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No. 81

Planning for accessibility and rural roads

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Editorial statements

The Transport and Communications Bulletin for Asia and the Pacific is a peer-reviewed journal published once a year by the Transport Division (TD) of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). The main objectives of the Bulletin are to provide a medium for the sharing of knowledge, experience, ideas, policy options and information on the development of transport infrastructure and services in the Asia-Pacific region; to stimulate policy-oriented research; and to increase awareness of transport policy issues and responses. It is hoped that the Bulletin will help to widen and deepen debate on issues of interest and concern in the transport sector.

Studies conducted by international organizations, donor organizations and research institutions in a number of countries, including Bangladesh, China, India, Indonesia, the Philippines, Sri Lanka, Thailand and Viet Nam provide ample empirical evidence of the positive impact of transport (rural roads, in particular) on poverty reduction. Findings from these studies show that investment in rural roads/access improvement can have a positive impact in many areas, including increases in total factor productivity in agriculture, shifts from subsistence farming to higher earning commercial farming, increases in rural wages, growth of non-agricultural employment and better social impact through improved access to basic services.

Recognizing the benefits of investment in rural road development, many countries have considered extensive rural road development programmes in their countries. As a result, vast networks of rural roads have been developed in many developing countries of the region. However, countries have faced a number of challenges in implementing such programmes. The major challenge in rural road development is both to expand road networks in order to provide access to remote areas and to upgrade and maintain already existing roads. The positive experiences of countries that have successfully met these challenges are worth sharing.

In consideration of the importance and interest in the subject, planning for accessibility and rural roads was chosen as the theme for the current issue of the Bulletin. Four articles are included in this issue.

An approach to infrastructure and services planning, known as Integrated Rural Accessibility Planning (IRAP), has emerged as the 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 issue in this approach. A number of quantification techniques have been used in various studies conducted so far. In the first article, an attempt has been made to suggest a modified quantification technique that was applied in an area of India and proved to be simple and practical. The main deviation is in the normalization of the collected data at every stage as well as 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 provision of infrastructure or services. One of the advantages of this method is the use of the weights collected through a participatory questionnaire survey, given to people in different villages and in different sectors, to identify actual accessibility needs.

Providing reliable road access to remote areas is a challenge for many countries. Earthen and gravel surface are commonly used in low volume roads. The second article discusses the use of Otta seal, a low cost road pavement designed to improve reliability and serviceability of unpaved and low traffic roads. Otta seal is an innovative type of bituminous material with characteristics that are quite different from the more traditional types of surface treatment. Otta seal roads have been constructed in many countries including Nepal. The

article outlines the design and construction of Otta seal roads. The various types of Otta seal, the materials required to create it and preparation and application procedures are described. Based on its use in Nepal, its advantages and disadvantages are also detailed.

The third article focuses on issues concerning rural road maintenance. There are many issues to be addressed prior to the successful implementation of rural roads maintenance systems, some of which have been highlighted in the article. It has been suggested that maintenance be considered as part of an overall road asset management system. Considering the complexity of such an endeavour, the author proposes a systematic approach to the problem. A step-by-step outline for developing rural road management in India is presented. An institutional arrangement is also proposed based on the the three types of maintenance; routine, periodic and emergency.

Many countries have implemented impressive rural road development programmes. However, often they have not been equally successful in establishing a sustainable maintenance programme, which is vital not only to preserve the value of this important national asset, but essential to provide continuing support to the growth of rural economy. In the Asia-pacific region, China has a high rate of rural road maintenance, with an estimated 90 per cent of rural roads currently maintained. The final article in this issue examines China's rural road maintenance system, and the institutional and financial arrangements that have ensured its success.

The Bulletin welcomes analytical articles on topics that are currently at the forefront of transport development in the region as well as policy analysis and best practices. Articles should be based on original research and should have analytical depth. Empirically based articles should emphasize policy implications emerging from the analysis. Book reviews are also welcome. See the inside back cover for guidelines on contributing articles.

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ACRONYMS

ADB	Asian Development Bank
AI	Accessibility Index
AIS	Accessibility Indicator Score
AIW	Accessibility Indicator Weight
AS	Accessibility Score
ASI	Accessibility Shortfall Index
ATT	Acceptable Travel Time
BPC	Block Planning Committee
CNB	Central Bank of Nigeria
DAP	District Accessibility profile
DoLIDAR	Department of Local Infrastructure Development and Agricultural Roads
DPC	District Planning Committees
GIS	Geographical Information System
ILO	International Labour Organization
ILO	International Labour Organization
ILO-ASIST AP	International Labour Organization- Advisory Support, Information Services and Training, Asia Pacific
IRAP	Integrated Rural Accessibility Planning
IRC	Indian Roads Congress
JRY	Jawahar Rozgar Yojana
MDR	Major District Road
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MNP	Minimum Needs Programme
NH	National Highway
NREP	National Rural Employment Programme
NRRDA	National Rural Roads Development Agency
ODA	Overseas Development Agency

ODR	Other District Road
PIARC	World Road Association
PMGSY	Prime Minister Grameen Sadak Yojana
RGC	Royal Government of Cambodia
RLEGP	Rural Landless Employment Guarantee Programme
ROMAPS	Road Maintenance, Planning, Budgeting and Programming System
SH	State Highway
SRF	State Road Fund
TRL	Transport Research Laboratory
VR	Village Road

QUANTIFICATION OF ACCESSIBILITY AND PRIORITIZATION OF VILLAGES FOR LOCAL LEVEL PLANNING

Ashoke K. Sarkar* and Motilal Dash**

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).

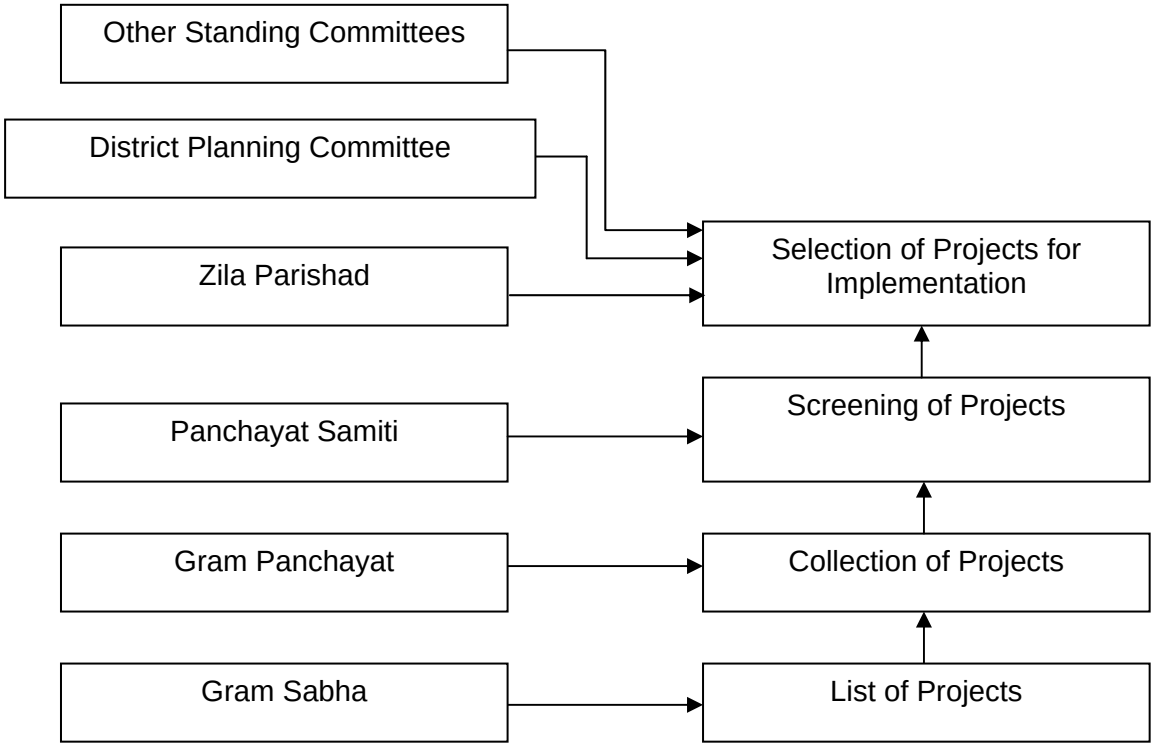
Possible Application of IRAP in India

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.

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

$$WI_m = W_m \times AI_m \quad \ldots\ldots (3.2)$$

$$PI_m = FP \times WI_m \quad \ldots\ldots (3.3)$$

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

CHOICE OF BITUMINOUS OTTA SEAL SURFACING AN ECONOMIC PAVEMENT SURFACING FOR LOW VOLUME ROADS

Durga Prasad Osti*

ABSTRACT

Providing reliable road access to remote areas is a challenge for many countries. Earthen and gravel surfaces are commonly used on low volume roads. This article discusses the construction and use of otta seal, a low cost road pavement to improve reliability and serviceability of unpaved and low traffic roads. Its advantages and disadvantages are discussed based on its application in Nepal where its performance is still under evaluation.

Key Words: Otta seal, road pavement, Nepal

INTRODUCTION

Road pavement surface provides driving space to vehicles using the road. It is desirable that a riding surface should be smooth enough to not cause jerking and jolting to the vehicles and its passengers. At the same time, it is desirable that the surface be skid-resistant. Pavement carries the wheel loads of vehicles and transfers the load to the sub-grade soil through various structural layers. The loads are transferred through the wheels of vehicles via contact pressure.

Types of Pavement

Mainly there are two types of pavement:

1. Flexible Pavement
2. Rigid Pavement

For the present, this article is dealing with flexible pavement surfacing. Flexible types of pavements have low flexural strength and are flexible in their structural action under the wheel loads. The flexible pavement layers reflect the deformation of the lower layers on to the surface layer. This means that when any layer of the pavement underneath is undulated, the surface becomes undulated as well. The flexible pavement layers transmit the vertical compressive stresses to the lower layers by grain to grain transfer through the points of contact in the granular structure. The flexible pavement usually has the following components and layers.

Different layers in flexible pavement

- Sub-grade
- Selected fill, capping layer or improved sub-grade
- Sub-base
- Base course or road base
- Surfacing

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Sub-grade, selected fill, capping layer or improved sub-grade

The sub-grade is a layer of natural soil prepared to receive the layers of pavement materials placed over it. It essentially consists of local natural soil or existing material or transported fill. It is well compacted in order to achieve the required strength. Weight loads on the pavements are ultimately absorbed by the soil sub-grade. The overlain layers have a function of distributing the load so as not to overstress the sub-grade beyond the limit. Therefore, it is important that the sub-grade be well compacted before adding other layers. Sometimes, if the strength of the sub-grade soil is very weak, a separate layer of reasonable strength will be paced and well compacted. This additional layer is referred to as selected fill, a capping layer or improved sub-grade.

Sub-base

Sub-base is a load distributing layer above the sub-grade and usually consists of

- Unprocessed natural gravel
- Gravel Sand
- Gravel sand clay

This layer serves as a separating layer, for overlaid road base and prevents contamination of the base course by sub-grade, material. Its other important function is to protect damage to the sub-grade caused by construction traffic.

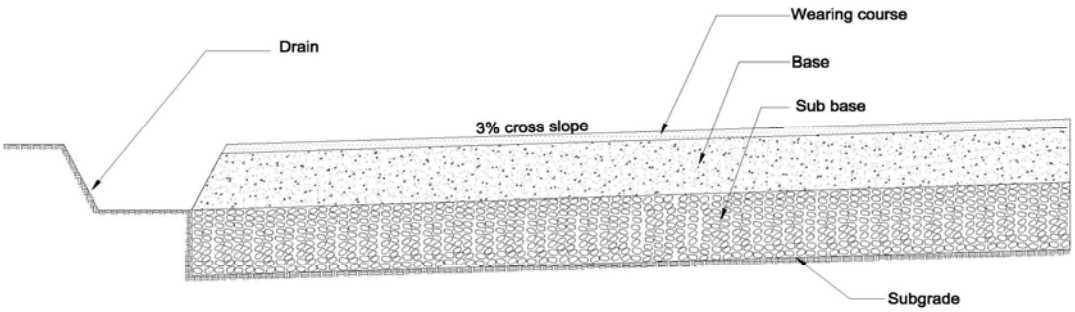
Base Course or road base

This layer acts as main the load spreading layer for the pavement by absorbing wheel loads of vehicles plying on the pavement. It consists of crushed stone, gravel, gravely soil, decomposed rock, sand and sand clays stabilized with cement, lime or bitumen.

Surfacing

This is an uppermost layer of pavement and consists of a bituminous material in the form of surface dressing, Otta Seal, or a layer of pre-mixed bituminous material. Sometimes premixed materials are applied in two layers and are referred to as the base course and the wearing course for the lower and upper layers respectively. A typical cress-section of the flexible pavement is as shown in the following figure.

Figure 1. Typical cross section of flexible pavement



I. SURFACING OF ROADS

Gravel roads are generally maintained as low cost roads in developing countries. In dry conditions, dust generated by traffic results in increased gravel loss which causes dust pollution. This can create safety hazards and discomfort to road users and can adversely affect agricultural yields the health of livestock. Dust pollution can contaminate food stores and water resources, which are susceptible to airborne dust concentration. Dust also reduces the life of electrical equipment. During wet seasons, there will be a high rate of gravel loss due to flooding and substantial surface water. This will necessitate re-grading and the laying of additional gravel. However, gravel roads are seldom maintained systematically. Lack of maintenance, often causes gravel roads to revert to earthen roads. These uneven roads can deprive communities of access to necessary services, creating serious social implications. In developing economies in order to seal gravel surfaces the following criteria must be met.

It should be:

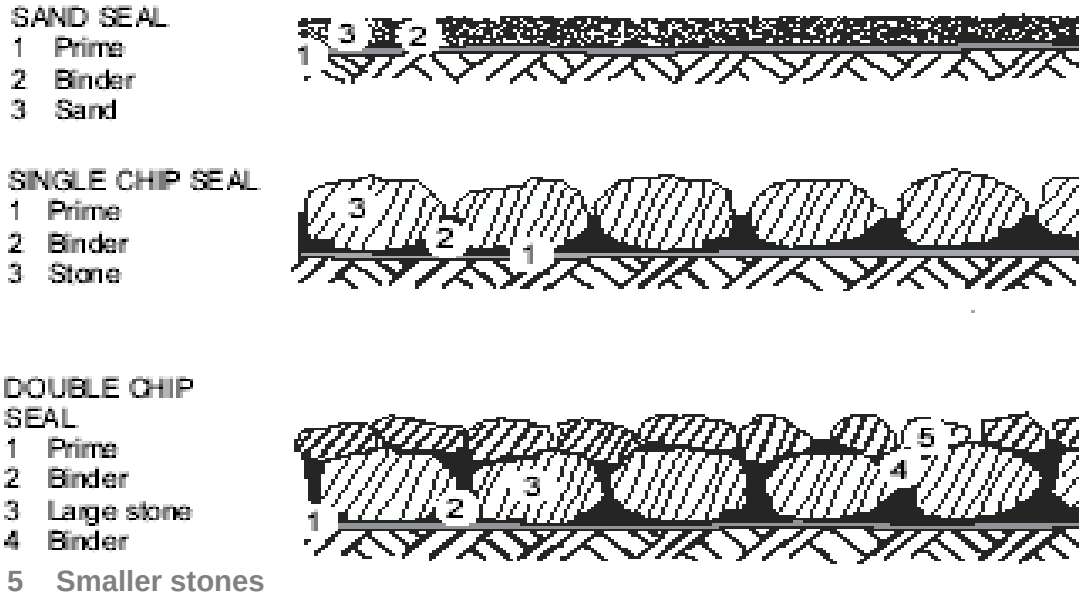
- Cheap
- Constructed with locally available aggregates
- Impervious
- Flexible
- Durable

Although gravel surfaces can be sealed in a variety of ways, the following three methods are the most common:

- Sand Sealing,
- Single Chip sealing and
- Double Chip sealing

These types of sealing techniques are shown in the Figure 1. The first illustration shows sand sealing with the help of a binder applied to the sand first, while the second and third illustrations show the sealing of pavement using stone aggregates, with a binder being applied once and twice respectively.

Figure 2. Type of sealing



In the above figures the gravel surface is first primed with cut back bitumen, a layer of hot bituminous binder is then applied and the surface is sealed with materials spread on the surface and rolled out.

Function of Bituminous Surfacing

The major functions of the bituminous surfacing are:

- To provide durable, tight impervious surfacing which seals and protects the underlying pavement layers from moisture, and the resulting pavement degradation;
- To provide a skid-resistant surface that is resistant to abrasion and disruptive forces caused by traffic and other environmental factors;
- To prevent the formation of corrugation, dust and mud;
- To permit relatively safe travel at higher speeds; and
- To lower vehicle operating and maintenance costs.

Types of sealing

Various types of bituminous surfacing with different characteristics and service lives have been developed for application in specific situations depending on factors such as, type and volume of traffic, type of pavement and environmental conditions.

In flexible pavement construction, the following types of sealing are in practice.

a) Single or multiple surface dressing
b) Seal Coat
c) Slurry seal
d) Sand seal
e) Otta seal
f) Semi –grouting + Seal Coat/Wearing course
g) Premixed asphalt concrete

Choice of Otta seal surfacing

Otta seal is a thin bituminous seal comprised of graded gravel or crushed aggregate of all sizes and either cut-back or soft penetration grade bitumen with or without a sand cover seal. The first Otta Seal Surfacing was created in Norway in 1963-65 as an experimental innovative approach to sealing gravel roads in a cost effective manner. The outcome was much more effective than originally expected and resulted in approximately 12,000 km of the roads in Norway to be resurfaced in 1999 using Otta seal.

A number of roads in Nepal in recent years have been constructed using Otta Seal surfacing. The product's performance is now being evaluated. The approach of surface dressing has long been practiced in Nepal, but using Otta Seal is a relatively new practice. Nepal began using Otta Seal in 2002. Currently, the total length of roads in Nepal that have been sealed using Otta Seal is estimated to be above 1000 km. Some examples of locations where Otto seal is being used in current road construction include Surkhet-Jumla, Surkhet-Dailekh and Basantapur-Tehrathum road in Nepal. An observation of the recently completed Surkhet–Jumla road indicated an improvement in the roughness index and in ride quality (NASC, 2011). The success of Otta seal depends upon sound construction, good workmanship and careful preparation of the area to be sealed. Failure to properly prepare surfaces as well as poor workmanship can be misinterpreted as a design failure. In terms of cost. Otta seal is less expansive than other bituminous pavement such as surface dressing, penetration macadam, and asphalt concrete. Use of Otta seal can prevent surface gravel loss and reduce air born dust, and can therefore benefit the environment as well as the lives of people living in the influence area.

Otta seal is different from surface dressing in that a graded gravel or crushed aggregate containing all sizes, including filler, is used instead of single sized-chippings. There is no formal design procedure but recommendations based on case studies have been published (Norwegian Public Roads Administration, 1999). Otta seal may be applied in a single or double layer. Evidence on the performance of these types of seal has shown them to be satisfactory for over 12 years on roads carrying up to 300 vehicles per day (Overby, 1999).

1. Single Otta Seal
   - With sand cover seal
   - Without sand cover seal

2. Double Otta Seal
   - With sand cover seal
   - Without sand cover seal

Aggregate grading can be "open", "medium" or "dense", depending upon availability, economy and engineering properties.

Graded aggregate is placed on a relatively thick film of comparatively soft binder. As a result rolling and trafficking, the binder works its way upwards through the aggregate interstices. In much the same was a bituminous premix does, the graded aggregate relies both on mechanical interlocking and bitumen binding for its strength.

The material requirements for Otta seal construction are provided in tables 1 through 3.

Table 1. Choice of binder for Otta Seal

AADT at Construction	**Type of bitumen for different aggregate grading**		
	Open	**Medium**	**Dense**
>1000	NA	150/200 pen	MC 3000 MC 800 in cold
100 – 1000	150/200 pen	150/200 pen in cold	MC 3000 MC 800 in cold
<100	150/200 pen	MC 3000	MC 800

Table 2. Binder application rate Lit/m^2

		Grading of aggregate		
		Open	**Medium**	**Dense**
Double	1st Layer	1.6	1.7	1.8
	2nd Layer	1.5	1.6	2.0
Single with a Sand Cover Seal	Fine Sand	0.7	0.7	0.6
	Coarse sand	0.9	0.8	0.7
	1st Layer	1.6	1.7	2.0
Single		1.7	1.8	2.0
Maintenance Reseal		1.5	1.6	1.8

Table 3. Aggregate grading requirement

Sieve sizes (mm)	Open grading (per cent passing)	Medium grading (per cent passing)	Dense grading (per cent passing)
19.0	100	100	100
16.0	80 - 100	84 - 100	93 - 100
13.2	52 - 82	68 - 94	84 - 100
9.5	36 - 58	44 - 73	70 - 98
6.7	20 - 40	29 - 54	54 - 80
4.75	10 - 30	19 - 42	44 - 70
2.0	0 - 8	3 - 18	20 - 48
1.18	0 - 5	1 - 14	15 - 38
.425	0 - 2	0 - 6	7 - 25
.075	0 - 1	0 - 2	3 - 10

II. CONSTRUCTION PROCEDURES

Preparation for Otta sealing:

Otta seal will not add to the structural strength of a road. For this reason, the surface to be treated must previously have been prepared to withstand the expected traffic levels. Preparation of the road base may include regravelling, reshaping and compaction. Immediately prior to the application of Otta seal, the road base must be broomed to keep the surface free of sand and excess dust, mud or any other material that might hinder bonding between the seal and the road base. Priming the road base with non-calcareous material is not normally required. Calcareous material does require priming due to its capacity to absorb high amounts of bitumen. MC 30 or MC 70 is normally used for priming and is applied at spray rates between 0.8 and 1.2 l/m^2. Therefore, calcareous road base material should not be used, as it requires priming before the use of Otta seal.

Stockpiles of aggregate must be inspected to determine whether screening is needed to remove excess fine or overly large particles. The spreading of aggregate should be carried out by either conventional mechanical or labour intensive methods. If aggregate is to be spread by hand then small stockpiles must be placed in sufficient quantities at ten metre intervals on either side of the road to be treated, but at sufficient distance from the road so as not to interfere with the binder spraying operation.

The procedure for applying Otta seal is outlined below:

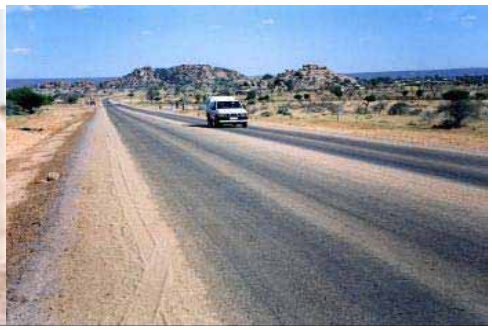
1. The area of road to be treated must be marked out by some means such as with string or small stones. This will ensure the correct placement of the binder and aid in avoiding possible overspray onto adjoining verge side areas.
2. Controls must be put in place to prevent the encroachment of traffic into the treated area. The binder distributor should be loaded with sufficient

binder to complete the work area. The binder should be maintained at the proper temperature for optimal spraying.

3. Cut-off sheets of paper or other material must be placed across the road at the start and end of the length of road to be sprayed. This produces a tidy appearance.
4. Check repeatedly and maintain the appropriate speed with the distributor in order to produce the correct binder spray rate.
5. Check the quantity of aggregate being placed and ensure that the workforce is ready to follow the distributor and spread the aggregate in order to maintain a correct spread rate.
6. Check that the rolling equipment is positioned and ready for rolling.
7. It is recommended that the distributor makes a spray run of 100 meters to allow for immediate covering of the binder with aggregate. Rolling can begin within 10 minutes of the binder being applied.
8. Spreading of the aggregate must begin immediately after the spraying of the binder has begun. The binder must be covered with aggregate as soon as possible.
9. The supervisor must ensure that no areas are left uncovered or that too little aggregate is spread. Aggregate must not be left in heaps. A drag broom, pulled manually or by tractor, can help ensure even distribution before rolling begins.
10. Twelve ton pneumatic-tyre rollers must be used in the application of Otta seal although it is possible to use loaded trucks in their place. The section of treated road may be reopened to traffic after 3 passes of the rollers but on the day of construction, the treated surface must receive a minimum 15 passes.
11. Traffic must be restricted to speeds of no more than 30 kilometres per hour for two to three weeks after construction in order to minimize the hazard of excess aggregate being thrown into the air.
12. During this initial period, aggregate displaced by the action of traffic should be swept back into the wheel paths. After 2 to 3 weeks, excess aggregate should be swept away and the traffic speed restriction can be lifted.
13. If a second layer is to be applied to create a double Otta seal, then a minimum of 2 to 3 months should pass before the application of the second layer.

Photographs 1 through 8 and figures 3 and 4 show Otta seal application as well as the various types of Otta seal surfacings that have been used in Nepal. There is, however, another type: double Otta seal. Otta seals can also be applied in combination with more traditional seals such as sand.

Photograph 1. Binder distributor **Photograph 2. Completed Otta seal**



Photograph 3. Base course being prepared just before the application of Otta seal

Photograph 4. Binder being sprayed by distributor over the freshly compacted Base

Photograph 5. Aggregates being sprayed by hand over the freshly sprayed binder by distributor

Photograph 6. Rolling process being carried out by pneumatic tyred roller

Photograph 7. Rolling process being carried out by a pneumatic tyre roller from edge to centre

Photograph 8. Finished Single Otta seal surface seen after the opening of traffic over the base course

Figure 3. Single Otta seal

Figure 4. Single chip seal (Surface dressing)

Performance Characteristics

The performance of Otta seal depends on a number of factors which include:

- Type of Otta seal (texture, durability etc.);
- Bearing capacity of the pavement; and
- Traffic using the road.

Table 4. Comparison of advantages and disadvantages of Otta seal

	Advantages	Disadvantages
1	Easier in construction and quality control	Initial inconsistent and somewhat patchy appearance;
2	Allows maximum use of local materials	Bleeding, in some cases, giving erroneous impression that something is wrong;
3	Longer service life	Need to consider a number of additional contractual issues
4	Allows use of low strength aggregate	
6	Better weather protection when used with sand seal	
7	Suitable to labour intensive construction	

CONCLUSIONS

The article outlines the design and application of Otta seal, a low cost pavement for low traffic roads. The types of Otta seal, the materials required, steps for preparation and its application procedures are described. Based on limited experience on its use in Nepal, its advantages and disadvantages are compared. Though it is gaining popularity, further evaluation and assessment of its performance would enhance its wider application on low volume roads.

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DEVELOPMENT OF A SUSTAINABLE RURAL ROADS MAINTENANCE SYSTEM IN INDIA: KEY ISSUES

Ashoke K. Sarkar*

ABSTRACT

Rural road sector in India got a major boost with the introduction of thePrime Minister Rural Roads Programme of 2000. The programme is going to be in existence until the goal of connecting all habitations with populations over 250 by all-weather roads is achieved. The major challenge now is to both expand the existing network of roads to include access to remote areas and to upgrade and maintain already existing roads. It has been suggested in this article to consider maintenance as a part of the overall road asset management system. Considering that the process would be fairly complex, it has been proposed to take a step-by-step approach. To that end, an outline has been presented for developing rural road management in India. An institutional arrangement has also been proposed on the basis of three types of maintenance- routine, periodic and emergency. Keeping in mind that community participation is the key to the success of any future maintenance strategy, good practices of involving community in a few selected countries have been discussed which may help in developing an appropriate participatory approach in India. There are many issues to be addressed for the successful implementation of a rural roads maintenance system. A few of the major ones have been highlighted here, such as the classification of rural roads and the managing of them all under one umbrella administration; the decentralization of responsibilities; the availability of relevant data; the development of manuals for road maintenance; the shortage of man-power; the critical involvement of the community and schemes to include social development issues.

INTRODUCTION

The necessity of a proper road network for the development of the country was understood quite early in India. The first road development plan (1943-61), popularly known as the Nagpur Plan, looked at the road needs of the country on a long term basis, and for the first time, classified the road system into a functional hierarchy comprised of National Highways (NH), State Highways (SH), Major District Roads (MDR), Other District Roads (ODR) and Village Roads (VR). The last two classes form the rural road system. Sufficient emphasis was given in the subsequent 20-year road development plan to increase road density by constructing roads of all categories. The latest rural road development plan vision 2025 has emphasized a planned rural road network development at the district level with the goal of connecting all habitations with populations over 250 by all-weather roads by the year 2021-22.

Constitutionally, the development of rural roads is the responsibility of the state government in India and thus the central government was not directly involved in the funding of rural road projects. However, from the fifth five-year plan of India,

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the central government started funding rural road projects through various programmes such as the Minimum Needs Programme (MNP), the National Rural Employment Programme (NREP), the Rural Landless Employment Guarantee Programme (RLEGP) and Jawahar Rozgar Yojana (JRY). There is overwhelming evidence that the provision of rural roads is a crucial factor in reducing poverty in rural areas (Ministry of Rural Development, 2007). Keeping this fact in mind, the Government of India initiated a programme in the year 2000 solely for rural road development, popularly known as the Prime Minister Gram Sadak Yojana Programme (PMGSY), with the objective of connecting all villages having populations over 500 by the end of 2007. Recently, Bharat Nirman, a time bound business plan was initiated to provide rural infrastructure during 2005-2009, in which rural roads was made one of the components was and blended with the PMGSY programme. Besides providing connectivity to unconnected villages, it also aims to upgrade existing rural roads for overall road network development.

The major challenge before the country is both expansion of the network to connect all unconnected villages and to upgrade and maintain the existing village road network. As a strategy it has been suggested in the Rural Road Development Plan: Vision 2025 to introduce a Rural Road Management Act, which emphasizes:

- defining the powers, functions and obligations of the departments in charge of rural roads;
- creating a detailed data-base in the form of a register of all public roads at the block level;
- establishing serviceability standards of roads; and
- requiring an asset management system to be instituted

The PMGSY roads constitute only a small percentage of the total rural road network in the country. It is well known that rural roads are not properly maintained due to lack of funds and because they are not given the importance they deserve. Thus, while discussing sustainable rural roads maintenance, a number of issues are to be resolved with respect to how future maintenance can be funded and organized. Logically, the entire network should be considered, but the question becomes whether sufficient funds will be available over the years to maintain such a huge network. If only the PMGSY roads are maintained, the goal of providing complete access to rural areas is not achieved because very often accessibility to National Highways, State Highways, Major District Roads or the nearest towns is provided by PMGSY roads through Other District Roads, pantheist and various other kinds of local rural roads. Secondly, this lack of consistency regarding roads might create dissatisfaction in villages that are not connected by PMGSY roads. Thus, a number of issues need to be resolved before a proper sustainable rural road maintenance system is developed.

An attempt has been made in this article to suggest an institutional structure for the development and implementation of a rural road management system in India Related issues have also been discussed.

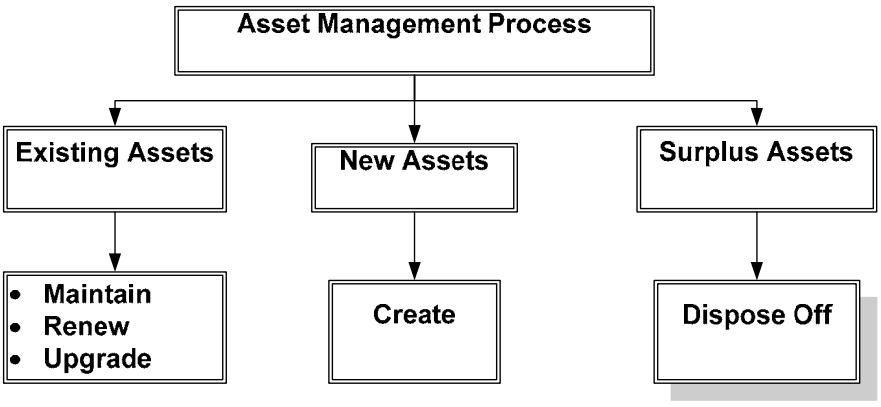
I. NEED FOR PROPER MANAGEMENT OF RURAL ROADS

The government has provided substantial funding for the development of a rural road infrastructure though various programmes since independence. Since 2000, high quality all-weather roads have been constructed under the PMGSY and the Bart Norman programmes. One of the conditions for the construction of these roads was that the maintenance for the first five years would be the responsibility of the concerned contractor. The state government had to give guarantees that they would be responsible for the maintenance of these roads after the initial five years. However, most of the state governments in India have problems in providing funds for road maintenance. The need for such maintenance has increased further as the newly constructed PMGSY roads are deteriorating faster than expected due to the diversion of heavily loaded vehicles on to these roads.

There were over 2.9 million km of rural roads in India in 2001. The huge wealth created in the country, at a heavy cost to the society, should be maintained and preserved adequately. The agencies responsible for providing these roads must maintain, improve and preserve this asset. At the same time, the financial and human resources needed to achieve the performance objectives of the road network are scarce and must therefore be managed carefully. Since these roads are under the scrutiny of the public and particularly the users of the asset, who increasingly demand improved levels of service, there is a need to develop an effective management system to improve efficiency, transparency and accountability in the management of rural roads. Some estimates put the replacement value of the existing rural road infrastructure in India at Rs.2000 billion (US$46 billion). These assets are deteriorating every year. In comparison with the value of the assets, the annual cost of maintaining them is estimated to be some Rs.75 billion (US$1.7 billion) a mere 4 per cent of the asset value (ILO 2005).

Maintenance of roads should be considered a part of the overall road asset management system. Asset Management may be defined as minimizing the life cycle cost of managing deteriorating road facilities, including construction costs, while maintaining the level of service provided to road users with limited financial and human resources, maintaining the existing road assets in good condition, and clearly explaining these activities to the public. The asset management process includes the maintenance, renewal and up-grading of existing assets; the creation of new assets and the disposal of surplus assets (Fig. 1). However, surplus assets are usually not observed in rural roads sectors in India where there is tremendous demand for the construction of new roads.

Figure 1. Maintenance as a component of Asset Management Process



II. OUTLINE FOR THE DEVELOPMENT OF A RURAL ROADS MANAGEMENT IN INDIA

Since the development of a rural roads management system would have complexities, attempts are to be made to take it step by step so that at the end an effective and robust system might be obtained. The possible steps involved in the development of such a system are shown in Figure 2.

Considering the fact that rural roads comprise a variety of roads under various departments of the government, the first thing to be decided for developing the maintenance management system is the smallest unit to be considered for this purpose. It may be at the block or panchayat or district level. However, for the effective implementation, a mechanism needs to be developed to integrate the smallest units to a larger unit to ensure uniformity and to guarantee the equitable distribution of funds. Sometimes, there is confusion as to whether a road is under the jurisdiction of the state PWD or the Panchayat or the municipality. The categories of roads to be included in the management system must be clearly defined and managed under the same administrative set-up.

Initially, it might be difficult to incorporate all of the various types of roads into the development of a rural roads management system. Therefore, the order in which each type of road is incorporated should be clearly identified. In the beginning, it would be wise to incorporate only those roads for which the organization already has a management system in place or such systems have been developed and applied in other places successfully. For example, extensive studies have been carried out all over the world on flexible pavement management systems, whereas enough work has not yet been done on the management systems for gravel roads, earth roads, shoulders, road side drains, road markings and other utilities.

One of the major steps for the development of a management system is to generate a comprehensive inventory of existing infrastructures, conditions and data collection and evaluation of assets. The success of the system will depend on effective data collection and analysis strategies. A comprehensive database can provide crucial historical information which includes year and cost of construction, materials used and other details including information on the asset's design, construction, repair and reconstruction. It might be difficult to gather historical information in the absence of well documented records. Therefore, in lieu of a highly sophisticated data-intensive management system, it may be more effective to utilize a simple system which can make use of the scant data which is available. The Geographical Information System (GIS) has been effectively used in various aspects of asset management, and can be used for the development of a spatial database and for the provision of a complete inventory of existing infrastructure. Spatial data would be collected from secondary sources and from surveys. This data would then be stored in the GIS database. The GIS provides the necessary programmes and tools for handling spatial data. Rajasthan and Himachal Pradesh, in India have already prepared detailed road inventories using the GIS platform. Since the road system of India has a large number of links and nodes, care should be taken to develop a standard method of labelling and numbering. In this way, even a small stretch of a minor road can be identified easily. The information regarding different elements of the assets should be entered in separate layers in GIS. This will allow each element to be studied independently, or compared and contrasted with other elements by integrating them using CIS. .Facilities should also be encouraged to record data using popular software applications such as Microsoft Excel and Microsoft Access database, after they are made compatible with GIS software. A

simple flow diagram has been developed connecting the GIS data-base, model-base and the user-friendly interface as shown in Fig.3. The software should be developed in such a way that it would be easy for users to input the required data, understand the displayed output, and generate reports whenever required.

Since any road management system involves a variety of assets and a large amount of data, a platform should be developed, or chosen from an existing set of platforms, for clustering the components based on a few chosen factors. This will make the analysis simpler as a set of components would be represented by one factor. Different parameters would be used for clustering different assets or their components.

A rural roads management system should have; (a) relevant data to predict road performance, (b) access to estimated and actual costs of various assets, (c) the authority to make decisions regarding management and maintenance activities, and (d) a voice in projecting future budgets. Thus, it is necessary to develop a management system for each asset separately using the concept of life-cycle assessment. This would necessitate the development of performance models for each element. Theoretical scenarios would be generated to plan for the management of the assets on a long-term basis. The most challenging task would be to integrate all these individual management systems into a single management system when needed, in order to examine all the elements of the system. Currently, a number of methods, such as multi-criteria decision analysis, are being successfully used for decision making in such situations and should be used for the management system. The condition of cracks and potholes may be difficult to quantify accurately in the field and may be rated subjectively. Similarly, while making decisions, the importance or weight of various parameters may not be represented in absolute terms. As a result, some subjectivity is likely to be present. Thus, to make the management system realistic and effective, fuzzy multi-criteria analysis may be a more appropriate tool. While such techniques are currently quite common, their success and effectiveness depend primarily on how accurately input data has been collected. While developing the tools, there must be scope for continuous refinement and for the inclusion of the elements of the asset which were not included in the beginning.

Figure 2. Out-line for the Development of Asset Management System

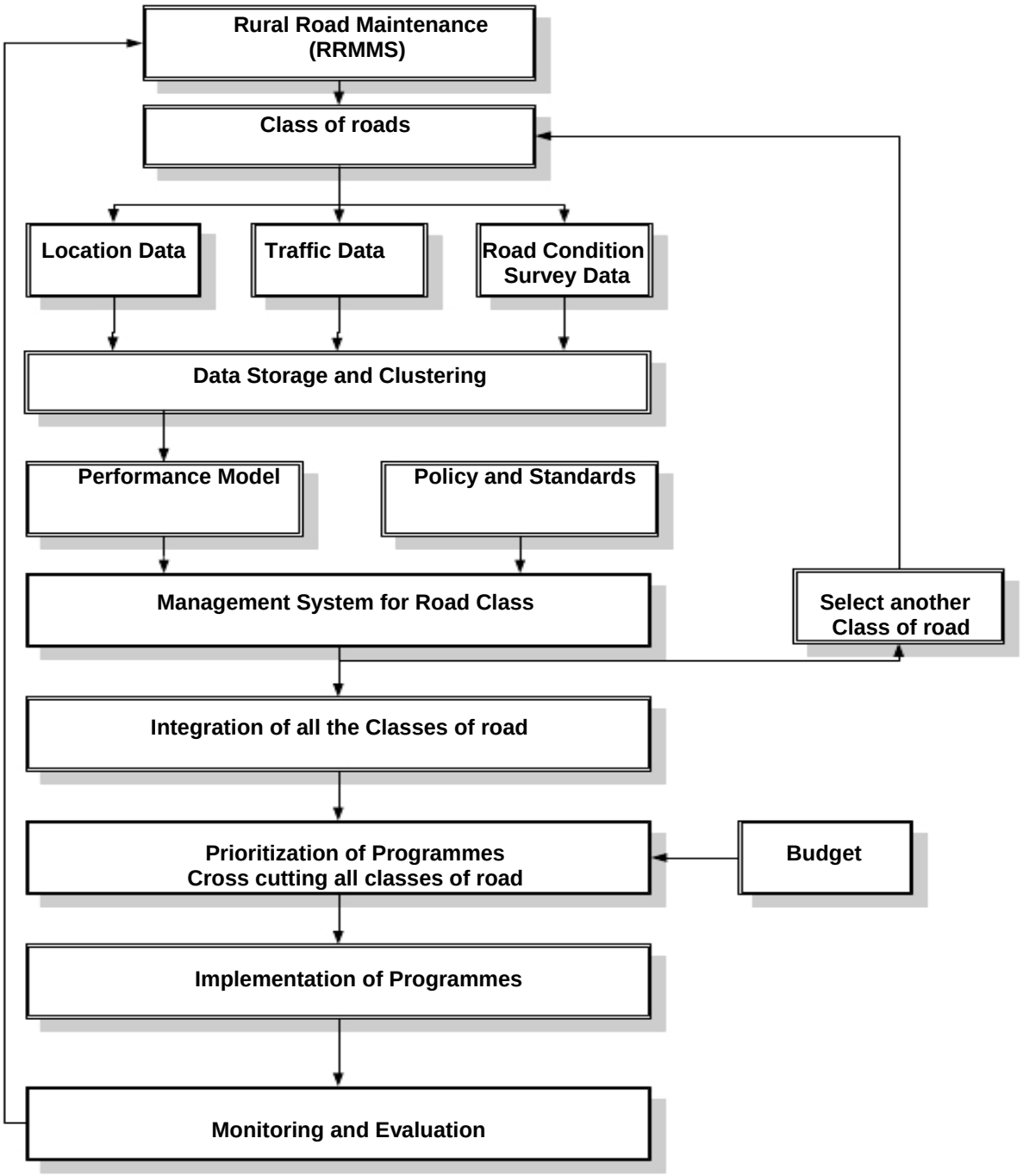
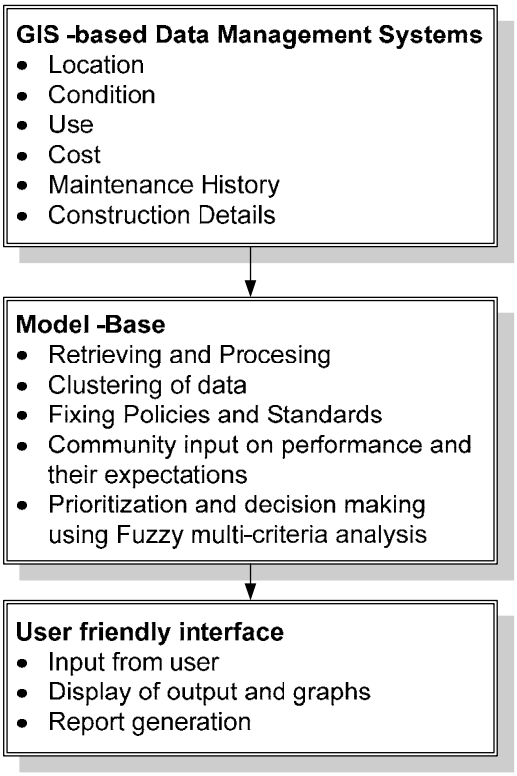


Figure 3. Interface between data base and output



III. TYPE OF MAINTENANCE OF RURAL ROADS

Rural roads may also be classified based on their surface composition, such as black-top, concrete, gravel and earth. Decisions will have to be made regarding whether these different types of roads should be put under the same management system. It may be appropriate to consider them separately and to develop separate maintenance management systems for them. Funds may be allocated separately for each one of them depending on length and requirements. This article has concentrated on black-top roads, the maintenance of which may be classified into categories such as routine, recurrent, periodic and emergency (World Bank, 1988; Lebo and Schelling, 2001; CNB, 2002). Routine maintenance involves small scale work carried out regularly with an objective to ensure passibility and safety of the existing roads in the short run and to prevent premature deterioration (Transport Research Laboratory, 1994). Typical activities in routine maintenance include drainage cleaning, carriageway repair, cleaning of silted ditches, grass cutting, pothole repair and bridge and culvert maintenance. The frequency of routine maintenance normally ranges between a week and a month.

Recurrent maintenance is required at intervals during the year depending on the topographic and climatic characteristics of the area as well as traffic volume. It mainly involves the maintenance of pavement, the filling of potholes and grading for unpaved roads.

Periodic maintenance covers activities on the road at regular but relatively long intervals. The aim is to maintain the structural integrity of the road (Burningham and Stankevich, 2005). Since these operations usually are large scale, requiring specialized equipment and skilled personnel, they require a proper system for identification, priorization, planning and design.

Emergency repair is needed when roads are damaged due to disasters such as floods and earthquakes. Such repairs sometimes require special measures and skills as the damage needs to be repaired quickly in order to maintain supply in the affected area.

IV. STATUS OF RURAL ROADS MAINTENANCE IN INDIA

Maintenance of rural roads has never been a priority with most of the states in India, due primarily to a lack of adequate funds and the absence of maintenance management systems. A situational analysis conducted in Madhya Pradesh has concluded that very little road maintenance was possible due to lack of three elements – (a) proper funds, (b) proper policy and (c) a strong institutional framework. While the need for adequate funds was not in doubt, more critical institutional issues such as maintenance planning, maintenance management, the effective delivery of maintenance work and accountability of expenditure in maintenance needed attention (ILO, 2005). The situation is similar is nearly all the other states.

The Central Road Fund (CRF) established in 1930, and revitalized under the Central Road Fund Act of 2000, is targeted primarily towards the development and maintenance of National and State Highway networks and the construction of new rural roads. There have been efforts to create a State Road Fund (SRF) by states such as Assam, Kerala, Maharashtra, Rajasthan and Uttar Pradesh, with most of the remaining states moving towards the setting up of such funds. The SRFs are financed by multiple resources such as budgetary support from the central government, direct road user charges for access to fuel, motor vehicle taxes, fees and tolls, indirect road user charges and levies on agricultural products. Similar to the CRF, these road funds are normally used for both development and maintenance of road networks. However, considering the poor connectivity in rural areas, emphasis is usually given to road development and maintenance is neglected. Uttar Pradesh is the first state in India that has dedicated funds for road maintenance. It was established in 1998 and clearly specifies the source, collection, mechanism and management of the maintenance funds (Chandrasekhar and others, 2006).

Rajasthan has taken the lead in developing a system for the maintenance of rural roads. Total funds required for the period of 2005-10 was estimated and yearly budgetary allocations were provided from the SRF, non-plan heads of the state government and loans from the National Bank for Agricultural and Rural Development. The Public Works Department has also been developing a road maintenance management system and accordingly a package called the Road Maintenance, Planning, Budgeting and Programming System (ROMAPS) that has been installed in all the thirty three districts of the state. Necessary base data has been collected and a process developed to collect road distress data periodically. However, it will take some more time to become effectively functional.

V. INSTITUTIONAL ARRANGEMENTS FOR RURAL ROAD MAINTENANCE

Until now, various state governments have primarily given emphasis to the construction of rural roads under the PMGSY programme. It may be mentioned here that the programme developed is an in-built maintenance plan for five years, as the respective contractors were responsible for the upkeep of the road during that period. However, roads constructed during the initial phases have been completed for five years. There is now an urgent need to have a maintenance system in place so that these roads can serve the population satisfactorily until the end of their design life and so that funds are available for the rehabilitation or reconstruction of these roads in a timely manner. It is expected that the Panchayati Raj Institutions would maintain these roads.

There are different implementation arrangements developed in different countries for executing rural road maintenance. The effective execution of any of these arrangements requires an efficient management organization. There are a few possible solutions to finding an institutional framework for the provision and maintenance of rural roads:

National authority which delegates responsibility to states, districts and panchayats

The strength of this arrangement is that scarce resources for the maintenance of rural roads are consolidated into one organization. With limited budget and logistical support, this arrangement will succeed if local offices are set up at strategic locations along the network. This set up may be difficult to implement in a vast country like India. However, the same structure may be adopted at the state level with the responsibilities delegated to districts and panchayats.

Decentralized to local government authorities with technical unit in the local government administration

In such an arrangement a road works section would be established in each panchayat samithi or a panchayat. This would require the development of tremendous amounts of capacity building exercises. When works are managed at the local level, pressure from the local public holds authorities accountable and forces them to deliver.

Communities responsible for rural roads maintenance

Attempts have been made in this regard, mainly on a project basis, with mixed results. It would be possible to utilize workers in the community to perform preliminary level maintenance work. However, for slightly specialized work, there would be the need for a technically competent agency.

Suggested structure

Over the years, the planning, construction and maintenance of rural roads has been the responsibility of local governments. The PMGSY is the first centrally funded rural road development project being executed by state governments. This was a special scheme launched to provide accessibility to remote villages. However, the understanding was that the state governments would take up the maintenance of these roads. There are two problems in such an arrangement. The most important point is that the state governments do not have sufficient funds to maintain the

existing rural roads and the new roads will add extra burden on them. Secondly, the lack of man-power at the local government level makes the physical maintenance problematic. Thus before assigning the responsibility of maintaining the roads to the local or state governments, it is necessary to determine their fund generation capacity as well as the availability of man-power and expertise.

To make the process realistic, Merrilees and Huong, 2003 have suggested that routine and periodic maintenance may each be divided into two levels. Accordingly, Routine I is mostly labour-based, while Routine II requires a plant, materials and skills. Similarly, Periodic I is mainly concerned with spot improvement, where Periodic II involves full re-gravelling, re-sealing and major repairs. In this process, it may be possible at the local level to perform Routine I or even Routine II maintenance. However, periodic or emergency maintenance maybe need to be managed and funded from higher levels.

Such arrangements would require understanding between governmental departments at various levels, with the responsibilities of each clearly specified. A maintenance management system would be required in order to prioritize those stretches of roads involving all stakeholders.

A structure for rural road maintenance is being suggested (Table-1) in which Routine I maintenance, which is primarily labour-based and does not require any equipment or skill, has been assigned at the village level. The Panchayat would be responsible for Routine II maintenance. Similarly, Periodic I has been assigned to Panchayat Samity while Periodic II has been assigned to Ziila Parishad. Emergency maintenance may be taken up by Zila Parishad or the State Government, depending on the severity of damage and the funds required. Presently, the local level governments might not have the expertise or man-power to take on this work. However, assigning responsibility does not necessarily mean that the work must be completed by conventional means. Local level governments should investigate creative and innovative methods for accomplishing the work. Periodic and emergency maintenance require specialized equipment and skilled personnel. Therefore, Panchayat Samity and Zila Parishad may have to work closely with the Public Works Department. This arrangement is only a suggestion and may be finalized by the state authority based on discussions with the different levels of the Government and depending on the available competencies at each level.

Table 1. Proposed Maintenance Responsibilities of Rural Roads[1]

Maintenance type	Responsibility
Routine I	Village
Routine II	Panchayat
Periodic I	Panchayat Samity
Periodic II	Zila Parishad
Emergency	Zila Parishad/ State Government

[1] In India the local grass-root level government system in known as Panchayati Raj system. The Panchayats are the basic units of administration and consists of a few villages. The Panchayat Samiti is local government body at the block level (consisting of a few panchayats) and at the district level it is called Zilla Parishad, All these local bodies are run by directly elected representatives at the respective levels with election being held every five years.

VI. METHODS OF ENGAGING THE COMMUNITY IN RURAL ROADS MAINTENANCE

While the responsibility of maintenance may be assigned to different levels of the Government, they may use innovative methods to perform their duties. However, it is always useful to involve community in the maintenance process, as they understand the need for well-maintained roads. Different methods have been used in a number of countries to cultivate this interest. For routine types of maintenance, the length man system, where small and manageable tasks are allocated to individual workers, has been tried successfully in a number of African countries. In this system, a labourer is hired for each section of road between one and two kilometres in length. A supervisor provides the worker with tools, while at the same time monitors the condition of roads, directs operations, makes reports and authorizes payment for satisfactory work. The lengthman system is desirable because continuous maintenance of the entire road may be guaranteed at all times. The system has been successfully used in a few African countries. A similar system has been adopted successfully in Bangladesh, where the work has been assigned to destitute women from the locality for a period of three years. A portion of each worker's daily wage is deposited into a bank account, and at the end of the three-year term the women are given their accumulated wages. This not only helps maintain the roads, it also serves society since these women usually start small businesses with the money they receive at the end of their term of work. Experiences from many parts of the world show that small private enterprises can produce quality maintenance work at lower cost than traditional direct labour forces employed by the state (ADB, 2005). In Peru, the routine maintenance of rural road networks is carried out by micro-enterprises (Ipingbemi, 2008). They are created, trained and contracted by the autonomous Rural Road Programme of Peru with the objective of guaranteeing year-round sustainability of the rural road network. The workers are selected from communities close to the stretch of the road concerned. They are responsible for routine maintenance such as the filling of potholes, the clearing of drains, culverts and other elements of the drainage system using basic hand tools. Major concerns when considering length man or other community contracting arrangements are; (a) the legal status of the individual workers and/or the communities, and (b) to what extent these workers can be held responsible when things go wrong. Integration of poverty-reduction objectives with rural roads maintenance will lead to a demand-driven participatory approach. When utilizing local workers in road repairs, scheduling of the work needs to be done with consideration for the rural labour cycle by scheduling work during periods when the poor labourers are not involved in agricultural or other activities. This will ensure that community participation is genuinely pro-poor and inclusive and will contribute to the sustainability of investment (ADB, 2005).

VII. ENSURING SUSTAINABILITY IN RURAL ROADS MAINTENANCE

When developing a sustainable system of road maintenance, it is necessary to approach the system from two different angles. The first is to develop guidelines, manuals, standards and policies that clear and well defined. This would ensure uniformity and eliminate confusion on the part of field engineers which would in turn minimize the time needed for decision making. Efforts have been made by the National Rural Roads Development Agency (NRRDA) and the Indian Roads Congress (IRC) in the construction of rural roads, but there is need for similar efforts towards the maintenance of roads. While sharing the experience of developing a rural roads maintenance programme in Viet Nam, Merrilees and Huong, 2003 suggested attacking the problem from two directions simultaneously; (a) top down support to the agencies towards improving guidelines, standards and policies, and

(b) bottom up support in building the ability of agencies to manage rural road networks.

Top-down support would require the following systems and procedures to be put in place:

- Maintenance manuals would be developed by the IRC in collaboration with the NRRDA and the Public Works Departments of various states. Considering the topographic, climatic and other variations of a vast country like India, special care would be taken to incorporate local issues into the manual.
- Technical training including training of trainers would be organized for disseminating the contents of the maintenance manual.
- A road asset management system for rural roads and a simple format for data collection would be developed.
- A communication network linking state agencies and panchayats would be created and implemented.
- Local level engineers would receive institutional support to design products with advice and support from technical support teams.

Bottom-up support would require the following systems and procedures to be put in place:

- A regional support system to deliver training, advice and capacity building to local authorities would be created.
- A situational review would be conducted, summarizing existing rural road networks, road management and maintenance policies.
- Maintenance workshops would be instituted for discussing existing situations/problems and suggesting solutions.

The most important aspect of ensuring sustainability is to develop ownership among the users of the rural roads. It is essential to involve the community in every aspect of a new road, from planning and design, to construction and maintenance. Efforts have been made in this direction in the case of the PMGSY roads with mixed success. Unfortunately, this degree of community involvement is usually not considered to be of value. However, if it was encouraged early on, perhaps less effort would be required later to elicit support from the community regarding road maintenance.

In India, it would be possible to implement the rural roads maintenance system provided it be linked with various poverty alleviation programmes initiated by the Government of India. A few years ago a massive poverty reduction scheme has been launched known as Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGA) in which each household in the rural areas are being provided 100 days employment. The scheme has been extremely popular and thus is expected to be continued for years to come. If properly planned, rural roads maintenance may be made in-built in the scheme where the villagers will be trained in various aspects of rural road maintenance and then will be asked to maintain stretches of roads and they will be paid from the MGNERAGA programme. Proper training of the villagers and monitoring of the quality of work are two vital components to make the programme successful.

VIII. ISSUES IN THE DEVELOPMENT OF A SUSTAINABLE RURAL ROADS MAINTENANCE SYSTEM

The following issues need to be addressed for the successful implementation of a rural road management system in India. There are many issues to be addressed and only the major ones are being highlighted below:

Classification of rural roads and bringing all of them under the same administration

In India, there are different kinds of rural roads and are being managed by various agencies and funding comes separately for each category. They may also be classified based on road surface. All the rural roads do not have the same function and do not have the same importance. Thus there is a need to classify rural roads depending on their functions and all kinds of rural roads need to be brought under one agency.

Decentralization of responsibilities

Road maintenance is a local activity and poor roads affect the local people the most. Thus it is reasonable to expect that decentralization of the responsibility for implementing maintenance of rural roads should include the local government at the lowest level. However, the responsibilities at each level must be clearly specified to avoid any confusion during implementation. .

Details of asset features may not be readily available

Very often the essential features such as year of construction and the subsequent maintenance, reconstruction or rehabilitation details of the rural roads constructed long time back are not available with the concerned agencies. This makes the development of a maintenance management system quite difficult. Thus a framework is to be developed for rural roads maintenance that is simple and is based on the available data.

Development of manuals for rural roads maintenance

Since the engineers in charge of rural roads are usually not exposed to a systematic rural roads maintenance management system, simple manuals are to be developed for the field engineers, contractors and the community for different levels of maintenance work. In a diverse country like India it would help if they were made available in various regional languages.

Development of trained manpower

The government agencies responsible for the construction and maintenance of rural roads mostly do not have sufficient number of trained manpower and thus the existing engineers need to work in different sectors at the same time. Thus it becomes difficult for them to concentrate fully on one sector. Ideally separate units should be created for maintenance work only. However, at least dedicated units should be created for construction and maintenance of rural roads. They will be trained in construction and maintenance aspects of rural roads time to time. It has also been reported that the field engineers working in various departments at the state level transferred very frequently which affects the continuity of work. Thus it

must be ensured that the engineers are not transferred frequently so that their expertise gained through training programmes is gainfully utilized.

Development of small contractors at community level

Keeping in view the fact that there is shortage of skilled personnel at local government level, there will be need to involve the community in maintenance work. This will require the development of small contractors at local level. Since they are going to be the direct beneficiary of the roads, it is expected that their involvement and commitment will be of the highest order. In addition, the local community will be free to express their dissatisfaction if any to them freely and the contractors will be under pressure to perform at a desirable level.

Funding constraints and need for long-term budget strategy

Traditionally, the government agencies are not used to prepare budgetary requirements based on life-cycle cost, which takes care of maintenance and reconstruction of the asset on a long term basis. This requires a long-term budgetary strategy and keeping in view the usual funding constraints in the developing countries, proper plan must be prepared to educate the decision makers to make them aware about the importance of developing a maintenance management system for rural roads.

Involving the community

Any effort without the involvement of the community will be almost impossible to sustain and thus ensuring their involvement is going to be a big challenge. This will be particularly true for roads constructed earlier when no efforts were made to involve the community in the planning, design and construction stage. Suddenly asking for their participation at maintenance stage might not be acceptable to the villagers. Thus, special approaches must be developed of participatory planning so that the community willingly come forward for getting involved in the process of rural roads planning.

Schemes to include social development aspects

Sustainability will certainly be easier to achieve if direct and visible social benefit aspects may be included in the implementation of rural road maintenance by involving the poor people living below the poverty line. The government of India has many poverty alleviation programmes and they need to be oriented in such a way that rural roads construction and maintenance become a part of the project.

CONCLUSION

Maintenance of rural roads has been highly neglected over the years in India. However, with the huge programmes that have been undertaken in the recent years through PMGSY and Bharat Nirman programmes, it is but natural that maintenance of these assets be taken seriously, otherwise the country will lose huge amount of money in the end. The initiative has already been taken by the National Rural Roads Development Agency (NRRDA) in this regard. However, it will take some time to come up with a proper management programme as many issues are involved in terms of funding, division of responsibilities among various departments and levels of the government, training of personnel and development of manuals. There is need to learn from the experiences of other developing countries and efforts need to be made

to involve social development aspect in the maintenance of rural roads. In addition, the involvement of the community is to be ensured to make the rural roads maintenance sustainable.

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RURAL ROAD MAINTENANCE IN CHINA

Hongye Fan*

ABSTRACT

The rural road is a vital building block of rural connectivity and plays an important role in the rural economy of most developing countries. Many countries have implemented impressive rural road development programmes. However, often they have not been equally successful in establishing a sustainable maintenance programme, which is vital not only to preserve the value of this important national asset but essential to provide continuing support to the growth of rural economy. In the Asia-pacific region, China has a high rate of rural road maintenance. An estimated 90 per cent of rural roads are now maintained. This article examines China's rural road maintenance system, especially the institutional and financial arrangements that have ensured such a high rate of maintenance. The article also provides descriptive details of the regulatory framework at the central level as well as government initiatives at local levels concerning rural road maintenance in China.

Key Words: Rural Road, Road Maintenance, China

INTRODUCTION

In China, rural roads are composed of county roads, township roads and village roads[1] which are defined at the administrative level rather than based on their functional level. County roads refer to the roads connecting counties. Township roads refer to the roads connecting towns, and village roads refer to the roads connecting villages. Rural roads play an important role in China's rural economic development and poverty reduction. In 2010, the total length of rural roads was 3,506,600 km, which was 87.4 per cent of the length of all roads in China[2]. From Figures 1 and 2, it is evident that the length of rural roads have dramatically increased in the last decade and the proportion of rural roads has stayed high around 88 per cent of the whole road system in recent years.

Figure 1.

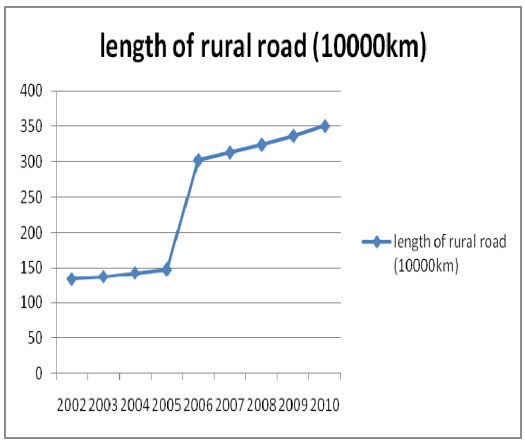
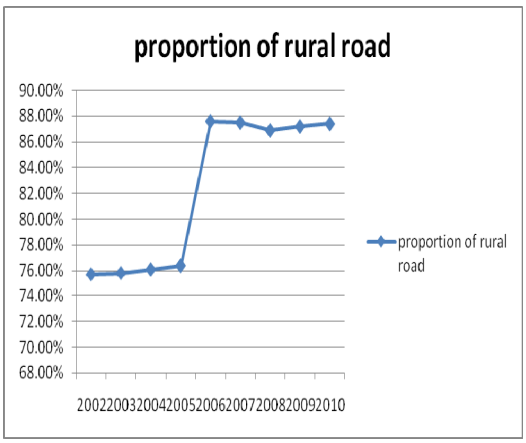


Figure 2.



Source: Statistical Bulletin of Highway and Waterway Transport Development, 2002-2010.

* The article is based on the work of the author when she was an intern at the Transport Division, United Nations Economic and Social Commission for Asia and Pacific (ESCAP).

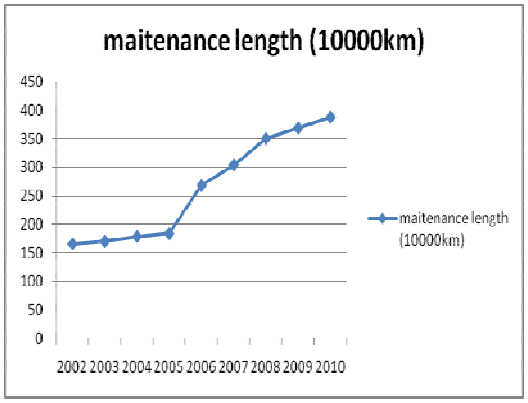
[1] China's General Office of the State Council, The Plan of Reform of Management and Maintenance System for Rural Road, 2005

[2] China's Ministry of Communications, Statistical bulletin of highway and waterway transport development, 2010

As to road maintenance situation in China, the Statistical Bulletin of Highway and Waterway Transport Development indicate that the length of maintained roads in China has increased between 2002 and 2010. The proportion of maintained roads has reached more than 90 per cent (Figures 3 and 4), except for years 2006 and 2007. If it is supposed that all the non-rural roads are maintained, which covers about 12 per cent of all roads, the remaining 80 per cent maintained roads are rural. Since the rural roads cover 88 per cent of all roads, it can be said that about 90 per cent of rural roads are maintained. This indicates that the rural road maintenance in China has reached a high level.

Therefore, to see how the rural road maintenance mechanism works in China is very significant to come up with valuable experience for other developing countries.

Figure 3.



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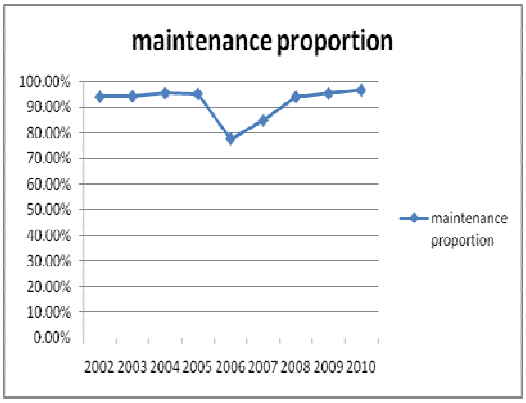


Source: Statistical bulletin of highway and waterway transport development, 2002-2010.

In China, there are three types of rural road maintenance: routine, medium and heavy maintenance. Routine maintenance is the frequent repair and maintenance of the slight damage of a road and the facilities alongside. Medium or recurrent maintenance is the regular repair of the general damage of roads and the facilities along the road in order to restore them to their original condition. Heavy maintenance is the periodic repair of heavy damage to roads and the facilities along the roads in order to restore the road to its original condition.[3]

The system of rural road maintenance in China experienced three distinct periods prior to 2005. The first period was from 1949 to 1978 when rural migrant workers and urban workers were used for road maintenance under the model called “unified leadership and classified management”. The second period was from 1979 to 1997, when road maintenance squads were set up and temporary workers were hired under professional implementers for rural road maintenance. In this period, maintenance quality and cost management issues were stressed. This was also the period when marketization in road maintenance was introduced. The third period was from 1998 to 2004 when separation of management and maintenance as well as institutions and enterprises were advocated.[4]

In 2005, China published the Plan of Reform of Management and Maintenance System for Rural Road, which marked a new era of rural road

[3] China’s Ministry of Communications, Management Method of Road Maintenance Engineering, 2001

[4] Chen Li, Zheng Bo Tao, Yu Jian, Exploration of Rural Road Maintenance Organization Management, Communication Standardization, 2008

maintenance. This plan, together with the Interim Management Methods of Rural Road Maintenance (2008) and Technical Regulations of Road Maintenance (2010) regulate the liable subjects and the technical criteria and subsidy distribution of rural road maintenance.

I. RURAL ROAD MAINTENANCE IN CHINA SINCE 2005[5]

A. Institutional and regulatory framework at the central level

The Plan of Reform of Management and Maintenance System for Rural Roads was issued by the Ministry of Communications, the National Development and Reform Commission and the Ministry of Finance. It clarifies that the goal of system reform is to establish a stable flow of finance for rural road maintenance based mainly on government investment, as well as to accelerate the marketization of rural road maintenance.[6] Specifically, the Plan redistributes the responsibilities of institutions at different administrative levels, directs towards establishing a funding system and stresses the separation between management and the implementation of maintenance.

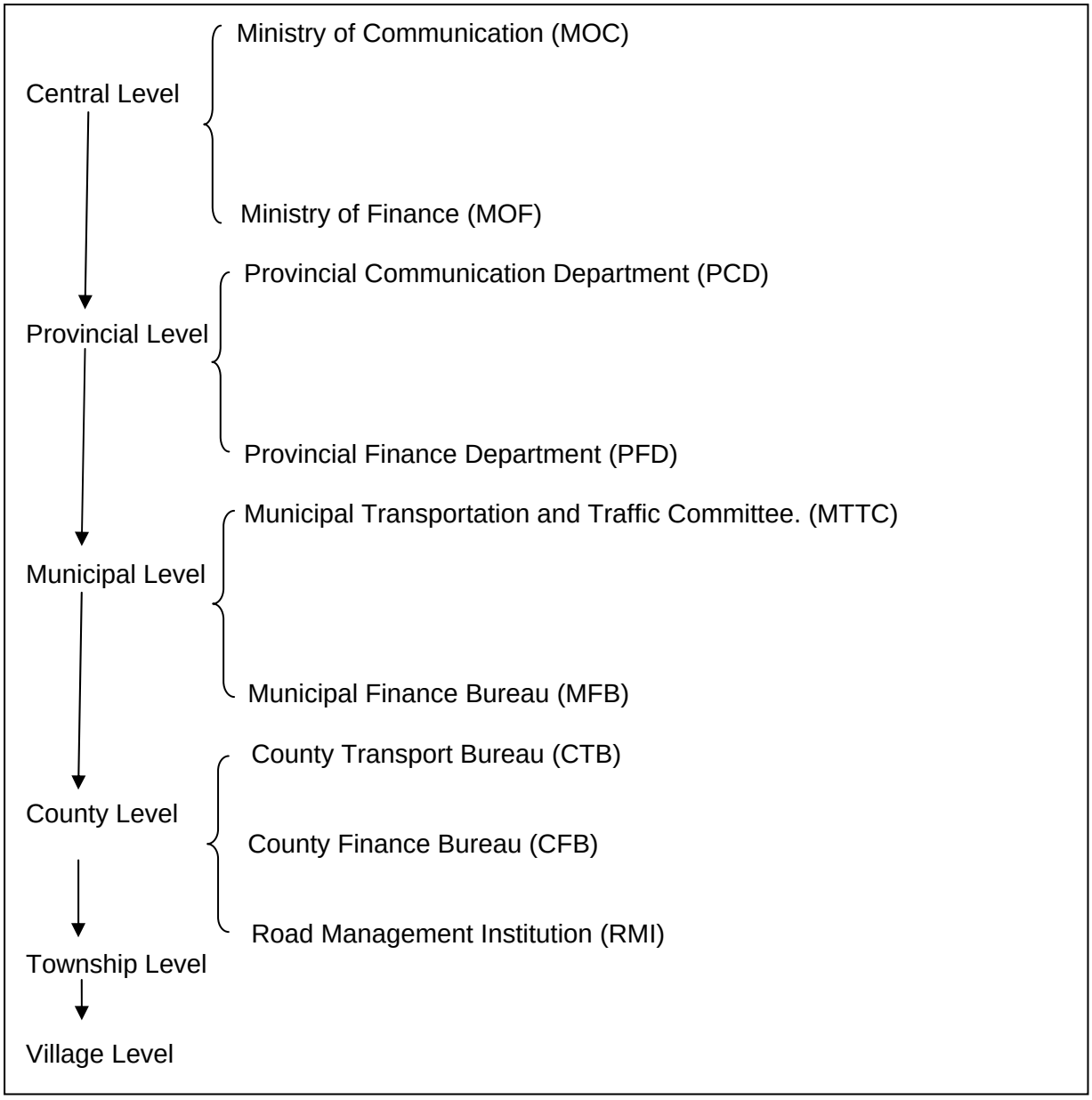
Responsibilities of institutions

Government institutions at different levels are responsible for managing and financing rural road maintenance. Among them, county government institutions take direct responsibilities of rural road maintenance. Provincial institutions are more responsible for financing, rather than managing, the implementation of rural road maintenance.

[5] The figure and table in this section are made based on China's General Office of the State Council, The Plan of Reform of Management and Maintenance System for Rural Road, 2005; and China's Ministry of Communications, Interim Management Methods of Rural Road Maintenance, 2008

[6] China's General Office of the State Council, The Plan of Reform of Management and Maintenance System for Rural Road, 2005

Figure 5. Hierarchy of Government Institutions in China regarding Rural Road Maintenance



The distribution of responsibilities is outlined below:

1. **Central government institutions**

Central government institutions are the highest administrative institutions related to rural road maintenance.

- The Ministry of Communication (MOC) is responsible for making the country-wide maintenance plan.
- The Ministry of Finance (MOF) provides funding resources by appropriating certain amounts of money to rural road maintenance.

2. **Provincial government institutions**

The provincial government is mainly responsible for raising funds for rural road maintenance, monitoring maintenance work and making detailed regulations for the responsibilities of the lower level governments to perform rural road maintenance.

- The Provincial Communication Department (PCD) is responsible for making the rural road construction plan, assigning rural road maintenance, monitoring and checking the process and quality of maintenance, arranging and monitoring the maintenance funds, allocating road tolls collected by the PCD to rural road maintenance, and directing and monitoring rural road management
- The Provincial Finance Department (PFD) is responsible for providing provincial subsidies to rural road maintenance from the provincial revenue.

3. **Municipal government institutions**

Municipal institutions function to make policies, monitor, and finance rural road maintenance and as a layer between the provincial and county governments.

- The Municipal Transportation and Traffic Committee (MTTC) is responsible for creating related regulations and administrative arrangements for the county-level government institutions, as well as funding the maintenance work from the collected road tolls.
- The Municipal Finance Bureau (MFB) is responsible for funding rural road maintenance from the revenues of the city.

4. **County government institutions**

County governments are the directly responsible bodies for rural road maintenance in the counties.

- The County Transport Bureau (CTB) is responsible for managing maintenance. They are responsible for implementing the rural road construction plans, making plans for rural road maintenance, raising and managing the rural road maintenance funds, monitoring the work of road management institutions, checking maintenance quality, and coordinating with township governments in protecting rural roads and facilities.
- The County Finance Bureau (CFB) is responsible for funding rural road maintenance using county revenue.
- The Road Management Institution (RMI) is a unit within the CFB. It is responsible for the daily management and maintenance work of rural roads, preparing road maintenance suggestions and implementing the maintenance according to the permitted plan, organizing bidding and contracting work, inspecting and accepting maintenance quality, and protecting road property and right of way. (If

there are no road management institutions under a county transport bureau, the work can be left to institutions directly under provincial or municipal road management institution rather than creating a new institution)

Table 1 provides a summary of the main responsibilities of institutions at different levels of Government

Table 1. Responsibility at different levels of government

	Plan	Fund	Implement	Monitor	Check
MOC	✓				
MOF		✓			
PCD	✓	✓		✓	✓
PFD		✓			
MTTC	✓	✓		✓	✓
MFB		✓			
CTD	✓	✓	✓	✓	✓
CFD		✓			
RMI			✓		✓

B. Financing system

To ensure a stable fund flow for rural road maintenance, there were two main financing channels before 2009: road tolls and government revenue. It was regulated that road tolls (including vehicle road tolls, tractor road tolls, and motorcycle road tolls) were to be mainly used for road maintenance. After deducting the cost of toll collection and traffic policing, no less than than 80 per cent of the tolls collected would be used for road maintenance. The road tolls collected by local governments must be used for road maintenance, which was a priority over road construction. The provincial transport departments were responsible for distributing vehicle tolls to rural road maintenance. The municipal and county transport departments were required to allocate all the tractor and motorcycle tolls to rural road maintenance.

The direct funding from government revenue was arranged by governments at different levels. With the exception of funds from municipal and county revenue and collected tractor and motorcycle tolls, all the other funds were managed by provincial governments and were appropriated to county government institutions.

However, in 2009, the central government abolished road tolling on government funded roads and a fuel tax was introduced. The government finance departments also collect fuel tax. The gasoline consumption tax has been increased from 0.2 RMB/litre to 1 RMB/litre and the diesel consumption tax has been increased from 0.1 RMB/litre to 0.8 RMB/litre. The increase in taxes is levied within the original price, which means that even though the tax rate was increased, the pump price of the fuel did not increase. As this policy has been effective for only one year so far, it hasn't significantly affected rural road maintenance. The financial system in this article, as discussed, relates to fund arrangements prior to 2009.

Funding for rural road maintenance comes from six different sources:

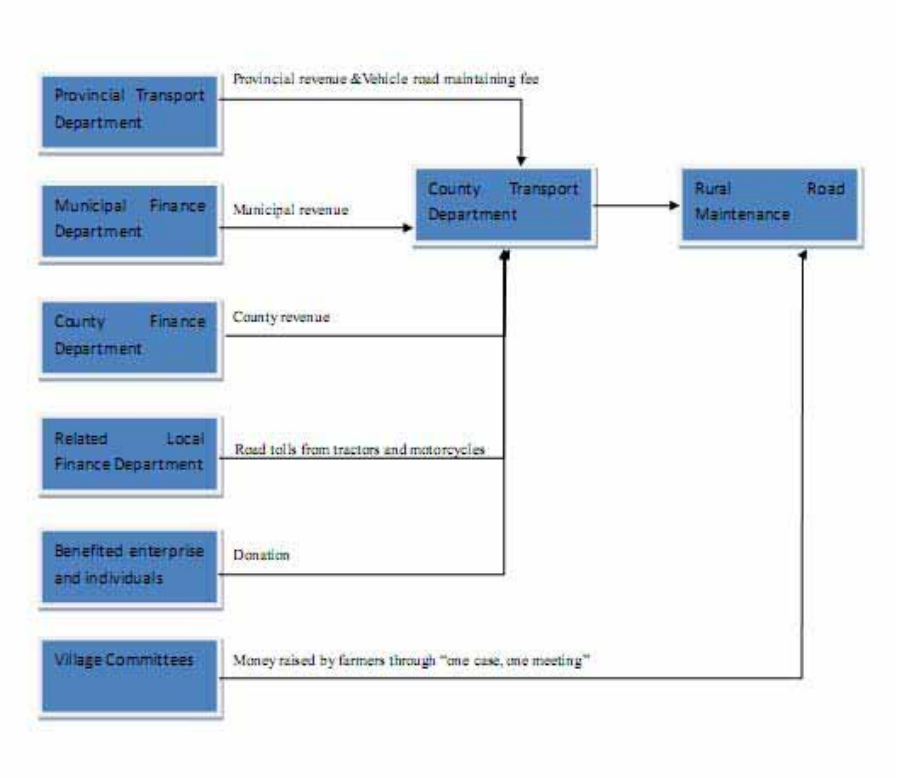
a) Local government revenues, which cover provincial, municipal and county-level revenues and are usually used for routine maintenance.
b) Central government revenue, which provides funds for rural road maintenance, particularly for poorer regions.
c) Road tolls from tractors and motorbikes, a part of which are used for

rural road maintenance.

d) Vehicle road tolls of provincial transport division, which are used for medium and heavy maintenance work and reconstruction projects. The funding criteria is no less than 7000 RMB/km per year for county roads, 3500 RMB/km per year for township roads, 1000 RMB/km per year for village roads.
e) Donations from benefited enterprises and individuals
f) Money raised by farmers through "one case, one meeting"[7]

The total funds available for rural road maintenance are appropriated to different organizations and individuals. Figure 6 illustrates how the funds are disbursed from those agencies to rural road maintenance. Subsidies are appropriated from six agencies which include governmental departments, enterprises and individuals. With the exception of money from village committees, which goes directly to rural road maintenance, funds from other sources are sent to the county transport department first, which funds rural road maintenance according to its plan.

Figure 6. Fund Appropriation



C. Separation of management and implementation of rural road maintenance

The separation of management and implementation of rural road maintenance is aimed at enhancing the efficiency and transparency of using maintenance subsidies as well as advancing the quality of maintenance. Two steps are followed to achieve this goal. First is the progressive elimination of maintenance units in the transport department and its road management institutions. In this sense, the staff who implement maintenance projects and related capital are reorganized to form road maintenance companies. The maintenance companies bid for the right of maintaining roads. Those road maintenance companies assume sole responsibility

[7] "One case, One meeting" is a way for villagers to decide public affairs in a democratic way.

for its profits and loss, sign contracts with its staff and manage labour according to the enterprise employment system. The main responsibility of road management institutions is the monitoring of the maintenance market as well as keeping order in the market.

The second step is to open the maintenance market to all interested parties through a bidding process. This will aid in the selection of the best maintenance implementers. Well-qualified companies are encouraged to compete in road maintenance projects transregionally. The engineering fee is determined by road management institutions, and is based on the maintenance quota and the nature of the work.

However, rural roads with low class and in special geographical conditions are usually hard to maintain through this process. In such cases, the work of construction, reconstruction and maintenance can be integrated into the same bidding process. The maintenance work itself can also be contracted to local farmers.

II. INITIATIVES AT LOCAL LEVEL

After the 2005 Plan was sent out to the local governments, they took actions to promote rural road maintenance reform in their areas. For instance, they issued plans for reforming maintenance systems, broadened the subsidy channels, held bidding events, and established contracting mechanisms. Since China is a very big country with 31 provinces and thousands of counties, this article tries to offer one case for each main action of local governments.

A. Institutional and financial arrangements at provincial level[8]

Provincial governmental institutions set up regulatory frameworks for maintenance activities. Those frameworks illustrate the detailed responsibilities of lower-level governments for rural road maintenance, the direction of financing and implementation arrangements. This section of the article uses the Fujian province as an example, to illustrate how provincial governments arrange institutional responsibilities.

The basic policy of the Fujian transport department for rural road maintenance indicates that county road maintenance is managed by county government institutions, township road maintenance is managed by township government institutions, and village road maintenance is managed by village government institutions. The details are shown in Table 2.

[8] Figure in this section is based on the Fujian Government, Management Method of Rural Road in Fujian, 2008; Fujian Transport Department, Notice of Provincial Subsidy of Rural Road Maintenance from Fujian Transport Department, 2009;Fujian Government General Office, Opinions About Further Develop Rural Road Maintenance Work, 2009; Fujian Transport Department, Report of Modifying the Road Tolls Rate, and Other Items, 1985

Table 2. Institutional arrangements in Fujian province

	Road to maintain	Responsibilities
County government institutions	County road	• Subject of liabilities of the rural road maintenance • Raise and manage funds for rural road maintenance • Set up a rural road management institution in county transport division • Maintain county roads and guide the maintenance of township and village roads • Responsible for administration of county and township roads
Township government institutions	Township road	• Maintain township roads • Guide and supervise village road maintenance • Appoint one responsible person, with some assistants, to routine management, which includes creating plans and organizing the implementation of road maintenance within the town • Assist county transport division with road administration
Village government institutions	Village road	• Maintain village roads • Appoint one person from Two Village Councils or "Six Person"[9] to administer road maintenance • This responsible person must create systems to, organize maintenance, check road conditions, report road damage, prevent village road damage, and protect road properties. • The person should be given certain allowance depending on performance.

[9] "Six Person" is the village organization where the members are responsible for making decisions regarding village public affairs.

Table 3. Utilization of funds

	Subsidy use	Subsidy supervision
Routine Maintenance	• Provincial subsidy is given out quarterly by provincial transport division • County transport divisions arrange the use of the subsidy • Municipal transport division monitors the use of subsidy	• Set special account only for rural road maintenance • Surplus of the subsidy should be used for the following year. • Publish allocation and use of subsidy on the transport division website
Medium &Heavy Maintenance (LM)	• Deducting funds for routine maintenance, the rest of the provincial subsidy is for medium and heavy maintenance • Half of the medium and heavy maintenance subsidy is managed by municipal institutions • The other half is managed by provincial institutions. It is mainly used for large-size special maintenance projects	

Road Tolls Rates of Fujian Province

The toll rate in Fujian as follow:

- Vehicles of all types are charged 115 RMB/ton/month according to their capacity.
- A tractor with a steering wheel is charged 10 RMB/month if its power is no more than 10 horse power (1 horse power = 0.735kw). a tractor with a steering wheel is charged 20 RMB/month, if its power is between 10 horse power and 20 horse power; a tractor with a steering wheel is charged 30 RMB/ month, if its power is between 20 horse power and 30 horse power; a tractor with a steering wheel is charged 40 RMB/ month, if its power is more than 30 horse power.
- Non-steering wheel type tractors of all sizes are charged 16 RMB/month.
- A motorcycle with sidecar is charged 3 RMB/month. A common motorcycle is charged 2RMB/month.

B. Raising and distributing fund at a municipal level[10]

Financing issues at local levels is mostly about making the subsidy criteria and the distribution of funds from different sources to different types of maintenance or to different types of roads. As for fund raising and funds appropriation, the local institutions mostly follow the rules of central institutions. This next section introduces the case of Luoyang, a city in the Henan province, and illustrates the details of financing issues at the local level.

In the city of Luoyang in Henan province, the rural road maintenance fund is composed of road maintenance fees from vehicles, tractors and motorcycles, as well

[10] This section is based on the Luoyang Eleventh People's Congress Committee, Luoyang County and Township Road Maintenance and Management, 2002; Luoyang Government General Office, The Plan of Reform of Management and Maintenance System for Rural Roads in the City of Luoyang, 2007; Luoyang Government, Further Strengthen the Management Method of Village Roads, 2006

as the revenue of governments at different levels. The funding instructions are clarified in the Maintenance Plan of Luoyang.

- Funds from municipal revenue are mainly used for medium and heavy maintenance, repairing of bridges and providing subsidy for the urgent repair of flood damaged roads.
- Funds from county and township revenues are primarily used for routine maintenance and flood control projects, and can also be used for medium and heavy maintenance.
- The minimum subsidy criteria for implementing routine maintenance is 4,100 RMB/km/year for county roads, 2,740 RMB/km/year for township roads, and 2,030 RMB/km/year for village roads.
- The routine maintenance funds for county roads should be raised mainly by county governments, but also can be raised by township governments. The routine maintenance fund for township roads should be raised mainly by township governments, but also can be raised by the county governments. The routine maintenance fund for village roads should be raised mainly by township governments, but also can be raised by county governments and village committees.
- The project for medium and heavy maintenance of rural roads should be considered into the revenue management.

Table 4. Criteria for fund distribution by source of funding

	County Roads	Township Roads	Village Roads
Municipal revenue	Min 1000 RMB/km/year	Min 1000 RMB/km/year	Min 1000 RMB/km/year
County revenue	Min 4000 RMB/km/year	Min 2000 RMB/km/year	Min 1000 RMB/km/year
Township revenue		Min 1000 RMB/km/year	Min 1000 RMB/km/year

Finance instructions for county and township road maintenance

- The maintenance funds in the budget of municipal governments should be used to maintain county and township roads. No less than 60 per cent of the funds should be used for maintenance.
- The total of maintenance funds received from central and provincial governments should be used to maintain county and township roads.
- The highway emergency fund from all kinds of revenues should be used for urgent repair and maintenance projects.
- More than one per cent of the county government budget should be used for medium maintenance, heavy maintenance, reconstruction, and emergency repair of county and township roads.
- Funds from other sources for county and township road maintenance should be used for maintenance projects.

Finance instructions for village road maintenance

- Municipal, county and township governments should take out 0.5 per cent, 1 per cent and 3 per cent of their annual revenues, respectively, for funding of rural road maintenance. More than 30 per cent of the funds should be invested into village road maintenance.
- More than ten per cent of road tolls from tractors and motorbikes should be used to maintain village roads.

- The money raised by "one case, one meeting"[11] should be permitted, by the concerned officials and village congress, for village road maintenance.
- Donations from benefited enterprises and other social organizations are used for village road maintenance.
- Awards from municipal, county transport divisions or the county/township highway management institutions can be transferred as a subsidy for village road maintenance.
- Other funds from governments and transport divisions at different levels are used for village road maintenance.

C. Bidding procedure of rural road maintenance projects at the county level[12]

The bidding procedure is very important to the marketization of rural road maintenance. For rural roads, the bidding is managed by county government institutions. The following section of the article describes the case of Jia county, in Shaanxi province. According to the Bidding Regulations of Rural Road Maintenance in Jia County, the CTB is responsible for directing and monitoring the bidding of rural road maintenance within the county. The procedure of bidding includes inviting bids, bidding, and evaluating bidding.

Inviting Bids

The maintenance projects for bidding should satisfy the following criteria:

- The projects for bid should be for routine, medium or heavy maintenance which is included in the annual maintenance plan.
- The funds for the maintenance projects have been secured.
- The related documents and plan of maintenance have been prepared.
- The bidding documents have been prepared.
- Other preparations have been completed.

The base bid price of maintenance projects should satisfy the following criteria:

- The smallest length for routine maintenance should be more than a continuous length of 1kilometre.
- The shortest contract duration for routine maintenance is one year.
- The investment for heavy maintenance projects should be more than 30,000 RMB.

Bidding principles of rural road maintenance

- The bidding process of routine maintenance is supposed to be held nearby the road. The bids for maintaining county roads should be held in the towns and villages alongside the road. The bidding of township roads should be held in nearby villages. Bidding for village roads should occur within the village.
- The medium and heavy maintenance of all rural roads should call for bids from all enterprises that have the professional qualifications for road maintenance.

[11] It refers to an agreed contribution by villagers at a meeting. "One case, One meeting" is a way of asking farmers to contribute labour or money for their common collective efforts such as rural road maintenance or some other public purpose. The meeting is held by the village committee to make a plan for the money and labour contribution from farmers through a democratic voting process. The plan needs to be examined by the township government and county government. After permitted by them, the plan can be implemented.

[12] The section is based on Jia County General Office, Interim Regulations of Bidding for Rural Road Maintenance Project, 2008

- Urgent rural road maintenance projects can be directly assigned to any specific maintenance company.

Each project can only have one bidding base. The base number for routine maintenance bidding can be published. Tenderees can bid based on the base number. Non-base bidding is also permitted. However, the base numbers for medium and heavy maintenance biddings must be kept secret.

Bidding system

- To verify the qualification of bidders for routine maintenance, it is stressed to check the bidder's name, place of birth, current residence, health status, technical ability, credit, and crime record.
  To verify the qualification of bidding units for medium and heavy maintenance, it is stressed to check the name of the company, proof of maintenance qualification, composition of staff, facilities, achievement, number of staff who are supposed to manage the project, technical staff, and availability of equipment.
- For routine maintenance, the bidders should submit a plan of project implementation including the schedule, the method, techniques, security plan, quality goals and the tendered sum.
- For medium and heavy maintenance, the submitted documents should include the form of tender and its attachments, the list of priced work and amount, the form of tender sum, and the plan of maintenance work.
- For routine maintenance, the period between the publishing of bidding documents to opening bidding is no longer than 7 days. For other maintenance projects, the period between the selling and the handing in of bidding documents is no less than 20 days.

Bid Evaluation

- The evaluation of bids is organized by the CTB, related transport departments and representatives from the subdivisions, as well as by experts who are disinterested third parties to the bidders. The evaluation team should be composed of more than five persons, half of whom should be experts.
- The principles of evaluating bids:
  - Bids should have reasonable quote prices, feasible plans of implementation, advanced technology, good achievement and credit for past work.
  - The lowest price should not be the only condition for winning a bid.
  - If the bidders offer similar conditions, routine maintenance bids should be awarded to bidders of low income.
- The evaluation can be based on grading, voting and other ways. In cases of routine maintenance, the winning bid is announced on the day of opening the bids. For medium and heavy maintenance projects, announcing the winning bidder can also be on the same day of that the bid was open. However, in some special situations, the decision can be made as much as a week later, if necessary.
- The bid winners should sign the contract within three days of winning the bid.

D. Contract models of rural road maintenance[13]

There are four contracting models for rural road maintenance. The contractors can be individuals, companies, road maintenance teams and benefited enterprises.

- Individual or family contracting model
  In this model, the rural road maintenance task is distributed to the farmers or to families alongside the road. The individuals or families sign a contract with the local government road institution and are paid for maintaining a certain length of the road. For example, in Zhuangbian town, Fujian province, the maintenance workers are recommended by the villages alongside the road and employed by the township transport institution. Each worker is responsible for four to five kilometres of road. Their work is evaluated by the town transport institutions and their villages. The result of the evaluation affects their payment. In the town of Luanfeng, Fujian province, the individual contractor for rural road maintenance is selected by the village committee. In Jiangshan town, Fujian province, some outlying villages adopt family contracting models of rural road maintenance, because of the short length of the road and their geographical condition.

- Company contracting model
  In this model, some counties, towns or villages assign the entire rural road maintenance work to the professional maintenance companies, which can be selected through bidding or authorized directly by the government transport institutions. For instance, Yongding county in Fujian province gave the entire maintenance task of 267 kilometres of county road to the Baolai Construction and Engineering Company of Yongding county. Similarly, in Xinxian town, the entire maintenance work was assigned to the township maintenance company. The company is paid according to the quality of their maintenance.

- Road maintenance team contracting model
  The road maintenance team contracting model ensures that the local governmental road institutions contract road maintenance work to local maintenance teams. For example, in Nanfeng county, Jiangxi province, the CRB selected maintenance team leaders through competition. Afterwards, the team leader will choose maintenance workers within the road bureau of Nanfeng county. The maintenance team leader is the person responsible for the team and is under the management of the maintenance company of the CRB. The maintenance company assigns tasks to each maintenance team every month and monitors the maintenance process.

- Benefited enterprises contracting model
  The benefited enterprises contracting model states that when certain sections of a road are mainly used to serve a particular enterprise, that enterprise can assume the road's maintenance. For example, in Baisha town, Fujian province, a section of road called Lvfeng mainly provides access to Jinlong Energy Enterprise. By negotiating between the local road bureau and Jinlong, the Lvfeng road maintenance was awarded to the enterprise.

[13] This section is based on the information on http://www.moc.gov.cn/06road/

E. Emergent maintenance of rural roads maintenance[14]

In the Technical Regulations of Road Maintenance[15], the general regulation for emergent road maintenance advocates policy of prevention, integrating prevention with control. Specifically, the ability to protect roads from disasters such as floods, snow, and sand, should be checked regularly depending on the local geographical and weather conditions. For roads that are frequently affected by flood water, snow, and sand storms, reserving the materials and machines for repairing these roads must be done in advance. Once the disaster takes place, the road should first be dredged, and then repaired in a timely manner. Related government institutions should establish an emergency response plan for road disaster prevention. The plan should include mobilizing the system, the rescue team, a guarantee of rescue staff, materials and money, a system for information reporting, a temporary transportation plan, and rescue measurements.

Apart from a general emergency response plan for rural road maintenance, there is another way to make emergent maintenance more practical and effective. This is to insure road maintenance through the commercial insurance system.

Shanghang county is located in Fujian Province in the southwest and has 1519.6 kilometres of rural roads (county roads of 349.5 kilometres and 617.7 kilometres, a village road of 523.3 kilometres, and a 29.1 kilometre private road). During the rainy season, landslides by mountains and hills create damage to the rural roads. The county thus needs to invest a substantial amount of money every year to repair and maintain them.

Rural road damage due to natural disasters in Shanghang County was brought under an insurance coverage system in 2010. The entire 1519.6 km of rural roads within the county were insured with the Shanghang branch of China Life Property Insurance Company with a total claim of 1.764 billion RMB. Insurance claims can include the costs of repairing the roadbed, bridges, tunnels and culverts, protection works, removal of landslide earth and debris, project losses etc. The annual insurance premium of 605,900 RMB is paid by the county government. When a road is damaged, the insurer can choose to either pay for the loss and the cost of the damage, or repair the damage. The compensation for each incident is no more than 0.3 million RMB. If the cost and loss are less than 10,000 RMB, the insurer does not have to pay.

This system has three advantages for emergent maintenance. First, the road facilities damaged by disaster can be repaired in time, and losses due to major natural disasters have a financial guarantee; the second is that insurance reduces the financial burden on local governments; and thirdly, it effectively ensures the smooth flow of funds for road damage repair and meets the needs of rural road safety.

[14] This part is based on Shanghang County Used Rural Road Insurance to Solve the Funding Problem of Repair Disaster Damage, 2010-08-10, accessed at www.fjgl.gov.cn/show.aspx?ID=3231&cid=10

[15] China's Ministry of Communications, Technical Regulations of Road Maintenance, 2010

CONCLUSION

China has established a clear rural road maintenance institutional framework to guide and regulate governments at different administrative levels. The government departments follow this framework and are monitored by higher-level authorities. Among all the institutions, county level government institutions take most of the responsibility for rural road maintenance. China has also set up a diverse set of financial resources for rural road maintenance, with main contributions coming from budgetary allocations of higher-level governments at the national and provincial levels. In addition, the bidding and contracting system of rural road maintenance guarantees the implementation and quality of maintenance work. The institutional arrangements and experience of China can be of assistance to other countries in considering a rural road maintenance system of their own.

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