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iRAP assessment of risk on national highways in Bangladesh

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Abstract

Bangladesh faces significant road safety challenges. As many as 55 people are reportedly killed in traffic crashes each day. Like many low-income countries, vulnerable road users (including pedestrians, motorcyclists and bicyclists) account for a large proportion of road deaths. In 2010, with the support of the FIA Foundation and local road safety organisations, iRAP undertook a risk assessment of two of Bangladesh's main highways, the N2 and N3. These roads experience death rates in the order of 10 times higher than equivalent highways in Australia. In the case of the N2, this is despite the fact that major upgrades were undertaken as recently as 2005.

This paper provides an overview of the iRAP project; it includes an explanation of the iRAP approach to assessing risk and proposing countermeasures, and provides a summary of key results. The assessments showed that the majority of the N2 and N3 are rated 2 stars or less (out of a possible 5 stars) for car occupants, pedestrians, motorcyclists and pedestrians, indicating a relatively high level of risk of death or serious injury. To mitigate this risk, a series of investment plan options were developed for each road. These generally focused on the provision of wider shoulders, safety barriers, pedestrian footpaths and crossings and safer intersections. The most comprehensive of the plans identified the potential to reduce deaths and serious injuries by 36% on the N2 and by 44% on the N3.

Keywords

Bangladesh, iRAP, Road safety, Risk assessment, Countermeasures.

Introduction

Although road safety in Australasia has steadily improved in recent decades, the same cannot always be said of the Asia Pacific. It is estimated that around half of the world's deaths – more than 3500 each day – occur in the region [1]. Without preventative measures, the number is projected to increase by 144% in South Asia and 80% in East Asia and the Pacific between 2000 and 2020 [2].

One country that is facing a considerable road safety challenge is Bangladesh, where as many as 55 people are killed in traffic crashes daily. Like many low-income countries, vulnerable road users (including pedestrians, motorcyclists and bicyclists) account for a large proportion of road deaths. It is estimated that pedestrians account for more than half (54%) of all reported road deaths in Bangladesh [1].

The challenge of catering for a vast mix of road users in a country that has little more than half the land area of Victoria, Australia, a population of 160 million and an economy that is growing at 6% to 7% per annum, is evident in the results of recent iRAP assessments [3]. The iRAP Bangladesh Pilot Project was initiated by the FIA Foundation for the Automobile and Society as means of supporting the Roads and Highways Department (RHD), Bangladesh University of Engineering and Technology (BUET), BRAC (formerly the Bangladesh Rural Advancement Committee), the Centre for Injury Prevention Research Bangladesh (CIPRB) and Chevron in their road safety efforts.

The project involved an assessment of risk on National Highway 2 (N2), which connects the capital of Bangladesh, Dhaka, with Sylhet, and National Highway 3 (N3), which connects Joyedpur and Mymensingh. These are two of Bangladesh's busiest highways, carrying between 10,000 and 85,000 motorised vehicles per day (vpd) , as well as catering for significant numbers of pedestrians, bicyclists and other non-motorised vehicles (see Figure 1) [4].

Figure 1. High pedestrian movements on the N3 at Joyedpur

According to data provided by BUET, 180 people and 89 people were killed in traffic crashes on the N2 and N3, respectively, in 2008. Compared to Australasian roads, these figures are enormous; the death rate on the N2 (0.6 deaths per km) is ten times higher than that of the Pacific Highway in NSW, Australia (0.06 deaths per km) [5]. However, there is evidence to suggest that these numbers are understated. The World Health Organization (WHO) estimates that the total number of deaths in Bangladesh is 20,038, which is almost five times higher than official figures [1]. Similarly, following a survey of more than 80,000 households, Transport Research Laboratories (TRL) concluded that actual number of deaths is four times the number officially reported by police, and the actual number of serious injuries 75 times greater [6].

Observations during the iRAP road inspections also revealed the enormity of the road safety challenge. School children, factory workers, farmers and people visiting markets all vie for limited road space with faster moving trucks, buses and cars. At numerous locations, hundreds of people spill out of textile factories onto the highways at the end of their shifts. There are no footpaths, no pedestrian crossings and inadequate space for buses. At times it's like watching traffic race through a pedestrian mall.

This paper provides an overview of the iRAP project. It includes an explanation of the iRAP approach to assessing risk and proposing countermeasures, and provides a summary of key results. The approach described in this paper is typical of iRAP's globally consistent approach to projects, which are now underway in countries in every region of the world. In the Asia Pacific region, iRAP projects are underway in Australia (led by AusRAP), Bangladesh, India, South Korea, New Zealand (led by KiwiRAP), Indonesia, China, Malaysia, Singapore and the Philippines.

About the N2 and N3

In its current form, the 229km-long N2 is a relatively new highway, with major rehabilitation and widening completed as recently as 2005 at a cost of US$150 million with financing from the World Bank [7]. The improvements included:

- rehabilitation or widening of about 154km of existing highway;
- construction of a new alignment (Auskandi-Jagadishpur section) with a length of 69km
- a new toll road section
- 38 bridges, two vehicle underpasses and three pedestrian underpasses
- provision of 18.5km of service roads on some sections of the road for local low-speed traffic.

The Government of Bangladesh has plans to significantly upgrade the 90km-long N3, beginning early in 2011. These works precede the potential construction of a new airport along the route. The planned improvements include:

- six-lane dual carriageway between Tongi and Joyedpur
- four-lane dual carriageway between Joyedpur and Mawna
- standard two-lane single carriageway between Mawna and just south of Mymensingh
- four-lane dual carriageway at Mymensingh
- standard median and service road at significant bazaars.

Road inspections and coding

Road inspection data for the N2 and N3 was collected by Indian Road Survey and Management (IRSM) with the support of ARRB Group in March 2010, using a vehicle specially equipped with digital cameras to record panoramic images of the road and roadsides and location data as it travelled at highway speed. The images were calibrated to enable on-screen measurements of the road features, and the system enabled automated measurement of horizontal curvature and vertical grades.

Representatives from RHD and BUET had the opportunity to participate in the inspections, which were completed over three days (see Figure 2). In addition to the formal inspections, further site visits were undertaken separately during the project to help ensure the subsequent risk analysis properly reflected local conditions.

After the inspection data was collected, an iRAP expert rater based in Germany used the ARRB 'Hawkeye Processing Toolkit' to review the images and 'code' attributes for each 100-metre section of road. A complete list of the attributes that are recorded in iRAP projects is provided in Table 1.

Figure 2. The inspection vehicle and participants in the inspections

Risk assessment

Following the inspections and coding of the road infrastructure attributes, a Road Protection Score (RPS) was calculated for each 100-metre section using iRAP's online software (which is made freely available to project partners). A separate RPS is calculated for car occupants, motorcyclists, pedestrians and bicyclists. The RPS forms the basis for generating the Star Ratings (and, in turn, Safer Roads Investment Plans).

The approach taken was consistent with the methodology described in *Safer Roads Investment Plans: The iRAP methodology* (which is available at http://irap.org/media/9573/irap504.04_star_rating_roads_for_safety.pdf) [8].

The RPS is based on a series of risk factors that relate road infrastructure with the relative likelihood of crashes and their severity. An example of such research is shown in Figure 3, which plots crash rates versus horizontal curvature [9]. It shows that the relative risk between a road segment with a very sharp curve (radius less than 100 metres) and one with a very mild, or no curve, is approximately 5.5. At the radius range of 100-200 metres, where the greatest number of crashes was observed, the risk ratio is 3.5. This finding is supported by published literature (see, for example, [10]). Notably, the RPS is independent of traffic volumes and actual crash rates on the road being assessed. These factors are taken into account later, in the Safer Roads Investment Plan stage.

Figure 4 shows the underlying level of risk (RPS) for car occupants for each 100-metre section of the N2 (the higher the score, the greater the risk). It also illustrates the Star Ratings along the road, whereby 5-star (green) roads are the safest while 1-star (black) roads are the least safe. It illustrates the variation in risk as the vehicle travels along the road (from Dhaka to Sylhet). Although some very short sections of road (which are typically new bridges built with roadside and median safety barriers) score in the 4- and 5-star range, the majority of the risk line is within the 2-star category. This is concerning, given that as recently as 2005, major upgrades had been made to this road.

Table 1. Road attributes recorded by iRAP

Road attribute	Road user types affected: Car occupants	Motorcyclists	Pedestrians	Bicyclists
Bicycle facilities				•
Delineation	•	•		•
Intersection road volume level	•	•		•
Intersection type[a]	•	•		•
Lane width	•	•		•
Median type[b]	•	•	•	•
Minor access point density	•	•		•
Number of lanes	•	•	•	•
Passing demand	•	•		
Paved shoulder width	•	•		•
Pedestrian crossing facilities [c]			•	•
Quality of crossing[d]			•	•
Quality of curved	•	•		•
Quality of intersection[d]	•	•		•
Radius of curvature	•	•		•
Pavement condition	•	•		•
Roadside design /obstacles[e]	•	•		•
Shoulder rumble strips	•	•		
Side friction/ roadside activities			•	•
Sidewalk provision			•	
Speed[f]	•	•	•	•

[a] Intersection types includes 3-leg, 4-leg, roundabout, grade separation, railway, median crossing, provision of turning lanes and signalisation.

[b] Median type includes centerlines (no median), centerline rumble strips, two-way left-turn lanes, and various width of raised, depressed or flush medians with and without barriers.

[c] Pedestrian facilities include unsignalised and signalised crossings, median refuges and grade separation.

[d] The quality of crossing, curve and intersection includes consideration of pavement markings, advance signing, advisory speed limits and sight distance.

[e] Roadside design/obstacles includes non-frangible objects such as trees and poles, drains, embankments, cuts, cliffs and the distance of objects from the side of the road.

[f] Speed is currently based on speed limit; consideration of measured operating speeds is a planned enhancement.

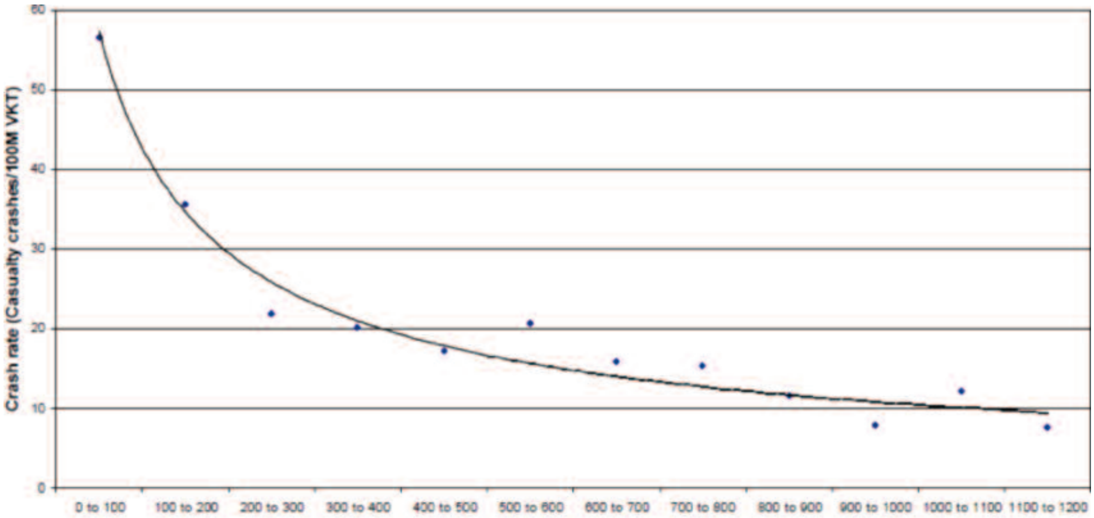

Figure 3. Casualty crash rates and curve radius [8]

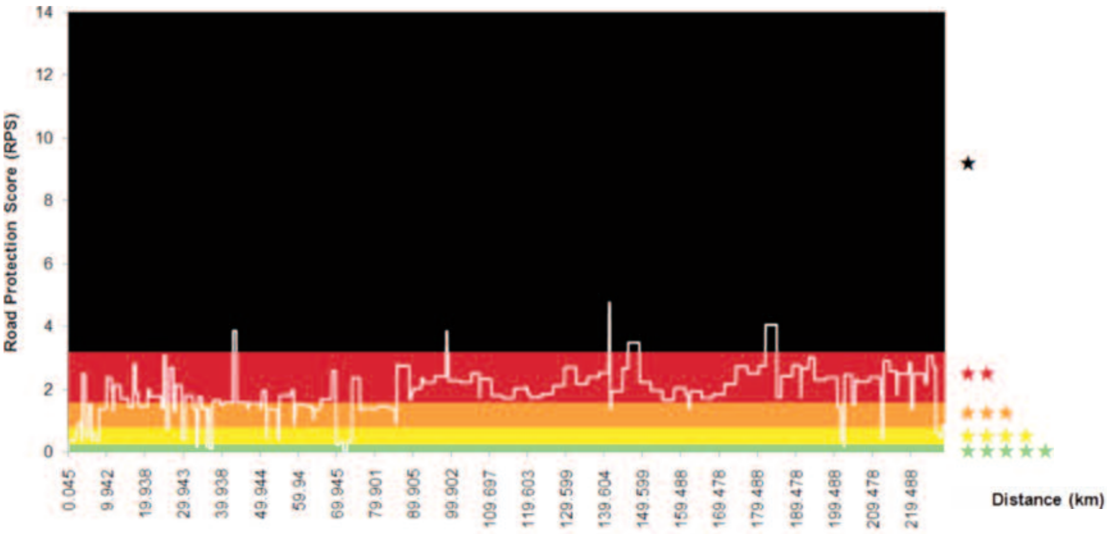

Figure 4. Road Protection Scores for car occupants, N2

Table 2 provides a summary of the Star Ratings for each of the roads by road user type. The majority of the N2 and N3 are rated 2 stars or less (out of a possible 5 stars) for all road users. It is noted that Star Ratings are not assigned to roads where there is very low use by that type of road user. For example, if no bicyclists use a section of road, then a bicyclist Star Rating is not assigned to it.

Figures 5 and 6 show examples of sections of roads, their Star Ratings and the road attributes that influenced the Star Rating (green-coloured attributes are associated with a relatively reduced level of risk; yellow-coloured attributes are associated with a relatively moderate level of risk; and red-coloured attributes are associated with an relatively increased level of risk). Some of the factors driving the relatively poor Star Ratings are as follows:

- High pedestrian flows along and across the roads and poor provision of footpaths and crossings mean the risk of serious pedestrian crashes occurrng is high (see Figure 5). More than 90% of the N2 and N3 do not have footpaths in place, and the average distance between zebra crossings is 9km. (It may also be argued that zebra crossings are inappropriate for roads carrying this volume of traffic.)
- High overtaking demand (caused by large speed differentials between vehicles) and very little median separation (96% of the N2 is undivided and 98% of the N3 is undivided) contribute to a high risk of serious head-on crashes (see, for example, Figures 6 and 7)
- 97% of roadsides on the N2 and all roadsides on the N3 are coded as severe, having fixed objects or steep embankments within 10 metres of the pavement. This increases the risk that a 'run off road' crash will result in severe injuries
- Poor quality, at-grade intersections are frequent (on average 1 every 1.6km). This increases the likelihood of severe intersection crashes occurring.

Overarching these factors is the speed limit, which is set at 80km/h along most of the roads. Based on research reported by the OECD, the risk of death and serious injury in most crashes is very high at this speed [11].

Table 2. Overall Star Ratings for the N2 and N3

	Vehicle occupants		Motorcyclists		Bicyclists		Pedestrians	
	Length (km)	%	Length (km)	%	Length (km)	%	Length (km)	%
Highway N2								
5 stars	2	1%	1	0%	0	0%	0	0%
4 stars	14	6%	11	5%	2	1%	0	0%
3 stars	45	20%	7	3%	4	2%	4	2%
2 stars	160	70%	147	64%	213	93%	225	98%
1 star	8	3%	63	28%	5	2%	0	0%
Not rated	0	0%	0	0%	5	2%	0	0%
Total	229	100%	229	100%	229	100%	229	100%
Highway N3								
5 stars	0	0%	0	0%	0	0%	0	0%
4 stars	6	7%	6	6%	0	0%	0	0%
3 stars	13	15%	1	1%	2	2%	2	2%
2 stars	60	67%	47	53%	49	55%	88	98%
1 star	10	12%	36	41%	38	43%	0	0%
Not rated	0	0%	0	0%	0	0%	0	0%
Total	90	100%	90	100%	90	100%	90	100%

Note: Percentages may not add to 100% due to rounding.

Figure 5. A section of Highway N2 rated 2 stars for pedestrians

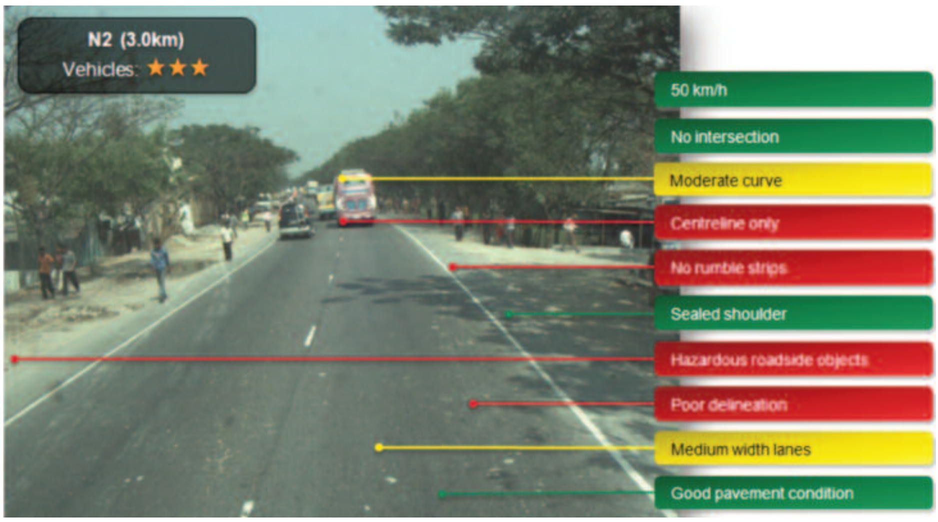

Figure 6. A section of Highway N2 rated 3 stars for car occupants

Figure 7. The result of a head-on crash between two trucks on the N2, which occurred during the inspections

Safer Roads Investment Plan methodology

The purpose of a Safer Roads Investment Plan is to provide an appreciation of the types of countermeasures that could affordably and economically reduce risk – and therefore prevent deaths and serious injuries. To do this, iRAP considers the suitability of various countermeasures from a list of 70 countermeasures, ranging from low-cost road markings and pedestrian refuges to higher-cost intersection upgrades and full highway duplication (more information on the countermeasures in the iRAP list is available in the Road Safety Toolkit (http://toolkit.irap.org) [12]).

The process used to generate Safer Roads Investment Plans in the Bangladesh project was consistent with the approach described in the paper titled *Safer Roads Investment Plans: The iRAP methodology* (available for download at http://irap.org/ media/10503/ irap504.05_safer_roads_investment_plans.pdf [13]). In general terms three steps were taken, as summarised below.

Estimating the number of deaths and serious injuries on road sections

To enable economic evaluation of various countermeasure options, an estimate of the number of deaths and serious injuries under existing conditions on each 100-metre section of road was made. As discussed previously, 180 people and 89 people were killed in traffic crashes on the N2 and N3, respectively, in 2008. However, there is strong evidence that many deaths are likely to have been under-reported. As a result, the reported numbers of deaths were scaled up by a factor of four, which is consistent with WHO and TRL reports, and advice provided by BUET and the RHD [1, 6].

Since the number of deaths was available only in aggregate form (that is, for the entire length of each road), the deaths needed to be distributed among the 100-metre sections of road. The number distributed to each section was a function of the product of each section's Road Protection Score (RPS) and exposure (in the case of car occupants, exposure is measured as the annual average daily traffic). Hence, it is feasible that a road with a 1-star rating (indicating high risk) can still experience very few deaths if its traffic volume is low, and the reverse is also true.

An estimate of the number of serious injuries on each section was then made by assuming that for each death, 10 serious injuries occur. This approach is based on research by McMahon and Dahdah (2008) [14].

Selecting countermeasures

For each 100-metre section of road, a series of countermeasures that feasibly could be implemented were identified. This was achieved by considering the ability of each countermeasure to reduce risk (as measured by the RPS) and 'application' and 'hierarchy' rules. For example, a section of road that has a poor pedestrian RPS and high pedestrian activity was likely to benefit from the installation of a pedestrian refuge, pedestrian crossing or signalised pedestrian crossing. Similarly, a section of road with poor delineation and a high car occupant RPS was likely to benefit from better delineation.

'Application' rules were used to help ensure that the countermeasures identified align with reasonable engineering practice. For example:

- Grade-separated pedestrian crossings should be at least one kilometre apart. Hence, a grade-separated crossing was not considered feasible if one had already been identified for the previous 100-metre section.
- New signalised pedestrian crossings (non-intersection facilities) should be at least 600 metres apart.
- Additional lanes (such as overtaking lanes or 2+1 cross section) should be required for a minimum length of one kilometre.

'Hierarchy' rules were used to ensure that more comprehensive countermeasures took precedence over less effective countermeasures. For example:

- If a grade-separated pedestrian facility was feasible, then it took precedence over other pedestrian measures (such as a pedestrian refuge or signalised crossing)

Table 3. Overview of investment plan options for the N2

	Plan N2-1	Plan N2-2	Plan N2-3
Investment	Tk 7,500 million	Tk 3,400 million	Tk 1,300 million
Deaths and serious injuries prevented (20 years)	31,330	22,950	14,370
Economic benefit (20 years)	Tk 29,400 million	Tk 21,600 million	Tk 13,500 million
Cost per death and serious injury prevented	Tk 240,000	Tk 150,000	Tk 90,000
Benefit cost ratio	4	6	10
Reduction in deaths and serious injuries	36%	26%	17%

Note: 1 USD = Tk 69.60 (29 August 2010)

Table 4. Overview of investment plan options for the N3

	Plan N3-1	Plan N3-2	Plan N3-3
Investment	Tk 3,800 million	Tk 2,300 million	Tk 1,400 million
Deaths and serious injuries prevented (20 years)	22,460	19,250	15,760
Economic benefit (20 years)	Tk 21,100 million	Tk 18,100 million	Tk 14,800 million
Cost per death and serious injury prevented	Tk 170,000	Tk 120,000	Tk 90,000
Benefit cost ratio	6	8	11
Reduction in deaths and serious injuries	44%	38%	31%

Note: 1 USD = Tk 69.60 (29 August 2010)

- If a horizontal realignment was feasible, then redundant countermeasures were not considered (for example, curve delineation and shoulder widening)
- If a segregated motorcycle lane was feasible, then other motorcycle lanes (such as an on-road motorcycle lane) were removed from the plan.

Economic analysis

Each countermeasure option identified was then subject to a benefit cost ratio (BCR) analysis. Countermeasures that failed to achieve a BCR of at least 1 were excluded from the analysis. However, higher BCR thresholds were also used to develop less expensive plans.

The benefit of a countermeasure was determined by calculating the net present value of deaths and serious injuries that would be avoided over 20 years if the countermeasure was installed (a discount rate of 7% was used). The reduction in deaths and serious injuries was determined by replacing the RPS used in the original estimate (made in the process of distributing deaths among 100-metre sections of road) with a new, lower RPS.

For the purposes of this project, the economic value of a death and a serious injury was determined by following guidance from McMahon and Dahdah (2008) [14]:

- economic cost of a death = 100 x Gross Domestic Product (GDP) per capita (current price) = Tk 4.34 million (USD $62,400)
- economic cost of a serious injury = 0.25 x economic cost of a death = Tk 1.09 million (USD $15,600).

The cost of a countermeasure was determined by estimating the net present cost of installing and maintaining each countermeasure over 20 years. These costs were estimated in consultation with the RHD.

Proposed countermeasures

Three investment plan options were generated for each highway, based on benefit cost ratio thresholds of 1, 3 and 5. The investment plan analyses were performed using iRAP's online software. The purpose of providing a series of investment plans was to enable the government (and development banks) to select a program of works that is both affordable within budget constraints and economically viable.

Tables 3 and 4 summarise the results of the Safer Road Investment Plan analysis for the N2 and N3. As just one example, Plan N2-1 (based on a BCR threshold of 1) identifies an investment of Tk 7.5 billion ($105 million). It is estimated that this could prevent 31,330 deaths and serious injuries over 20 years (36% reduction) and generated a BCR of 4:1.

Table 5 lists countermeasures types proposed in Plan N2-1 and Table 6 lists countermeasure types proposed in Plan N3-1. For each countermeasure type, the tables also summarise:

- the length or number of sites to be treated
- the number of 'KSI saved' (KSI is killed and seriously injured)
- the economic benefit (based on the net present value of the reduction in the cost of deaths and serious injuries)
- the net present cost of the countermeasure
- the cost per KSI saved
- the benefit cost ratio.

Table 5. Overview of countermeasures for Plan N2-1 (costs and benefits over 20 years)

Countermeasure type	Length / Sites	KSI saved	Economic benefit (Tk million)	Cost (Tk million)	Cost per KSI saved ('000 Tk)	BCR
Duplication	90 km	14610	13700	4100	280	3
Roadside safety - barriers	320 km	5060	4800	1300	260	4
Pedestrian crossing	180 sites	3740	3500	400	90	10
Intersection - grade separation	9 sites	1940	1800	500	260	4
Pedestrian footpath	130 km	1630	1500	400	260	4
Roadside safety - hazard removal	70 km	1070	1000	200	190	5
Intersection - roundabout	7 sites	960	900	20	20	59
Additional lane	30 km	740	700	500	660	1
Shoulder widening	5 km	560	500	20	40	26
Delineation	30 km	320	300	30	30	9
Intersection - signalise	4 sites	240	200	10	40	22
Rumble strip / flexi-post	2 km	180	200	2	5	109
Central hatching	5 km	140	100	3	10	47
Lane widening	2 km	60	60	30	290	2
Median barrier	1 km	40	40	5	70	8
Bicycle facilities	2 km	10	10	4	370	3
Central turning lane full length	1 km	10	9	8	510	1
Traffic calming	1 km	10	7	1	40	14
Regulate roadside commercial activity	1 km	10	7	1	120	5
Total		31330	29400	7500	240	4

Note: 1 USD = Tk 69.60 (29 August 2010)

KSI = Killed and seriously injured

Table 6. Overview of countermeasures for Plan N3-1 (costs and benefits over 20 years)

Countermeasure type	Length / Sites	KSI saved	Economic benefit (Tk million)	Cost (Tk million)	Cost per KSI saved ('000 Tk)	BCR
Duplication	40 km	8390	7900	1700	210	5
Shoulder widening	60 km	3400	3200	200	60	16
Roadside safety - barriers	170 km	3390	3200	700	210	4
Pedestrian crossing	100 sites	2610	2400	200	70	13
Pedestrian footpath	70 km	2250	2100	300	120	8
Additional lane	20 km	690	600	300	420	2
Lane widening	20 km	510	500	100	170	3
Delineation	40 km	510	500	30	20	14
Intersection - grade separation	3 sites	240	200	200	690	1
Intersection - roundabout	4 sites	200	200	10	50	18
Intersection - signalise	3 sites	100	90	9	90	10
Bicycle facilities	30 km	80	70	30	330	3
Regulate roadside commercial activity	1 km	40	40	2	30	20
Parking improvements	1 km	30	30	2	30	20
Roadside safety - hazard removal	1 km	20	20	2	130	7
Total		22460	21100	3800	170	6

Note: 1 USD = Tk 69.60 (29 August 2010)

KSI = Killed and seriously injured

As can be deduced from Tables 5 and 6, the countermeasures proposed in the plans focus on:

- reducing the likelihood and severity of 'run off road' and head-on crashes by widening shoulders, installing roadside safety barriers and median barriers
- reducing the likelihood and severity of pedestrian crashes by installing crossing facilities and footpaths
- reducing risk at intersections through grade separation, roundabouts and traffic signals.

Because the Safer Road Investment Plan analyses are based on 100-metre sections of road, it is possible to provide local engineers with a detailed listing of the countermeasures for each section along the road. This aids in reviews of the appropriateness of the countermeasure and detailed design. The engineers are also able to make use of interactive maps within the iRAP software that plot the exact location of proposed countermeasures. The iRAP plans are supplemented by the Road Safety Toolkit (http://toolkit.irap.org), which provides additional information on what is meant by each countermeasure, typical benefits and implementation issues.

Safe System approach

Although the plans summarised in the previous section identify opportunities to significantly reduce deaths and serious injuries, in order to make the N2 and N3 truly safe, efforts that go beyond engineering improvements alone will be necessary. Bangladesh is one of many countries in which fundamental road-safety education and enforcement (seatbelts, helmets, drink-driving and general adherence to traffic law) are not in place. As a result, the benefit of some infrastructure improvements may be compromised because they are not used as they are intended. For example, pedestrian overpasses are only effective if pedestrians use them. Nonetheless, basic infrastructure, such as clear signs and road markings, will be essential if road users are to know what they are expected to do and if traffic law is to be effectively enforced.

Near the completion of the N2 upgrades in 2005, BRAC reported on a survey of people living along and using the road, which emphasises this point. BRAC concluded that local communities need to have the opportunity both to contribute to road designs and to understand the intended use of various road design features, if roads are to be used safety [15]. The implementation of any countermeasures proposed by iRAP needs to take this into account.

Given Bangladesh's situation, significant benefits could also be realised through coordinated targeting of risk factors for road users (such as speed, seatbelt wearing and alcohol) and vehicles. This would be consistent with taking a Safe System approach to the program. The Road Safety Toolkit and United Nations Road Safety Collaboration Good Practice Manuals provide further information on this issue [16].

Conclusion

The iRAP Bangladesh Pilot Project provided the first comprehensive infrastructure risk assessment of the N2 and N3 Highways. The assessment showed that despite recent large-scale upgrades to the N2, road users still face a high level of risk. The N3 is also categorised as high risk for all road users.

The project identified a range of economically viable countermeasures that have the potential to prevent thousands of deaths and serious injuries. These include wider shoulders and safety barriers to reduce 'run off road' and head-on crash risk, footpaths and pedestrian crossings to reduce risk of severe pedestrian crashes, and roundabout and traffic signals to reduce the incidence of serious intersection crashes. The most comprehensive of the plans identified the potential to reduce deaths and serious injuries by 36% on the N2 and by 44% on the N3.

The results of the project provide the Government of Bangladesh with a means of planning infrastructure safety improvements and negotiating support from the development banks. The plans also provide a basis for setting infrastructure safety performance indicators and associated targets for the roads. For example, it is now possible to monitor and aim to decrease the percentage of travel on roads that have high risk of death or serious injury due to head-on crashes (car occupants and motorcycles).

Overall, the pilot project demonstrated that the iRAP approach to risk assessment is able to be applied in Bangladesh, as it has been in numerous countries around the world. With the Government's demonstrated commitment to road safety, and with the support of local road safety organisations and the regional development banks, it is hoped that significant gains can be made during the Decade of Action for Road Safety.

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Literature Review

Emergency lane deaths

Twenty-nine people died in emergency lane collisions over the last 10 years, and 12 more cases are being investigated by a coroner, according to data released by the National Coroners Information System (NCIS) located at the Victorian Institute of Forensic Medicine. Almost 80% of the emergency lane deaths involved males and 70% were aged between 20-49 years. Heavy trucks were the most common counterpart vehicle.

Based on these data the Director of NCIS, Professor Joan Ozanne-Smith, is encouraging motorists to stay well clear of their vehicle following a breakdown, if it is safe to do so. 'The most common scenario is people being killed while parked in the emergency lane or being too close to the car,' Professor Ozanne-Smith said. She recommended that if motorists had to stay inside their stationary vehicle, it was imperative to keep their seatbelts firmly fastened.

This advice is confirmed by public motoring authorities, which recommend that motorists leave a stationary vehicle through the passenger-side door and wait for assistance as far away from traffic as possible. They also discourage motorists from working on their vehicle in the emergency lane, particularly on the traffic side.

The NCIS Fact Sheet, *Deaths in emergency lanes,* is available at http://www.ncis.org.au/web_pages/FACT-SHEET%20-%20Deaths%20in%20emergency%20lanes%20-%20final.pdf

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Raftery SJ, Wundersitz LN. *The efficacy of road safety education in schools: A review of current approaches.* CASR077. March 2011

This report provides an overview of current road safety education (RSE) programs for school students that are currently in use in Australia and overseas, with the primary aims of commenting on the effectiveness of current approaches and identifying any gaps in the provision of RSE. The report includes only RSE programs that have been evaluated or that are comparable with similar evaluated programs. RSE programs were categorised according to the five primary strategies adopted: indirect or holistic approaches, one-time interventions, driver training, curriculum-based, and multi-modal approaches. The lack of well-designed evaluations makes commenting on the short- and long-term efficacy of RSE programs problematic; however, the report makes use of evidence from a variety of sources to facilitate an informed discussion.

The effectiveness of current road safety educational programs remains largely undetermined as there is little evidence showing that RSE either does or does not work, although programs addressing the general causes of risk-taking behaviour are