

## **Effectiveness of Road Safety Measures on Rural Roads of Bangladesh**

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### **Abstract:**

Road accidents in Bangladesh exist in an alarming situation. Every day road accidents are taking heavy toll of human lives. Most of the reports and researches are focused on accidents on highways. But accidents on rural roads are unaddressed. Cause of road accident depends on various factors. Road user's education, engineering practices on road construction, management and enforcement are major factors. Concern authority, Local Government Engineering Department (LGED) has taken several initiatives including awareness campaign for road users like drivers, students, related concerned like UP chairmen, members etc, installation of traffic control devices like road signs, markings, speed breakers and guide posts at hazard locations to reduce road accidents on rural roads. But what level these initiatives are working, yet not evaluated. This study empathized on measure of the level of understanding of road signs and markings of rural road users on which depends the effectiveness of safety measures (signs and markings), physical scenarios of signs and markings which helps to encoding the messages to the drivers and effects of safety measures on accident trends and economic benefit of safety measures that provides on rural roads.

**Keywords:** *rural road, safety measures, level of understanding, signs and markings.*

### **1 Introduction**

Road accidents in Bangladesh exist in an alarming situation. Every day road accidents are taking heavy toll of human lives. So many researches, studies or reports have been done to analyzed accident trends, evaluate road safety scenarios and effectiveness and functional ability of road safety measures taken by different projects on the national highways. Road accident situation on rural roads is not in very satisfactory level. Most of the cases, accident record on rural roads is not reported by police or by print or electronic media. Rural roads (upazilla road, union road and village road) are more exposed than the highways, trends of rapid increases in traffic, especially non motorized and substandard vehicles, increasing speed differentials between non-motorized and motorized vehicles, insufficient roadway geometric features, local road and traffic related environmental hazards causes the high risk of road accidents on rural roads. Due these issues, the rural roads are becoming hazardous day by day. On the other hand, with more degree of exposure, institutional and individual unplanned activities like allowing plantation, frequent driveway, roadside development, local activity etc. and due to ever increasing mobility and accessibility of all type of vehicles (formal and informal) to growth centers, markets and other institutions, rural road safety issues have become a major concern. Traffic control devices are act vital role to improve the road safety and efficiency by providing orderly movement of all road users on roads and highways. In the last decade, several initiatives has taken to improve road safety through installation of traffic control devices like road signs, markings, speed breakers at markets and schools, guide posts at bends and bridge approaches etc. and awareness campaign for road users including drivers, students, related concerned like UP chairmen, members, NGOs/CBOs by different projects[1,2]. But all those initiatives to improve the rural road safety situation yet not evaluated.

The key issue of this paper is to focus on the effectiveness of safety measures on rural roads by three ways. Firstly, the perception and level of understanding of road users (drivers, pedestrians and officials) on the road signs and markings, secondly, the uniformity and consistency of installed signs and markings on which meaning and encoded of traffic signs depends and finally, functionality by undertaking before-after analysis of installed safety measures and calculating its associated benefit-cost ratio.

## 2 Rural Road Safety Scenarios

The accident rate on rural roads (LGED's road) is not significant as compared to the national scenarios. Road Traffic Accident (RTA) annual report 2008, prepared by BRTA, reported total casualty accidents on rural roads is 10% and 11% of fatal accidents occurs on rural roads (LGED's road)[3]. According to ARI study (2006-2013), 84.8% of fatal road accidents occur in rural areas of Bangladesh. Among them National, Regional and District roads account for 74.8% and Rural roads (LGED's road) account for 9.9% of total fatal accidents. The rest 15.2% fatal accident occurs in urban streets[4].

### 2.1 Characteristics Of Rural Roads

The prevailing problem characteristics on rural roads are very different from highways. Rural roads are more exposed than the highways, trends of rapid increases in traffic, especially non motorized and substandard vehicles, increasing speed differentials between non-motorized and motorized vehicles, insufficient roadway geometric features, local road and traffic related environmental hazards etc.[5].

Insufficient roadway geometric features which reduces the road safety in LGED's roads are-

- No or insufficient shoulder ( both side pond/dish, one side pond and other side housing areas or both side housing areas).
- Insufficient sight distance (trees or housing area at intersections)
- Unprotected / untreated intersections with higher road network
- No super elevation at curve sections
- No widening at curves
- No or insufficient safety fences/barrier at narrow roadway section
- No or insufficient signs and marks
- Sharp horizontal and vertical curve at same segment of bridge approaches
- Parking on roadway
- Both side Hat/Bazar area
- No or insufficient drainage system
- Excessive side roads and bends

## 3 Rural Road Safety Initiatives

In the last decade, LGED has taken several initiatives to improve road safety in rural roads under various road projects namely RDP-25/RIIP, RDP-26/RTIP, RIIP-II, SRIIP and currently RTIP-2[1,2,5]. Funding agencies involved in these initiatives are World Bank (IDA), Asian Development Bank(ADB), Kfz and Gtz, JFPR etc. Taken road safety measures through installation of traffic control devices like road signs, markings, speed breakers (road hump) at pedestrian crossing near markets and schools, guide posts at bends and bridge approaches etc. and awareness campaign for road users including drivers, students, related concerned like UP chairmen, members, NGOs/CBOs personals etc. It is observed that, lack of awareness of road users and drivers, unskilled drivers, tendency of disobeying traffic rules, faulty vehicles, hazardous roads are the main causes of road accidents.

The objectives of these initiatives were:

- Create mass awareness regarding road use and safety among the road users i.e. drivers, vehicle owners, pedestrians and related concerns.
- Inform attendees about the main causes of road crashes and possible way to avoid
- Inform existing traffic rules, meaning of signs, markings, signals etc.
- Responsibilities of NRSC, DRSC, URSC in implementing road safety plan and National Road Safety Strategic Action Plan.

An assessment of the impact of this awareness campaign has shown very positive results.

## 4 Study Area And Survey Instruments

To examine the effectiveness of different countermeasures, sample roads in different geographical location had selected. Based on reconnaissance survey fully paved eight upazilla and village roads with safety measures taken had chosen from 4 divisions i.e. Dhaka, Chittagong, Rajshahi, and Khulna. Another four fully paved roads without safety measures taken each from selected each district as control site. To evaluation perception and level of understanding of traffic signs and road marks, self- administered questionnaire-type survey instruments were used selected signs and markings (29 nos. signs and 7 nos. road markings) which are more prevent and relevant

for rural road traffic condition. To evaluate the safety measures w.r.t. before-after accident analysis, the control site technique has adopted in the study. In each survey district, one control road was selected carefully with almost similar road traffic characteristics and without having any safety measures. In the absence of accident statistics for before scenario, initiative was taken to collect accident records by conducting household/shops survey along 500m strip on both sides of selected road alignment. Two years accident data was collected for before-after accident analysis.

### 5 Road User's Level Of Understanding On Traffic Signs and Markings

The understanding level for all signs and markings in this study was only about 42%, percent of not correct 37% and percent of not sure is about 21%. This understanding is very poor, it means that the signs and marks that provided on the rural roads are not effectively used. Only 22% of road user can understood the meaning of markings.

Table 1. Poorly level of understanding (signs and markings)

| Signs / Markings                              | BRTA Designation | % Understanding General Road User | % Understanding LGRD Officials |
|---|------------------|-----------------------------------|--------------------------------|
| Stop and Give way on major road or roundabout | A1               | 36                                | 50                             |
| Give way on major road or round about         | A2               | 10                                | 20                             |
| National speed limit apply                    | A27              | 24                                | 42                             |
| Major road ahead                              | B2               | 12                                | 25                             |
| Hairpin bend ahead                            | B11              | 19                                | 19                             |
| Pedestrian on road ahead                      | B24              | 16                                | 40                             |
| Dangerous Shoulder                            | B41              | 24                                | 52                             |
| Level crossing without gate                   | B44              | 21                                | 42                             |
| Level crossing with gate                      | B45              | 30                                | 44                             |
| Location of Rail Way Crossing                 | B47              | 12                                | 11                             |
| Stop Line                                     | F1               | 12                                | 13                             |
| Give way Line                                 | F2               | 27                                | 13                             |
| Pedestrian Crossing                           | F3               | 30                                | 52                             |
| Lane Line                                     | F5               | 15                                | 21                             |
| Barrier Line                                  | F6               | 15                                | 23                             |
| Warning Line                                  | F7               | 28                                | 23                             |
| Edge Line                                     | F9               | 27                                | 52                             |

#### 5.1 Response With Respect To Demographic And Driving Characteristics

Figure1. to Figure4. represent the average understanding for 36 signs and markings used in this study with respect to demographic and driving characteristics of respondents.

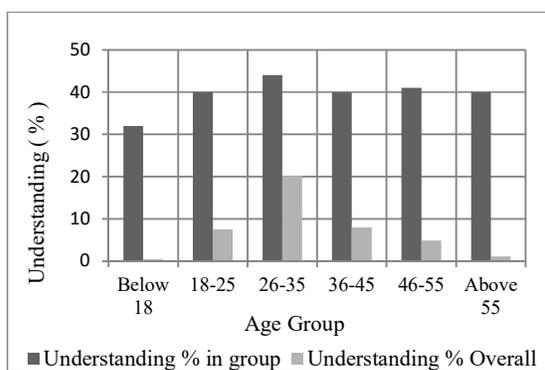


Figure 1. Understanding with respect to Age group.

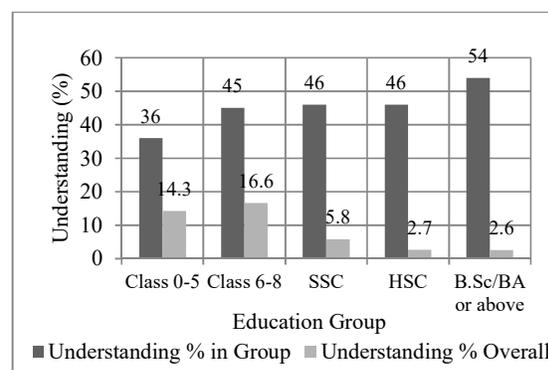


Figure 2. Understanding w.r.t. Education level.

Above result shows there is a little effect on age group. Age group 26-35 appears better understanding (44%) and age group below 18 appears less understanding (32%). Other age groups show almost same understanding level (40%-41%). Age group 26-35 is the most efficient group to do any work which also reflects in this study. Education group has a significant effect on understanding level. Class 0-5 shows minimum 36% and B.Sc./BA or above maximum 54%. Changing rate is gradually increasing with increasing education level. It proves higher road user's education has better understanding and will be reduces road accident.

Table 2: Over all response to various signs and markings with respect to driving for Job.

| Signs                                | Driving for Job | Sample nos. | Understanding in group (%) |           |          | Over all Understanding (%) |           |          |
|--------------------------------------|-----------------|-------------|----------------------------|-----------|----------|----------------------------|-----------|----------|
|                                      |                 |             | Correct                    | Incorrect | Not sure | Correct                    | Incorrect | Not sure |
| All signs and marks under this study | Yes             | 228         | 41                         | 37        | 22       | 36.9                       | 33.3      | 19.8     |
|                                      | No              | 25          | 46                         | 40        | 14       | 4.5                        | 4.0       | 1.4      |

This study shows adverse effect of driving for job or not. In general, the professional drivers have better knowledge then others but this study indicates who taken driving as job correct the less answer (41%) and others whose driving is not taken as job shows better correct respond (46%). It is identified that, who taken driving as a job in rural areas are less educated electric driven auto or 3-wheller driver (58% of sample) and have no formal training on driving and road safety. On the other hand, driver whose driving is not job are motor bike driver (14% of sample) shows better level of understanding.

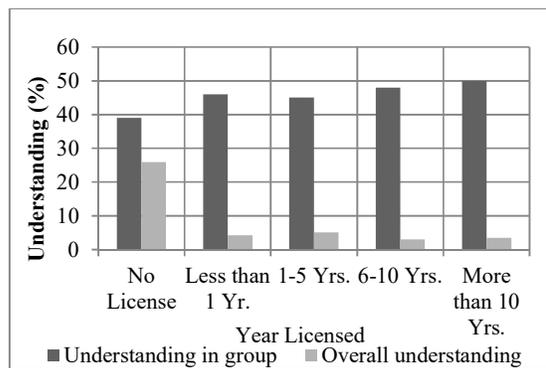


Figure 3. Level of understanding of w.r.t. year licensed

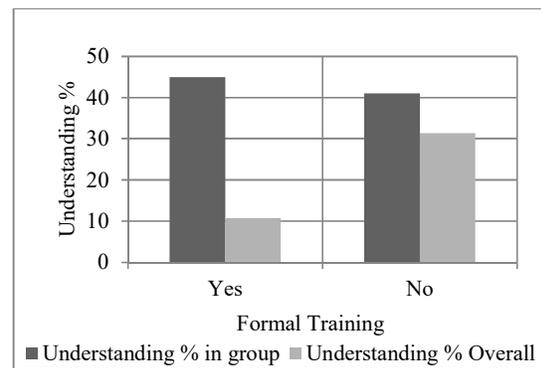


Figure 4. Level of understanding of w.r.t. formal training

It's common there will be a significant difference in understanding level between licensed and non licensed drivers. But in this study, it shows there is no significant difference in understanding level between them. Licensed driver's understanding level = 46%-50% depending on year licensed and 39% for non licensed driver. According to BRTA's rules, license should not be issue to any driver without adequate knowledge of traffic signs, markings and traffic rules. But the field survey says the different scenario. It proves inefficiency of driving license issuing process. On the other hand formal training has a great impact on any better performance. Basically drivers in rural areas have not any opportunity to attained formal education or training on traffic signs and road marks. A very few number of formal training for drivers were organized by LGED and some other NGOs. At the time of group discussion at data collection, some drivers informed, they attained one/two days training on road safety. But not detail on road markings and signs which they seen beside the road. This very small initiative shows a positive result on level of understanding.

Table 3: Understanding of various signs and marks with respect to different zone.

| Zone     | Resp. Nos. | Understanding (%) |            |         |             | Road Marks | Literacy Rate <sup>01</sup> |
|----------|------------|-------------------|------------|---------|-------------|------------|-----------------------------|
|          |            | Overall           | Regulatory | Warning | Informatory |            |                             |
| Bogra    | 54         | 50                | 52         | 48      | 74          | 35         | 49.38                       |
| Jamalpur | 62         | 39                | 34         | 40      | 74          | 21         | 38.44                       |
| B.Baria  | 68         | 41                | 46         | 42      | 61          | 19         | 45.29                       |
| Jessore  | 69         | 38                | 35         | 41      | 65          | 15         | 56.52                       |

<sup>01</sup>. Bangladesh Bureau of Statistics, 2011

Obviously there is an impact on level of understanding of drivers on traffic signs and road markings in zone where drivers are living/working. There are so many factors which changes the intellectual level of drivers and hence encoding capacity of signs. The symbols of traffic signs are design in a way that drivers can encode the meaning easily. Overall level of understanding are 50%, 41%, 39% and 38% in Bogra, B.Baria, Jamalpur and

Jessore respectively. Except Jessore, this study found directly proportional relationship between literacy rate and level of understanding. Lower the literacy rate, lower the understanding level. To Improved the road safety, there should be increase the education level and literacy rate.

## 6 Physical Scenarios Of Safety Measures

On rural roads found no road signs and marks in excellent level of standard which meets all requirements of BRTA standards. From this study, it has found that, colour of all type of signs is satisfied only 39% and all signs are laying without maintenance (0%). There are no program to maintain the signs and markings. It is also observed in field data, dimensions of traffic signs found not satisfactory = 87%. Similarly, location and position and adequacy are not meets the standards by 61% and 42% respectively. It is also observed that, all signs are used materials with no retro-reflective feature.

Field observation shows the following major mistake in rural road's signs:

- Signs placed opposite side of road (23%)
- Signs placed more close or far distance from hazard location (38%)
- Signs not placed in standard height (24%)
- Not placed in proper orientation (38%)
- Not follow sign shape (circle for regulatory signs, triangle for warning signs or rectangle for informative signs) (19%)
- Under size signs or not proper shape (83%)
- BRTA's symbols and font not used (77%)
- Wrong symbols (11%)
- Signs missing (inadequate sign) (42%)
- Complement of sign and marks (0%)
- Lack or no maintenance (100%).

## 7 Effects Of Safety Measures On Accident Trends And Economic Point

### 7.1 Change Of Accidents After Safety Measures Taken

There is a positive impact of road safety measures provided in rural road networks. Severity, collision type and casualty are decreased by 53.5%, 11.4% and 52.6% respectively. On the other hand accident time changes 13.2%.

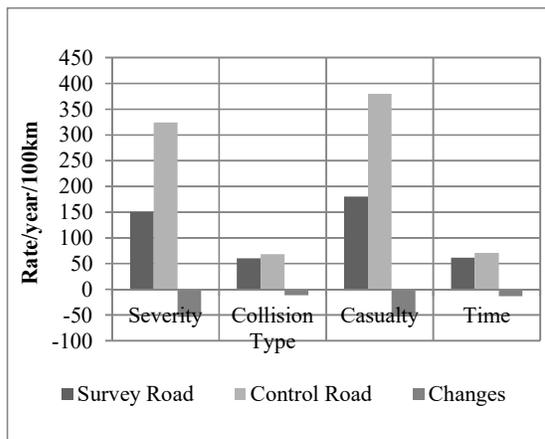


Figure 5. General Changes of Accident

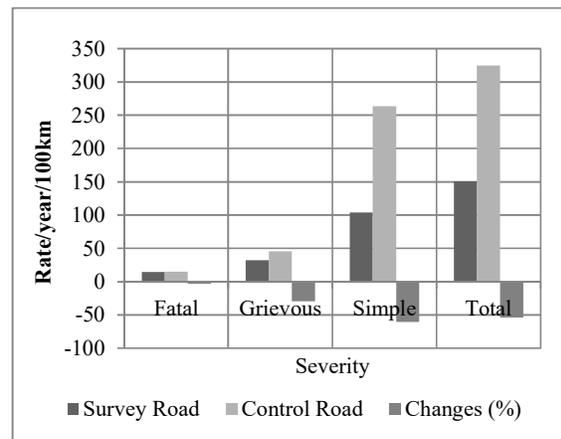


Figure 6. General Changes of Severity

In average of eight study roads, it's observed from the study that the fatal accident reduces by only 3.3% but grievous and simple accident reduces 29.4% and 60.6% respectively. In terms of accident patterns, hitting pedestrian, head on, hit object, over-turn side swipe and right angle type of accidents are changes by +18.6%, -13.4%, +12.0%, +25.5%, -27.4% and -81.6% respectively considering last two years (+sign indicate increases and -sign indicate decrease). This situation indicates that the improvements of safety measures undertaken in the selected roads are not effective in reducing these types of accidents. On the other hand it is also shows that even after implementation of these improvement measures only right angle accidents are reduced significantly

by 81%. The accident scenario in terms of accident time, which indicate increase of accident in evening and night time by +232% and +48% but reduces in morning and day time by -64% and -23% respectively. This is because in rural roads all signs are without retro-reflective features which are not visible in evening and night time.

### 7.2 Economic Evaluation Of Safety Measures

In this study an attempt is made to evaluate the effectiveness of safety measures in economic point of view as well. One of the events leading to initiation of this study is to estimate the cost-benefit analysis of the implemented safety schemes. In order to conduct economic analysis, determination of economic losses (using accident cost)[6] through costing of accident is important; this would justify the expenditure / investment involved in developing countermeasures. This study shows out of eight roads, 4(four) roads have no effect of safety measures taken based on accident cost. Other four roads have benefit cost ratio greater than 1. The maximum value is 18.13 (Islampur HQ–Jhagrarchar GC, Islampur Upa-zilla, Jamalpur District), and the minimum value is 1.43 (Baghopara NHW–Ghoradhap GC, Sharpur Upa-zilla, Bogra District). Though the understanding level of the rural road users is poor and due to shallow knowledge of LGED officials regarding road safety, they implemented incorrect, non-uniform and non-standard safety measures in rural roads, safety measures not served effectively.

### 8 Conclusion

For safer operation of traffic on road, very good engineering practices and road users awareness is essential. From the study, it is observed that overall level of understanding of rural road user about traffic control devices is 42%. It essentially suggests that a majority of rural road users are indifferent of traffic sign and markings. Understanding of ‘Regulatory and Warning Signs’ are found to be 41% and 43% respectively. It is observed that the road users in rural setting have little idea about road markings, which is only 22%. Among the officials of LGED the executing agency, overall level of understanding on the selected traffic control devices is found only 56%. On other side, only 13% traffic signs complied with the standard dimension and 39% complied with colour and locational position. The misuse and abuse of traffic signs were also found frequent. This definitely revealed that there is a shear deficiency in maintaining uniformity in design and application of traffic signs by LGED. Moreover, as per MUTC (USA) and BRTA Traffic Signs Manual, the traffic control devices should be maintained at high standard, but field observation revealed that virtually there is no maintenance initiative by the implementing agency and thereby most of the cases signs were found to be in unusable condition. This prompted that the culture of ‘install-forget-reinstall’ should be replaced by ‘install and continuous monitoring’ approach for ensuring sustainable development of safer road infrastructures of Bangladesh. With respect to ‘before-after’ accident analysis, out of eight roads under this study, four roads have found no tangible impact of safety intervention. Other four roads have benefit-cost ratio greater than 1 with the maximum value is 18.13. It also learnt from this study, a small input in road user awareness campaign results a big increase on level of understanding. So awareness campaign and proper engineering practices would promote road safety on rural roads.

### 9 References

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