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Impact of PMGSY Roads on the Traffic Safety of School-Going Children in Rural Areas

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Executive Summary

In the year 2000, the Government of India initiated a programme, popularly known as Prime Minister Gram Sadak Yojana (PMGSY), for the construction of all-weather roads for connecting all the villages having population over 500 by the end of 2007. This has changed the traffic scene considerably as high speed and heavy motorized vehicles are able to reach villages. However, in the process the traffic safety level in rural areas has gone down considerably. The problem of safety is particularly prominent among school-going children, who travel long distances to reach schools. Keeping in view the above facts, a study was conducted in a few selected villages in Neemrana Block of Alwar District of Rajasthan (India) with an objective to quantify the Accident Exposure Index (AEI) along PMGSY roads of high school-going children. The parameters considered were: Geometric characteristics of roads; width and quality of shoulder; distances need to be traveled along PMGSY; mode of transport used by the student and traffic volume and mix on road. The relative weights of the parameters were determined through an expert opinion survey and the score on different parameters were collected from the students through a questionnaire survey. The AEI value thus determined would help the decision makers to quantify the stretches which require immediate attention for improvement to enhance the safety standards. It also helps to identify the parameters which need up-gradation and then appropriate steps could be suggested to ameliorate the situation.

1. Introduction

1.1 Rural Road Development in India

The necessity of a proper road network for the development of the country was understood quite early in India. The first road development plan of (1943-61), popularly known as 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 comprising National Highways, State Highways, Major District Roads, Other District Roads and Village Roads. The last two classes of roads form the rural road system in the country.

The Nagpur plan postulated certain accessibility standards for different areas based on development criteria and also suggested empirical formulae for estimating the required lengths under different categories of roads. The second road development plan (1961-81), known as Bombay Plan, retained the same classification of road system but introduced the class of Expressway as a concept. Accessibility criteria were retained and the network concept of Web and Lattice was introduced for planning the network system. The third road development plan (1981-2001) stressed the need for expressways. New accessibility criteria for village road were introduced and this plan suggested several approaches for rural road development. These approaches include preparation of long-term master plan for rural roads; stage construction in view of the low level of traffic in the initial stage of development of a rural road; integration of rural road development plan with the other rural development programmes.

During all the road development plans the rural roads have received significant attention and emphasis. A number of programmes were launched to achieve the goal of rural connectivity such as the minimum needs programme (MNP), National Rural Employment Programme (NREP), Rural Landless Employment Guarantee Programme (RLEGP) and Jawahar Rozgar Yojana (JRY). In the year 2000, the Government of India initiated a programme, popularly known as Prime Minister Gram Sadak Yojana (PMGSY), for the construction of all-weather roads for connecting all the villages having population over 500 by the end of 2007. Rajasthan is one of the very few states which would reach the target in time. It has been widely acknowledged that these roads have improved social, physical, financial and human capital of the population of the connected villages.

1.2 Change in road safety scene in rural areas with the development of roads

In the first 20-year road development plan of India, 1941, roads have been classified into five categories: National Highways (NH), State Highways (SH), Major District Roads (MDR), Other District Roads (ODR) and Village Roads (VR). Out of them the ODR and VR are being categorized as Rural Roads. At present, India has about 2.7 million km of road length and the rural roads constitute about 2.2 million km. The motorized traffic on rural roads has been increasing in rural areas over the years due to the increase in income level and easy availability of such vehicles in the market. Moreover, public transport modes such as buses and trucks have also started plying in interior areas. However, with improved accessibility, the accidents on such roads have also increased over the years. The construction of high quality all-weather PMGSY roads in recent times has changed the rural traffic scene considerably as high speed and heavy motorized vehicles are able to reach the villages. Rural road crashes are generally more fatal than crashes on urban roads due to differences in operating speeds (higher on rural roads), road geometry (rural roads have evolved rather than having been designed), functionality (rural roads are multi-functional), enforcement levels (rural roads receive a lower priority) and other factors. Thus the possibility of fatal accidents (per kilometer driven) is generally higher on rural roads than on urban roads. There is a perception among the villagers about the possible safety hazards due to the high speed motorized vehicles using the roads. The villagers were primarily exposed to slow moving vehicles and suddenly the scenario has changed considerably after the construction of high quality PMGSY roads. The problem is particularly prominent among school-going children who travel long distances to reach schools. No special initiative has been taken to educate the children about the basic traffic safety rules after the construction of such roads. Earlier they used to travel along village roads where there was no motorized

traffic, but now, after the construction of the PMGSY roads, they are exposed to high speed motorized traffic. These children, who perhaps were never exposed to fast moving traffic, sometimes are not able to perceive how quickly a fast moving vehicle could reach him/her. Hence the possibility of accidents has gone up tremendously. Thus there is an urgent need to take up studies to understand the impact of PMGSY roads related to the deterioration of safety in rural areas, especially among school-going children.

1.3 Objectives of the study

Keeping the above facts in view, the following objectives have been set for this study:

- To identify the parameters to be considered for determining the traffic safety of school going children;
- To determine the weights of the identified parameters as perceived by the villagers;
- To quantify the exposure index to accidents for school going children traveling along PMGSY roads in a few selected villages.

2. Methodology

Quantification technique
The methodology adopted in this study was to develop a quantification technique by which accident exposure index along the PMGSY road for school going children in a village could be determined based on a few selected parameters. This would help to compare the villages in the study area based on the susceptibility levels of school going children to traffic accidents.

The Accident Exposure Index (AEI) for school going children of a village has been expressed as:

$$AEI = \sum w_i V_i$$

Where
N = Number of parameters considered for quantifying accident index;
w_i = weight associated with parameter i;
V_i = score on ith parameter based on the existing situation.

The weights associated with the selected parameters were normalized so that $\sum w_i = 1$ and scores were assigned on the selected parameters which varied between 1 and 5, where 1 represented highly satisfactory and 5 highly dissatisfactory. Theoretically, the maximum possible value of AEI is 5 representing very high exposure index to traffic accidents.

3. Case Study

3.1 Identification of parameters:

After the initial review of literature and discussions with experts and village representatives, the various factors responsible for road accidents on one-lane paved roads in rural areas were identified and analyzed and finally the following parameters were considered for the study to determine the accident exposure of the school going children on PMGSY roads:

- Geometric characteristics of road
- Width and quality of shoulder,
- Distances need to be traveled along PMGSY road for school-going children,
- Mode of transport used by the students, and
- Traffic volume and mix on the road

3.2 Weights of the parameters:

To determine the relative weights of the parameters for calculating the AEI, opinion from eight experts were collected. They were explained about the background, objectives and methodology of the study and then were asked to rate the parameters according to their importance in a scale ranging between 1 and 5, where 1 represented *not at all important* and 5 *extremely important*. The responses of the experts are shown in Table1.

Table-1 Responses from experts on the weight on the selected parameters

	Importance Score							
Road geometric characteristics (RGC)	4	5	4	4	4	4	5	4
Width and Quality of Shoulder (WQS)	4	4	4	4	4	5	4	4
Distance to travel along PMGSY road (DT)	3	2	3	2	3	3	2	2
Mode of Transport of the user (MT)	2	3	2	2	2	3	2	2
Traffic volume and mix encountered during travel (TV)	3	4	3	3	4	3	4	3

The averages of the weights thus obtained on each parameter were calculated and then normalized considering all of them so that the summation of the weights of all the parameters was 1 (Table 2). The geometrics of rural roads are usually not up to the mark with winding alignments and sharp curves without proper super-elevation and inadequate sight distances. Similarly, proper shoulders are quite often not provided and even when provided are inadequate and not maintained properly. This creates a major problem especially for the traffic in a single-lane road. It might be observed that both these parameters have been considered quite important and were assigned almost equal weights by the experts. Traffic volume and mix are also quite important in a village road. Usually the interior rural areas are not exposed to high speed or heavy motorized vehicles. But the scenario changes suddenly after the construction of an all-weather good quality road. The local population takes time to adjust to the new situation and thus the weight on traffic volume and mix has also been rated moderately high by the experts.

While going to school in rural areas, the students need not travel along PMGSY or any other good quality road for all the distance they need to travel to reach schools. The route might be a combination of path, earth road and PMGSY road. The traffic safety issue is only important while the student is moving along PMGSY road and thus the total distance of traveled along such roads have been considered as a parameter. The longer the distance the greater is the exposure to accident. For this particular study, only two kinds of modes have been considered for analysis, walk and bicycle. It has been observed that most of the students travel by either of these two modes. Now-a-days school buses are also quite popular, but mainly for primary school going children. Both the parameters i.e. distance and the mode of travel were weighted almost equally by the experts.

Table-2 Normalized weight of the selected parameters

Weights Parameters	Normalized Weight
Road geometric characteristics	**0.26**
Width and Quality of Shoulder	**0.25**
Distance of travel	**0.15**
Mode of Transport of the user	**0.14**
Traffic volume and traffic mix encountered during travel	**0.19**
Total	**1.00**

3.3 Data collection

The case study was conducted in five villages in Neemrana Block of Alwar District of Rajasthan. The villages were chosen such that the PMGSY roads had been constructed in different years. The selected villages, year of construction of PMGSY road and the length of roads have been shown in Table-3.

Table-3 Details about PMGSY roads connecting the villages in the study area

Name of village	**Population of village**	**Year of construction of PMGSY road**	**Length of PMGSY Road in Km**
Mahatwas	2606	2002	3.400
Kutina	3357	2003	2.425
Chawandi	1209	2004	2.910
Bighana Jat	1026	2005	3.850
Bhim Singh Pura	811	2006	0.700

For collection of data, a draft questionnaire was prepared and then was finalized in consultation with the villagers and a few high school students in the area. The relevant data was collected in collaboration with a local NGO, *Sohard* based in Anandpur in Neemrana Block. Accordingly the enumerators were trained in the field by the research team for the collection of relevant data through interview. In total 100 students of both the sexes were interviewed separately (Table-4). It was expected that the perception on road safety might be different for boys and girls. Moreover, the exposure to accident was presumed to be different for students using different modes of travel.

Table-4 Data collection details

Village	Number of students interviewed		
	Boys	**Girls**	**Total**
Mahatwas	19	20	39
Kutina	07	-	07
Chawandi	13	07	20
Bighana Jat	09	11	20
Bhim Singh Pura	08	06	14
Total	56	44	100

Each of the five parameters chosen for this study for quantifying the accident exposure index were graded in scales between 1 and 5 based on their severity.

The geometric standards for PMGSY roads have been improved over the years. The older roads constructed during the first few phases do not have excellent alignments, but gradually things have improved. In many cases proper alignments could not be provided due to land acquisition problems. The PMGSY programmme does not permit funds for land acquisition and expects the villagers themselves would contribute land along the alignment for the development of the village. This has not worked in a number of cases. Very often signposts and road markings are absent in PMGSY roads. The scores assigned on alignment and geometrics considered for the study are given in Table 5.

Table 5: Score on alignment and geometrics of the road from the point of view of safety

Road Geometric Characteristics	**Score**
Number of sharp curves without signposts and markings	5
One/Two sharp curves without signposts and markings	3
Moderately straight level road	1

Sharp curves with poor sight distances

Provision of proper shoulder is very important, especially for one-lane roads. Besides providing lateral support to the pavement, it helps pedestrians and cyclists to travel on it and also the space is being used for overtaking and crossing operations of vehicles. Proper shoulders are sometimes not provided, and when provided, they are very often inadequate and not maintained properly. In some cases it has also been observed that the farmers encroach upon the shoulder thereby reducing the width causing structural danger for the pavement and also inconvenience for the traffic. In the absence of proper maintenance over a period of time a difference in level is created between the pavement surface and the shoulder, which is very dangerous especially for pedestrians and cyclists. Keeping the above facts in view, scores have been assigned on width and quality of shoulder as shown in Table-6.

Table-6 Scores on the Width and quality of shoulder provided

Shoulder Characteristics	**Score**
No proper shoulder	5
Inadequate shoulder	4
Shoulder with level difference with the carriageway	3
Shoulder not properly maintained	2
Proper shoulder	1

No proper shoulder

The objective of the PMGSY road is to provide connectivity to unconnected villages by constructing road to the nearest connected village or to the nearest all-weather road and thus in most of the cases the length of the PMGSY road is not very high. It has been presumed that the possibility to exposure to accidents is higher when the students need to travel longer distances and accordingly scores have been assigned (Table-7).

Table-7 Scores on Distance traveled along PMGSY roads

Distance (kms)	**Score**
Above 4	5
3-4	4
2-3	3
1-2	2
Less than 1	1

The accident statistics in developing countries show that the pedestrians and cyclists are the most vulnerable road users and thus the scores on the modes of travel have been assigned accordingly as shown in Table-8.

Table-8 Scores on Mode of Transport used for traveling to school

Mode of Transport	**Score**
Walk	5
Bicycle	4
Motorized two-wheeler	3
Animal drawn vehicles	2
School Bus	1

The traffic volume and mix on the road also increase the possibility of accidents. The villagers are usually habituated in negotiating non-motorized vehicles on roads and thus are not used to the sudden surge of fast moving motorized vehicles. Since the traffic volume data is not usually recorded in rural roads, the scoring has been assigned on subjective evaluation (Table-9).

Table-9 Scores on the kind of vehicles encountered on the way while going to school or returning from school

Traffic mix	**Score**
Mix of heavy vehicles (bus, truck), jeep, car, tractor and other non-motorized vehicles.	5
Mainly jeep, car, tractor and other non-motorized vehicles.	3
Mainly non-motorized vehicles	1

4. Analysis and discussion

The data was collected for high school-going children in five villages separately for boys and girls. It was expected that the perception on traffic safety and exposure to accidents of the two groups could be different. But, it was found during the survey that there was not much variation in their perception and thus the analysis has been done for both the groups together. However, the assumption that vulnerability to accidents varies with the kind of mode was substantiated because all the respondents indicated that risk was higher for pedestrians as compared to cyclists.

The questionnaire survey also reveals that there is a general sense of insecurity concerning traffic safety after the construction of the PMGSY road. In fact a school-going boy was killed in an accident in one of these roads in the last year. Very often minor accidents take place and there are high possibilities of major incidents any time. The main reasons for insecurity as told by the respondents were as follows:

- Increase in fast moving motorized vehicles;
- Speeding and disobedience to traffic rules by most of the drivers of the motorized vehicles;
- No road markings and sign posts;
- Lack of education on road safety of the villagers.

None of the villages in the study area has a high school and thus the students need to travel long distances to reach school. Usually they travel either by walking or by bicycle and only a part of the distance is along PMGSY road. The possibility of a major accident is quite low in village roads and thus the accident exposure has only been calculated for the part of the distance travelled along PMGSY road. The details regarding high school location and distances of travel are shown in (Table-10). The scores recorded for each attribute in all the villages were obtained as shown in Table-11. It has already been mentioned that even though data was collected separately for boys and girls, the responses received were identical and thus the analysis has been done with the combined data. It was found that in all the villages except for Bighana Jat, students- both boys and girls go to school by cycle and thus it was not possible to get the difference in perception on traffic safety for users of different modes. However, in Bighana Jat, the students either walk or use bicycle. The pedestrians felt themselves more vulnerable than those of cyclists. The road geometrics in all the roads are quite poor except for the road connecting Bighana Jat. This is contrary to the belief that the alignment characteristics have been improved with time. During the interaction with the villagers it was found that the proper consultation was not done to come up with a proper alignment so as to reduce the number of acute horizontal curves. On the other hand, the concerned engineers alleged that the villagers usually did not cooperate in land acquisition and thus the alignments were selected based on the existing revenue path. Whatever might be the fact, the ultimate sufferers would be the villagers. The quality of the shoulders was quite satisfactory on the roads connecting Kutni, Chawandi and Bighana Jat. However, the road connecting Mahatwas, which was constructed in 2002 was found to be in poor shape. In fact some part of the shoulder has been encroached upon by the villagers and could not be used. The condition of the road connecting Bhim Singh Pura was also very poor even though it has been constructed recently. The villagers complained that the workmanship during construction was very poor and in the absence of proper rolling during construction the shoulder has become undulated and thus almost unusable. In addition, the traffic has increased tremendously in all the roads after the construction of the roads and it consists of all kinds of motorized and non-motorized vehicles including tractors.

Table-10 Distances travelled by students for going to school

Village	**Location of School (name of village)**	**Total distance to school in km**	**Distance traveled by school going children along PMGSY road in km**
Mahatwas	Mandhan	6.000	2.500
Kutina	Shahajanpur	10.000	2.425
Chawandi	Mandhan	7.000	2.910
Bighana Jat	Raisrana	3.850	3.850
Bhim Singh Pura	Majri	4.000	0.700

Table-11 Scores on the selected parameters as obtained through questionnaire survey

Village	**Scores on**				
	Road Geometrics (RGC)	Shoulder quality (WQS)	Distance of travel (DT)	Mode of travel (MT)	Traffic characteristics (TV)
Mahtawas	5	4	3	3	5
Kutina	3	2	3	3	5
Chawandi	5	1	3	3	5
Bighana Jat	1	1	4	3/5*	4
Bhim Singh Pura	3	5	1	5	5

** Some girl students use bicycle and a few of them walk. Score 3 is for those who use bicycle and 5 for those who walk.*

The Accident Exposure Index for each village was calculated using the corresponding values from Table 11 in Eq. 1 and the final indices are shown in Table-12. Since data was available for cyclists and pedestrians, two indices are being shown for Bijhana Jat. It might be observed that the exposure index is the highest for the children going to school from Mahatwas (4.12) and the lowest for those from Bighana Jat traveling by bicycle. The reasons could be observed from Table-11. For example, the scores for all the parameters on the road connecting Mahatwas are quite high. Both road geometrics and the quality of shoulder are very poor and also the traffic volume and mix are also quite heavy. The AEI indices help to prioritize the stretches according to exposure to possible accidents. The worst stretches could then be taken up for improvements to reduce the possibility of accidents. This could be done by looking at the scores (Table-11) for that stretch, identify the parameters which have high (poor) scores and then take measures to improve so as to improve the scores on those parameters.

Table-12 Accident Exposure Indices of the villages

Village	**Accident Exposure Index for students traveling by**	
	Walk	**Bicycle**
Mahatwas	-	4.12
Kutina	-	3.10
Chawandi	-	3.37
Bighana Jat	2.57	2.29
Bhim Singh Pura	3.86	-

5. Conclusions

A simple technique has been suggested in this study to quantify the possibility of accidents in road stretches based on a few selected parameters. This would help the decision makers to quickly identify the stretches which require immediate attention for improvement to enhance the safety standards. It also helps to identify the parameters which need up-gradation and then steps could be suggested to ameliorate the situation. The parameters were chosen and their scores were decided based on the existing conditions in the study area and these might change from place to place depending on the prevailing situation. The present study was conducted with a limited scope. A full scale study would allow to consider a large number of parameters and their scoring methods could also be improved and standardized.

6. Bibliography

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