of which are determined by the availability and quality of roads and paths as well as by the type and efficiency of available transport. All households need to have access to facilities, goods and services in order to fulfil their basic, social and economic needs. The well being of these households depends on their ability to access them. Logically, access may be provided or improved either by transport interventions such as better “sitting” of basic facilities, goods and services or by non-transport interventions such as improving the mobility of rural people. Thus, accessibility should be considered the criterion on which rural infrastructure and services are planned. However, different villages may have different priorities for accessibility, such as education, drinking water and health care. A sector-wide planning

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approach may fail to satisfy the urgent need of a specific village. Therefore a multi-sectoral planning methodology, using accessibility as the criterion, would be appropriate in rural infrastructure and services planning.

I. LOCAL LEVEL DEVELOPMENT PLANNING

For local governments of rural areas, a major issue is rural development and investment choices that are associated with this process (Donnges, 2001). An effective planning environment should have features such as the existence of regular planning functions, the provision for people's direct participation in decisions, clear guidelines for the disbursement of funds and the provision for capacity building. In most developing countries, the planning environment is non-existent as, in many cases, the process of decentralization is not in place. Sometimes local government bodies are ineffective in the absence of meaningful transfer of executive and budgetary powers. In certain cases, even though decentralization has been achieved, the solutions generated and implemented by local bodies fail to satisfy the population at large. This is due to the absence of active participation by the population in the decision making process and to a lack of suitable local-level planning tools. In an effective planning process, the members of a community should be aware of the needs of their community in a wide context. This means they should not only be aware of their own personal needs, but of the needs of others in the community as well. They should then have access to a decision making tool which is well understood and easy to implement.

Integrated Rural Accessibility Planning (IRAP)

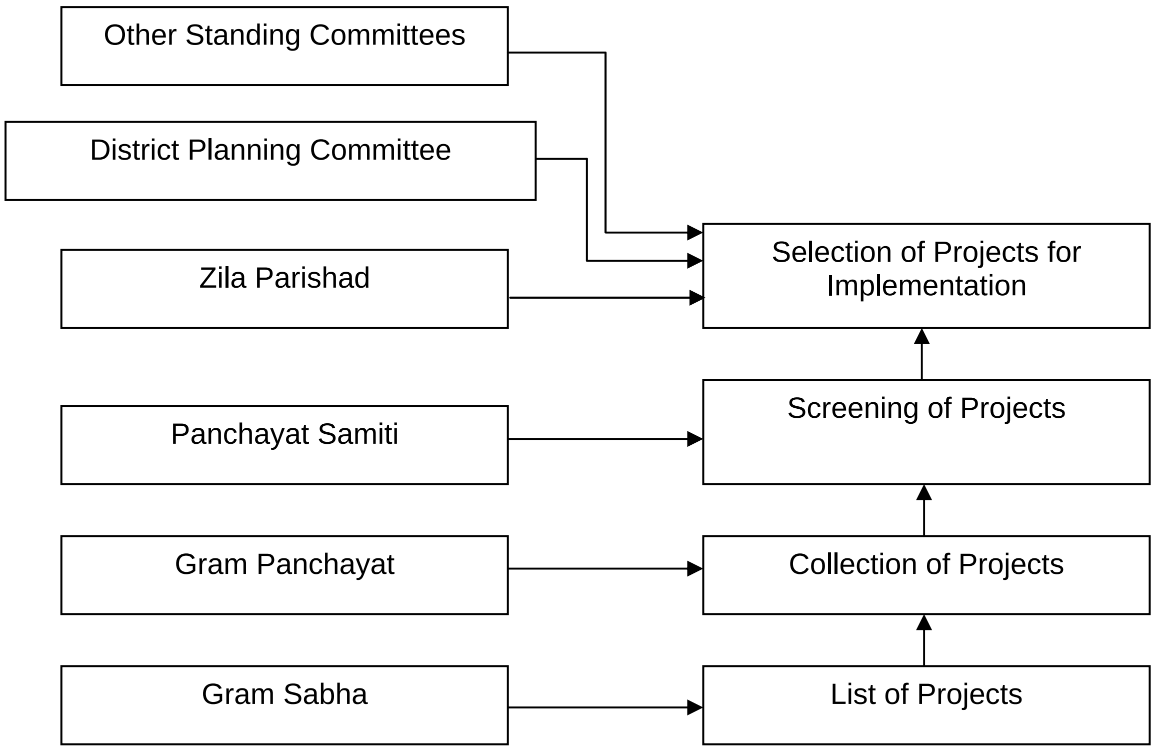
A new approach to local level planning has emerged as a result of a series of studies conducted by the International Labour Organization (ILO), the World Bank and other agencies in a number of Asian and African developing countries and is known as Integrated Rural Accessibility Planning (IRAP). The central innovation of this approach is the introduction of the household as the unit of analysis. Its goal would be to redefine rural transport in its totality and to encompass the movement of rural people and their goods to meet their domestic, economic and social needs, by any means, including the use of tracks, paths and roads. Rather than analyzing the needs of a transport system from the point of view of a particular function to be performed, researchers would focus on the study of the transport needs of communities. It has been specifically designed with local planners in mind, and is multi-sectoral in its approach, though it can also be used in planning for a specific sector. The steps involved in IRAP are shown in Appendix-I (Mhina, 1997).

Possible Application of IRAP in India

The three-tier local level government in India, known as the Panchayati Raj system, was launched with the goal of achieving decentralization with respect to economic and political powers. The seventy-third amendment to the constitution of India in 1992 has strengthened the Panchayati Raj system and has given more power to planning and implementing projects. The participation of the community was stressed not only in the planning process, but also in the implementation of the plan. In the existing system there are three different levels; (a) the Gram Sabha is the parliament of a village, where all villagers above the age of 18 are members. Gram Panchayats are the basic units of administration and consists of a few villages. (b) the Panchayat Samiti is a local government body at the block level (consisting of a few Gram panchayats) and (c) the Zila Parishad is the highest authority and exists at the district level. Even though the system was introduced quite some time ago, only a few states have been able to implement it successfully. One of the most considered attempts at coupling decentralization with people's participation has been in the state of West Bengal. However, the system there does not allow for the first level of people's organization (Gram Panchayats) to take an active part in preparing the development plans. This takes place at the block level, in which the locally elected representatives of Panchayat Samiti have a presence in the Block Planning Committee (BPC) and are able to communicate the needs of the villagers. The basic needs, proposals and budgetary requirements drawn up by the Gram Panchayats have to fit the financial parameters defined by the BPC and its contents have to correspond to the main development programmes defined by the district and the state. All the shortlisted plausible projects are sent to the district level government (Zila Parishad), which in turn looks at them and selects the most feasible ones. At this level, consultations are made with the District Planning Committees (DPC) and other standing committees and a consolidated development plan for the district is prepared. A pictorial representation of the broad outline of the local level planning process is shown in Figure1.

The IRAP may be introduced at the district level, to complement the existing planning system and provide the planners the means to be more effective in the delivery of investments. However, once the Panchayati Raj system becomes truly functional, there is scope to introduce the IRAP in all the three decision making stages. In an ideal scenario, it may also be applied at the village level, in Gram Sabhas, for the identification of development projects.

Figure 1. Broad Outline of the Existing Local Level Planning Process in India



Quantification of Accessibility

One of the most important features of a local level planning tool is the development of a quantification technique by which the accessibility levels of each settlement in an area would be determined. These levels would be expressed in the form of indices based on the availability of facilities and on the quality of services provided by them. This would help to identify the most inaccessible areas and prioritize them based on an accessibility index. The determination of the indices should be simple so that local level representatives and officials could easily understand them. The challenge would then become creating a simple technique of quantification, which would reflect the situation regarding accessibility to basic needs and would help to prioritize villages based on those needs

A study was conducted in Bochum-My Darling Transitional Local Council in the Northern Province, South Africa (Sarkar and Mashiri, 2000) to develop an activity-based methodology to determine the travel needs of rural communities and to quantify and prioritize the overall accessibility levels. The level of accessibility was expressed with respect to overall accessibility by the entire community. Data to determine the level of importance of each activity and the level of satisfaction with the existing situation were collected from the villagers through a questionnaire, which helped identify how severe the problem of inaccessibility to different services was for all the villages in the study area. This indicated the problem areas in terms of accessibility but did not identify exact reasons for it. Some possible reasons could have included lack of roads, condition of roads or poor transport service, among other things. In addition, the population was not considered as a parameter while prioritizing the villages in terms of accessibility.

The Accessibility Indicator (AI) was devised as an aid to the decision-making process and shows the difficulty or ease with which households have access to goods and services such as water, fuel wood, education, health etc. (Barwell, 1996). The basic formulation of the AI involves multiplication of the number of households that need access to a certain service or facility by the length of time it takes to reach the service or facility. The logic of the IRAP methodology suggests modification of the AI based on mode of transport, gender and other relevant variables. For example, a longer distance travelled by bus may be preferable to a shorter distance travelled on foot along steep hills. To take this into account, the difficulty factor was introduced in studies conducted in Tanzania (Mhina, 1997) and Malawi (Dingen, 2000).

In the IRAP study conducted in Laos (Donnges, 1998), the accessibility indicators were derived at two levels: the village level, where they were used to identify sector interventions by relating indicators to standards, averages or targets; and the local government level where they were used to identify villages that were not adversely affected in relation to the required services, goods and facilities. The primary village data was translated into a set of indicators which related to the specific sector considered in the study. After processing the indicators, a District Accessibility Profile (DAP) was prepared. Keeping in view the fact that not all the indicators would have equal importance, the villagers were asked to determine the weights to be assigned to each of the indicators. The score for a particular village within a certain sector was calculated by multiplying the respective indicator and the weight. A higher score indicated a higher priority. The quantification technique applied in the study was quite simple, but the number of indicators used to quantify accessibility to sectors was quite high which may have made the data collection process quite complicated. There is enough scope to simplify the quantification of accessibility by choosing less, but more appropriate, indicators.

The Access Indicator is a relatively neutral unit of measurement. It can be used to assess the level of difficulty that people encounter in all activities. In addition, it shows the magnitude or size of the problem, and how widespread or common it is. Sarkar and Ghosh (2000) had questioned the logic behind the methodology of assigning scores to indicate levels of difficulty based on the nature of the terrain and types of vehicle used, and argued that if pushed to its logical end, it would require much more information on various aspects of the transportation task, which would be difficult and expensive. They suggested the introduction of a new parameter, Acceptable Travel Time (ATT), which would help in calculating the Accessibility Shortfall Index (ASI). It was suggested to determine, in consultation with the villagers, the acceptable travel time (ATT) for performing different activities in view of the condition of the locality. The accessibility shortfall index was then calculated by multiplying the number of households in a village with the difference between the average travel time and the acceptable travel time. If, however, the average travel time is found to be less than the acceptable travel time, the village is considered not to have an accessibility problem for performing that particular activity.

In the application of IRAP in Indonesia (ILO ASIST AP, 2003) two parameters, the Accessibility Indicator score (AIS) and Accessibility Indicator weight (AIW) were introduced. The AIS was obtained by comparing the state of a sector in the village under consideration with the standards specified for the sector. The weight or priority to various factors within a sector was determined on a five-point scale in consultation with the villagers. The area with lowest Accessibility Score (AS) was given priority for further development over other areas in the study. One of the positive points of the method is that the local people are involved in the decision making process through the computation of Accessibility Indicator Weights (AIW). However, it cannot be used to compare the accessibility between sectors. The main drawback of this method is in the logic of the expression of AS. The denominator (score on number of households) is reducing the severity of the value representing accessibility. It is felt that the AS score would be reflect the severity more accurately if the numerator was multiplied by the household score.

In a Nepal study (ASIST Asia Pacific, 2003) the Accessibility Index (AI) was calculated based on criteria such as travel time and difficulty factor. It was recognized that both factors need not be considered for calculating the accessibility index for all sectors. For example, for access to irrigation, it is not required to consider travel time, but the quality of the service would be very important. A number of factors were considered for correctly determining the accessibility indices in order to make the method realistic. The score based on the population of the area was multiplied by the Social Accessibility Index to determine the Economic Accessibility Index. The actual needs of people for a particular sector were accounted for by attaching weight to each factor. However, the home interview survey, which was time consuming and expensive, could have been avoided by collecting the relevant data in a village-level meeting using participatory approach. Household data usually is not used for planning in IRAP.

In the Orissa study (Donnges et al, 2004) factors such as the number of households in a village, the average time spent to reach each facility or service, the frequency of travel to a facility and a few selected qualitative characteristics were considered for calculating the Accessibility Indices. The total score for accessibility to a particular service was expressed as the summation of scores on population, travel time and quality. The quality was expressed in different ways for each sector. A number of factors responsible for lack of accessibility to various sectors had been considered in this study and thus the score was expected to represent the problems in the area accurately and meaningfully. However, the main drawback of this method was the summing up of all the scores (population, travel time and quality of service) without incorporating the weight given to each indicator by the villagers and the planners. As the index was a result of a summation of scores from three different factors, the sub factors in quality needed to be balanced in such a way that the total factors always added up to the same number. Otherwise, the sector with more sub-factors would always receive a higher index, regardless of the severity of the problem.

To fix the village priority, indices were developed to quantify the existing levels of accessibility in each village in a study carried out in Rajasthan, India (Sarkar, 2005 and Sarkar & Ghosh, 2008). The factors considered for quantification were population, represented by the number of households in the village, travel time and quality of service. Scoring on these factors and the weights assigned to the parameters representing the factors were assigned in consultation with the local government officials and representatives from all the villages in the study area. They were arbitrary in nature, but reflected the perception of the local community into the accessibility problems faced by them. A review of the available quantification techniques has been done by Sarkar and Neelima (2005).

Attempts were made in this study to incorporate the major factors that were the reasons for the lack of accessibility to a particular facility or service and thus represented the problems of an area realistically. As the contribution of various factors to a particular problem was studied, the method also helped in identifying measures to improve accessibility to a certain area. It is felt that instead of adding the population factor, it would have been more appropriate to multiply the accessibility factor obtained by considering travel time and quality of service factors.

II. DEVELOPMENT OF A MODIFIED QUANTIFICATION TECHNIQUE

Based on a detailed analysis of the methods used in studies carried out in different countries, it was felt that a slightly modified approach would be more appropriate, where the process could be made more accurate without sacrificing its simplicity. Three parameters, travel time, travel cost and quality of service would be used in the quantification of accessibility represented by the Accessibility Index. The fourth parameter, the percentage of a population using a facility or service, would be used to prioritize the villages. To facilitate the comparison among various sectors the accessibility index would be multiplied by relative weight as given by the villagers on a sector, being aware of the needs of all other sectors considered in the study. This new index has been named the Sector-weighted Accessibility index. Another, the Priority Index, is obtained by multiplying the Sector-weighted accessibility index by the population parameter. Unlike most of the previous studies, instead of total population or the number of households in a village, the number of actual users of a facility has been considered as population in this new approach.

Accessibility Index, Sector-weighted Accessibility Index and Priority Index are expressed as shown in Eq-3.1, Eq.3.2 and Eq. 3.3 respectively.

$$AI_m = \{FT \times w_1 + FCT \times w_2 + w_3 \times {}^{N}\sum_{i=1} \{w_{3i} \times FQS_i\}\} \quad \text{.......... (3.1)}$$

$$WI_m = W_m \times AI_m \quad \text{.......... (3.2)}$$

$$PI_m = FP \times WI_m \quad \text{.......... (3.3)}$$

Where,

AI_m = Accessibility Index for sector m

WI_m = Sector- Weighted Accessibility Index for sector m

PI_m = Priority Index of a village for sector m

W_m = Relative weight assigned to a particular sector m while considering all other sectors considered in the study.

FP = Score on a scale between 0 and 4 based on number of people accessing the sector in a village

FT = Score on a scale between 0 and 4 based on the average travel time for reaching the service.

FCT = Score on a scale between 0 and 4 based on the cost of transportation to a service.

FQS_i = Score on a scale between 0 and 4 based on the one of the sub-factors which determines the quality of the service.

w_1 = Relative weight assigned to Travel time while considering all factors in a sector.

w_2 = Relative weight assigned to Cost of transportation while considering all other factors in a sector.

w_3 = Relative weight assigned to Quality of service while considering all other factors in a sector.

W_{3i} = Weights assigned to sub-factors of Quality of Service so that ${}^{n}\sum_{i=1} W_{3i} = 1$

n = Total number of sub-factors used in defining Quality of service.

III. CASE STUDY

Using the technique suggested in this article, a case study was conducted in a cluster of villages in the Neemrana Block in the Alwar District of Rajasthan, India. This block is adjacent to Haryana state and the residents of some of the villages use a few facilities available on both sides of the border. In all, ten adjacent villages, with a varying number of households, were considered. The number varied between 120 in Porula and 700 in Giglana. Relevant data required for the study was collected through a village level questionnaire survey conducted through a participatory approach. The number of households in each village is shown in Table 1.

Table 1. Number of Households in the Villages

Village	Number of Households
Nanagwas	550
Sato	360
Giglana	700
Mahatwas	500
Adind	280
Raisarana	220
Chawandi	225
Nangli Balahir	500
Porula	120
Bighana	125

Bicycle and motorized two-wheelers (scooters and motorcycles) are quite popular in most of the villages. Mehatwas has the highest ownership with 100 per cent and 60 per cent of the households owning bicycles and motorized two-wheelers respectively. Camel carts play a very important role in the transportation of goods from the fields and thus ownership of these vehicles, to some extent, is observed in all the villages. Donkey carts are also used for carrying goods. A few households also own jeeps, which are being used for commercial purposes as para-transit in rural areas. Besides the income level of the residents, the ownership of vehicles in a village depends largely on its connectivity with surrounding villages, availability of efficient public transport services, distances to infrastructure and on the type and quality of connecting roads. Most of the villages are well connected with adjacent villages, though not necessarily by quality roads.

The survey was conducted primarily for the quantification of accessibility to the basic amenities such as clean drinking water, primary schools and primary health care centres. Availability of some of the other facilities such as secondary and high schools, post offices and health care in the villages was also collected as shown in Table 4.2. Chawandi, Porula and Bighana have no other facilities except for a primary school. Giglana, the largest village, has all the facilities.

Table 2. Availability of a Few Selected Services in the Villages

Village	Facilities				
	Primary School	**Secondary School**	**High School**	**Post Office**	**Primary Health Care Centre**
Nanagwas	√	√	X	√	√
Sato	√	√	X	X	√
Giglana	√	√	√	√	√
Mahatwas	√	√	X	√	X
Adind	X	√	X	X	X
Raisarna	√	√	√	√	X
Chawandi	√	X	X	X	X
Nangli	√	√	√	√	X
Porula	√	X	X	X	X
Bighana	√	X	X	X	X

√ Available X Not- available

Scores on Primary Education Sector

Access to primary education was one of the three sectors considered for the study. Various factors such as number of students, travel time and cost, quality of service in terms of the student teacher ratio, classroom to class ratio and teacher to class ratio were used to arrive at an index for this sector. These parameters were represented by scores for quantifying the accessibility. The scores were assigned arbitrarily but they were relative and were derived considering the maximum and minimum values of each parameter. The number of students in each village is detailed in Table A-1 (Appendix-II) and depending on the variation in numbers, scores were assigned. A village which had more than 225 students was given the highest score of 4 and with less than 75 was assigned the lowest score of 1. Similarly, travel time was assigned scores as shown in Table A-2 (Appendix-II). Travel time of less than 10 minutes was assigned a score of 1 and travel time of over 30 minutes was assigned a score of 4. Since there was no cost involved in travel to school in all the villages, the score on travel cost was assigned zero.

The quality of service in the primary education sector depends on a number of factors such as infrastructure and facilities for extra-curricular activities as well as number and quality of teachers. However, keeping in mind the fact that very often in rural areas the schools have an inadequate number of classrooms and teachers, the quality in this study has been measured based on: classroom to class ratio, teacher to class ratio and student to teacher ratios. The scores used to grade these are given in Appendix-II in Tables A-3, A-4 and A-5 respectively. All the children in all the villages walk to school and no cost was involved in travel and thus the score on travel cost FCT_{PS} was assigned zero for all cases.

Scores on Primary Health Care Sector

Primary health care constitutes a very important sector in any village and it was expected that all the villagers use the nearest health care centre. The parameters used to arrive at the health care index were population, travel time, travel cost and the quality of service. The scores assigned to the different population levels in the villages are given in Table A-6 (Appendix-II). Travel time and cost were used as input factors to calculate the accessibility to the service. The scores assigned to travel time and travel cost are represented in Tables A-7 and A-8 respectively (Appendix-II).

The factor representing the quality of service for primary health care has been subdivided into two factors, namely hours of availability of the service and the average waiting time before being attended to at the health care centre. The scores assigned to these two factors are given in Tables A-9 and A-10 respectively (Appendix-II).

Scores on drinking water sector

The factors that were used to arrive at the accessibility index for the drinking water sector were the population that uses the service, travel time, travel cost and the quality of service. The factor representing the quality of service has been subdivided into two categories, one representing the average number of people using a water point and the other representing the quality of water available at the source. The scores assigned to the population factor are detailed in Table A-11 (Appendix-II). With respect to drinking water, the classification of population is done more based on households rather than individuals. Most households make more than one trip to the water source every day. Hence, the total travel time was obtained by multiplying the time for one trip by the average frequency. Scores have been assigned on total travel time as shown in Table A-12 (Appendix-II). Since most villagers walk to collect their daily requirement of water, the factor associated with travel cost was zero in this case also. The scores assigned to the quality of service are detailed in Tables A-13 and A-14 in Appendix-II. The quality of water was considered to be satisfactory in the case of tube wells and the worst case scenario was where portable drinking water was not available.

Values of the parameters and their scores

To calculate the accessibility indices for primary education, drinking water and primary health facilities, relevant data was collected from each village through a participatory approach. Besides population served, data on travel time, travel cost and the quality of service provided by each sector was collected. The values as obtained in the villages on the parameters for the quantification of accessibility to primary education, drinking water and primary health care are shown in Tables 4.3, 4.4 and 4.5 respectively. These values are then represented in terms of the scores discussed in sub-section 5.3 and the corresponding values are obtained as shown in Tables 4.6, 4.7 and 4.8 respectively.

Table 3. Values of Parameters for Accessing Primary Education

Name of village	Students in school	Travel time (min)	Travel Cost (Rs.)	Class Room/Class	Teacher/ Class	Student/Teacher
Nangawas	25	10-15	0	0.8	0.4	12.5
Sato	200	20-25	0	0.8	0.4	100
Giglana	30	10-15	0	1.6	0.8	7.5
Mahtawas	61	10-15	0	1.2	0.4	30
Adin	175	10-15	0	0.63	0.87	25
Raisarana	270	10-15	0	1.2	0.8	67.5
Chawandi	15	10-15	0	1	0.4	7.5
Nangli	100	5-10 &10-15	0	1.2	0.6	33.33
Porula	65	10-15	0	0.6	0.4	32.5
Bighana	150	10-15	0	1.5	0.75	25

Table 4. Values of the Parameters for Accessing Drinking Water Supply

Name of Village	No. of Households	Travel Time(min)	Travel Cost	Population per Point	Source of Water
Nangawas	550	90	0	275	Tube well
Sato	360	200	0	180	Tube well
Giglana	700	0	0	233	Tube well
Mahtawas	500	480	0	63	Tube well
Adin	280	360	0	94	Tube well
Raisarana	220	140	0	110	Tube well
Chawandi	225	540	0	75	Tube well
Nangli	500	600	0	50	Tube well
Porula	120	360	0	60	Tube well
Bighana	125	225	0	42	Tube well

Table 5. Values of the Parameters for Accessing Primary Health Facility

Name of village	Population	Travel time(min)	Travel cost in Rs.	Waiting Time(min)	Availability of Doctor and Medicine
Nangawas	3000	45	100	60	24 hrs
Sato	2500	10	0	60	24 hrs
Giglana	4200	10-15	0	30	24 hrs
Mahtawas	3500	10	0	0	Not Available
Adin	1400	15	150	60	24 hrs
Raisarana	1600	60	200	60	24 hrs
Chawandi	1250	30	200	30	24 hrs
Nangli	3500	60	200	60	24 hrs
Porula	1000	30	200	60	24 hrs
Bighana	993	30	50-100	120	24 hrs

Table 6. Scores on Parameters for Accessing Primary Education

Name of Village	Scores on				
	Students in school (FP_{PS})	Travel time (FT_{PS})	Class Room/Class ($FQS1_{PS}$)	Teacher/ Class ($FQS2_{PS}$)	Student/ Teacher ($FQS3_{PS}$)
Nangawas	1	2	4	4	0
Sato	3	3	4	4	4
Giglana	1	2	0	2	0
Mahtawas	1	2	0	4	1
Adin	3	2	4	2	1
Raisarana	4	2	0	2	4
Chawandi	1	2	0	4	0
Nangli	2	1	0	3	2
Porula	1	2	4	4	2
Bighana	2	2	0	3	1

Table 7. Scores of the Parameters for Accessing Drinking Water Supply

Name of village	Scores on				
	Number of households (FP_{DW})	Travel time (FT_{DW})	Travel cost (FCT_{DW})	Population per water point ($FQS1_{DW}$)	Source of water ($FQS2_{DW}$)
Nangawas	4	1	0	4	0
Sato	2	2	0	3	0
Giglana	4	1	0	4	0
Mahtawas	3	4	0	1	0
Adin	2	3	0	2	0
Raisarana	2	2	0	2	0
Chawandi	2	4	0	2	0
Nangli	3	4	0	1	0
Porula	1	3	0	1	0
Bighana	1	2	0	1	0

Table 8. Scores of the parameters for accessing primary health facility

Name of Village	Scores on				
	Population (FP_{PH})	Travel time (FT_{PH})	Travel cost (FCT_{PH})	Waiting time ($FQS1_{PH}$)	Availability of doctor and medicine ($FQS2_{PH}$)
Nangawas	3	2	1	1	0
Sato	3	0	0	1	0
Giglana	4	0	0	0	0
Mahtawas	4	0	0	0	2
Adin	2	0	2	1	0
Raisarana	2	3	3	1	0
Chawandi	2	1	3	0	0
Nangli	4	3	3	1	0
Porula	1	1	3	1	0
Bighana	1	1	1	3	0

Weights on the sectors and the parameters

Villagers attach different levels of importance to each sector depending on the existing level of accessibility prevailing in a village. Hence, it was essential that the accessibility index developed reflected the aspirations of the villagers. To achieve this goal, three indices have been suggested in this article. The Accessibility Index (AI) is calculated by multiplying the scores with the weights assigned to the factors such as travel time, travel cost and quality using Equation 3.1. The weights on each factor and sub-sector were collected by asking the villagers to put importance ratings in a scale between 1 and 4 where 1 represents low and 4 represent high importance. These weights were then normalized such that their sum equalled one. To facilitate inter-sectoral prioritization, data was collected from each village on the importance it put on accessibility to different sectors in a scale ranging between 1 and 5 where 1 represented low importance and 5 represented high importance. Weights thus obtained have been normalized. Once the sector indices were multiplied with these weights, the Weighted Accessibility Index (WAI) was obtained (Equation 3.2) which reflects the relative importance of a sector within the village and among other villages. However, this prioritization may not have been enough for the planners to make a clear decision, as it was still unknown as to how many people were going to benefit by any action of improving accessibility to a sector. Thus, the concept of the Village Priority Index (VPI) has been introduced (Equation 3.3) in which the number of people using a sector has also been taken into consideration.

The weights assigned and their normalized values to different sectors in the villages are given in Table 4.9. It may be observed that in most of the villages accessibility to water is the highest priority. The normalized values of the weights assigned to different parameters and sub-parameters for accessibility to primary education, water and primary health care centre are shown in Tables 4.10, 4.11 and 4.12 respectively. Quality of service has been assigned a high weight in most of the villages with regards to accessibility to primary education, whereas weight on travel time is the highest for accessibility to drinking water. In the case of accessing primary health care, both travel time and travel cost have been given equal weights in all the villages.

Table 9. Weights Assigned to Different Sectors and their Normalized Values

Name of the village	Weights on Primary Education		Weights on Drinking Water		Weights on Primary Health	
	Out of 5	Normalized	Out of 5	Normalized	Out of 5	Normalized
Nangawas	1	0.11	5	0.56	3	0.33
Sato	3	0.25	5	0.42	4	0.33
Giglana	3	0.24	5	0.38	5	0.38
Mahtawas	4	0.28	5	0.36	5	0.36
Adin	5	0.38	4	0.31	4	0.31
Raisarana	2	0.18	5	0.46	4	0.36
Chawandi	1	0.13	4	0.5	3	0.37
Nangli	5	0.42	4	0.33	3	0.25
Porula	3	0.30	5	0.50	2	0.20
Bighana	2	0.22	3	0.34	4	0.44

Table 10. Normalized values of weights allotted to travel time (w1), travel cost (w2), quality of service (w3) and sub-parameters of quality of service for quantifying accessibility to primary education

Name of the Village	Weights on					
	Travel time ($W1_{PS}$)	Travel cost ($W2_{PS}$)	Quality of service ($W3_{PS}$)	Class Room/ Class ($W31_{PS}$)	Teacher/ Class ($W32_{PS}$)	Student/ Teacher ($W33_{PS}$)
Nangawas	0.14	0.14	0.72	0.33	0.33	0.33
Sato	0.40	0.10	0.50	0.45	0.45	0.10
Giglana	0.20	0.20	0.60	0.20	0.20	0.60
Mahtawas	0.33	0.33	0.33	0.14	0.14	0.72
Adin	0.14	0.14	0.72	0.33	0.33	0.33
Raisarana	0.14	0.14	0.72	0.33	0.33	0.33
Chawandi	0.45	0.09	0.45	0.14	0.14	0.72
Nangli	0.14	0.14	0.72	0.36	0.36	0.28
Porula	0.23	0.12	0.65	0.33	0.33	0.33
Bighana	0.17	0.17	0.66	0.13	0.50	0.37

Table 11. Normalized values of weights allotted to travel time (w1), travel cost (w2), quality of service (w3) and sub-parameters of quality of service for quantifying accessibility to drinking water

Name of Village	Weights on				
	Travel time ($w1_{DW}$)	Travel cost ($w2_{DW}$)	Quality of Service ($w3_{DW}$)	Population/ water point ($w31_{DW}$)	Source of water ($w32_{DW}$)
Nangawas	0.72	0.14	0.14	0.83	0.17
Sato	0.72	0.14	0.14	0.83	0.17
Giglana	0.14	0.14	0.72	0.50	0.50
Mahtawas	0.45	0.45	0.10	0.83	0.17
Adin	0.72	0.14	0.14	0.83	0.17
Raisarana	0.72	0.14	0.14	0.83	0.17
Chawandi	0.50	0.10	0.40	0.50	0.50
Nangli	0.28	0.36	0.36	0.56	0.44
Porula	0.72	0.14	0.14	0.50	0.50
Bighana	0.72	0.14	0.14	0.83	0.17

Table 12. Normalized values of weights allotted to travel time (w1), travel cost (w2), quality of service (w3) and sub-parameters of quality of service for quantifying accessibility to primary health services

Name of Village	Weights on				
	Travel time ($w1_{PH}$)	Travel Cost ($w2_{PH}$)	Quality of service ($w3_{PH}$)	Waiting time ($w31_{PH}$)	Availability of doctor and medicine ($w32_{PH}$)
Nangawas	0.45	0.45	0.10	0.17	0.83
Sato	0.33	0.33	0.33	0.50	0.50
Giglana	0.45	0.45	0.10	0.17	0.83
Mahtawas	0.45	0.45	0.10	0.17	0.83
Adin	0.45	0.45	0.10	0.17	0.83
Raisarana	0.45	0.45	0.10	0.17	0.83
Chawandi	0.45	0.45	0.10	0.17	0.83
Nangli	0.36	0.36	0.28	0.17	0.83
Porula	0.33	0.33	0.33	0.17	0.83
Bighana	0.33	0.33	0.33	0.17	0.83

Calculation of indices

Using the quantification technique developed in this study and the score and weights collected through the survey, the accessibility indices have been calculated using Equations 3.1, 3.2 and 3.3. However, to facilitate comparison, they have also been shown using a percentage. Each score has been divided by the maximum possible value of 5 and then multiplied by 100 to get the percentage. The accessibility indices (AI) and the percentage scores of the sectors considered in this study, such as primary education, drinking water and primary health services of each village have been shown in Table 4.13. This helps to prioritize the villages sector-wise. From the table it may be observed that regarding accessibility to primary education, Sato has a major deficit in this area, with a score of 70, whereas Giglana has the fewest problems in that area, with a score of 17. However, the villagers would be more concerned over the problems caused due to lack of access to one sector than another depending on the importance they put on them. The importance, or the weight, is a reflection of the need to access the facility. For example, drinking water is a basic need and education is a social need. Therefore, a higher importance would be accorded to a basic need over a social or an economic one. To solve this problem, the sector weighted accessibility index (WAI) has been introduced. Prioritization based on these values would make the planner understand the most critical sector in a village (Table 4.14). For example, for village Nangwas, accessibility to drinking water is most critical, with a score of 13, primary health is next with a score of 9 and primary education is the last priority with a score of 5. The population also needs to be considered when prioritizing for villages and sectors. Logically, villages with higher populations should get higher priority. This would ensure that more number of people would get service from an infrastructure. Accordingly, the village priority index has been devised. This has been obtained by multiplying the sector weighted accessibility index with a score proportional to the population of the village or the number of people expected to benefit (Table 4.15). Accessibility to drinking water in Sato was the highest priority, with a score of 60 among all the villages in all sectors. However, the decision to give higher priority to villages having higher population might not be appropriate all the times because sometimes the decision makers would prefer to give higher priority to the villages having the higher AI values. These policy decisions would be decided based on the input received from the villagers collected through the participatory approach.

Once the accessibility problems in different villages are identified and prioritized, the next step is to identify the alternative projects and then select the best solution with in the available budget, in consultation with the villagers. The interventions may be in the form of improving accessibility through the construction of a new road and/or transport service; improving the level of service at the existing infrastructure or constructing a new infrastructure at a suitable location. Due to lack of adequate demand, some facilities such a primary health centres or high schools can not be provided for a single village and thus are located in order to service a cluster of villages. Thus, while identifying appropriate projects it is necessary to include the impact of the facility or infrastructure on the nearby villages as well.

Table 13. Accessibility Index

Name of village	Primary Education AI_{PS}		Drinking Water AI_{DW}		Primary Healthcare AI_{PH}	
	Accessibility Index (AI)	Accessibility Index in percent	Accessibility Index (AI)	Accessibility Index in percent	Accessibility Index (AI)	Accessibility Index in percent
Nangawas	2.32	46	1.18	24	1.32	26
Sato	3.50	70	1.79	36	0.17	3
Giglana	0.84	17	1.58	32	0	0
Mahtawas	1.43	29	1.88	38	0.17	3
Adin	2.36	47	2.39	48	0.92	18
Raisarana	2.27	45	1.67	33	2.72	54
Chawandi	0.88	18	2.40	48	1.80	36
Nangli	1.60	32	1.32	26	2.21	44
Porula	2.62	52	2.23	45	1.38	28
Bighana	1.67	33	1.56	31	0.83	17

Table 14. Sector-weighted Accessibility Index

Name of village	Primary Education WI_{PS}	Drinking Water WI_{DW}	Primary Healthcare WI_{PH}
Nangawas	5	13	9
Sato	18	15	1
Giglana	4	12	0
Mahtawas	8	14	1
Adin	18	15	6
Raisarana	8	15	20
Chawandi	2	24	13
Nangli	13	9	11
Porula	16	23	8
Bighana	7	11	8

Table 15. Village Priority Index (VPI)

Name of village	Primary Education PI_{PS}	Drinking Water PI_{DW}	Primary Healthcare PI_{PH}
Nangawas	5	52	36
Sato	54	60	4
Giglana	4	48	0
Mahtawas	8	56	4
Adin	54	30	12
Raisarana	32	30	40
Chawandi	2	48	26
Nangli	26	36	44
Porula	16	46	12
Bighana	14	11	8

CONCLUSION

The suggested technique is quite simple and is not very different from the methods already used in some other studies carried out in a few countries in Asia and Africa. The main deviation is in the normalization of the collected data at every stage and also the suggestion that three different parameters, accessibility index, weighted priority index and village priority index be used to help the decision makers arrive at a decision regarding the provision of infrastructure or services. One of the advantages of this method is the use of the weights collected through participatory questionnaire surveys from people in different villages in different sectors to identify actual accessibility needs. The prioritization technique is based on the scores as obtained in terms of the indices suggested in this article. The accessibility indices (AI) help to compare villages sector-wise and the weighted priority indices (WPI) are used to compare accessibility to different sectors in each village and among the villages. Keeping in view the fact that a village with a higher population should get higher priority, the concept of village priority index (VPI) has been introduced which helps the decision makers to prioritize the villages sector-wise. Since the data is collected based on primary surveys conducted using the participatory approach, the indices calculated should not be taken as absolute values. It would be appropriate if the prioritization is done group-wise based on score ranges rather than individual scores while carrying out a study with a large number of villages.

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APPENDIX-I

STEPS IN INTEGRATED RURAL ACCESSIBILITY PLANNING (IRAP)

Step 1: Define the Planning Objectives
Set the scope, such as which sectors to include in the planning and what targets to meet. Major questions to be asked here are; who will benefit will then needs of women be addressed if the objectives do not spell out that the needs of both men and women have to be considered.

Step 2: Define the Rural Access Needs that Relate to these Objectives
People need to travel for different purposes. For rural development all needs should be considered, while if only certain sectors are involved, fewer access needs would be assessed.

Step 3: Collect Data on Relevant Access Needs and Prioritize and Produce Accessibility database
Data should be collected at the lowest possible level on population, village structure, transport infrastructure and services, location and quality of facilities and transport patterns. This forms the database upon which the result of the exercise depends. Quantitative data is supplemented by qualitative data through local participation.

The key here is the type of data collected and its desegregation by gender in order to understand the scope of the needs of women and men and the opportunities and constraints in addressing them. The main categories of data to be collected concern the travel and transport patterns of women and men to and from crucial activities and services.

Step 4: Define Main Access problems
The analysis of the accessibility database identifies those access needs that face the greatest problems. A methodology is provided for using gender segregated data to devise indicators for accessibility problems in order to prioritize such problems in an objective and scientific manner.

Step 5: Define Strategy to Address Access Problems
Different interventions, which may include improvement in the transport system or in the location and quality of services, are identified. Potential methods for implementation are also identified.

The strategies for addressing rural access problems can be grouped into three categories; closer proximity of essential services; increasing mobility and efficiency in transport through greater access to various means of transport; reducing the number of tasks that have to be done by walking and head loading.

Step 6: Priorities Locations of Specific Interventions
This concerns the prioritizing of communities, villages, wards, etc. for specific interventions. The community-expressed priorities are taken into consideration. A key question that needs to be asked at this step is how to make choices regarding interventions where resources are not adequate to meet all the needs.

Step 7: Consolidated Prioritized Interventions to Produce Action Plan
The last step in the process is to package the findings into an action/development plan which puts forward costs and funding for the investment, operation and maintenance. This is the culmination of all the steps and therefore many of the questions addressed in the previous steps will resurface.

APPENDIX-II

Scores for Access to Primary School

Table A-1 Score on Population for Access to Primary School (FP_{PS})

Number of students	Score
Less than 75	1
75-150	2
150-225	3
More than 225	4

Table A-2 Score on Travel time for Access to Primary School (FT_{PS})

Travel time(min)	Score
0-10	1
10-20	2
20-30	3
Over 30	4

Table A-3 Score on Quality of service: Class room to class ratio ($FQS1_{PS}$)

Class room to class ratio	Score
More than or equal to 1	0
Less than 1	4

Table A-4 Score on Quality of Service: Teacher to Class Ratio ($FQS2_{PS}$)

Teacher to Class ratio	Score
More than 1	0
0.75 -1	2
0.5-0.75	3
Less than 0.5	4

Table A-5 Score on Quality of Service: Student to Teacher Ratio ($FQS3_{PS}$)

Student to teacher ratio	Score
Less than 15	0
15—30	1
30—45	2
45-60	3
More than 60	4

Scores for Access to Primary Health

Table A-6 Score on Population (FP_{HC})

Population	Score
0-1000	1
1000-2000	2
2000-3000	3
Above 3000	4

Table A-7 Score on Travel Time (FT_{HC})

Travel time(min)	Score
Less than 15	0
15-30	1
30-45	2
45-60	3
More than 60	4

Table A-8 Score on Cost of Travel per Trip (FCT_{HC})

Travel Cost (Rs)	Score
Less than 50	0
50-100	1
100-150	2
150-200	3
More than 200	4

Table A-9 Score on Quality of Service: Availability of Basic Services ($FQS1_{HC}$)

Availability of Doctor and Medicine	Score
Doctor and medicine available for 24 hrs	0
Doctor and medicine available only during day	2
No doctor available	4

Table A-10 Score on Quality of Service: Waiting Time at the Health Centre ($FQS2_{HC}$)

Waiting time(min)	Score
Less than 30	0
30-60	1
60-90	2
90-120	3
More than120	4

Scores for Access to Drinking Water

Table A-11 Score on Population (FP_{DW})

No. of households	Score
Less than 180	1
180-360	2
360-540	3
More than 540	4

Table A-12 Score on Travel time (FT_{DW})

Travel Time(min)	Score
Less than120	1
120-240	2
240-360	3
More than 360	4

Table A-13 Score on Quality of Service: Population per water point ($FQS1_{DW}$)

Population per point	Score
0—70	1
70—140	2
140—210	3
Above 210	4

Table A-14 Score on Quality of Service: Water Quality at the source ($FWS2_{DW}$)

Type of Source	Score
Tube well	0
River, lake, pond, well	2
Potable water not available	4