CHAPTER 2: SCALE AND SEVERITY OF RAILWAY LEVEL CROSSING ACCIDENT PROBLEM IN SELECTED COUNTRIES OF THE REGION

2.1 General

This chapter surveys the level crossing safety problem in relation to the overall railway safety problem in certain countries of the Asia-Pacific region. The countries for which level crossing safety data were obtained are : Bangladesh, India, Islamic Republic of Iran, Philippines, Russian Federation, Thailand, and Viet Nam. Detailed data were requested and obtained from India, the Islamic Republic of Iran, the Russian Federation and Viet Nam while the data requested and obtained from Bangladesh, Philippines and Thailand were of a more general nature.

Major factors included in the analysis for individual countries include:

(i) *Level crossing safety record* – trend details for absolute numbers and rates per million train-km of level crossing accidents, fatalities, injuries and (where possible) property damage;

(ii) *Level crossing characteristics and effectiveness* – details and effectiveness of the types of level crossings and level crossing protection systems in operation, and planned for future operation;

(iii) *Administration of railway safety regulations* – responsibility for enforcement of safety (including level crossing safety) regulations and for investigation of accidents;

(iv) *Techniques used for evaluation of level crossing safety improvements* – technical and financial (including quantified risk analysis, where applicable);

(v) *Initiatives taken for level crossing safety improvement in recent years* – technical and non-technical (including pedestrian/motor vehicle driver education); and

(vi) *Impediments to safety improvement at level crossings.*

2.2 Level Crossing Safety in India

2.2.1 Summary

The Indian Railway network with a route length of 62,495 km has a total of 40,445 level crossings, or an average of one every 1.5 kilometres. Of this total, 16,132 crossings are manned with some form of barrier protection facing road users, 20,528 are open crossings with fixed road warning signs, 948 are road crossings adjacent to canals without barrier protection, but with road warning signs, and 2,837 are simple open crossings with neither barrier protection nor fixed road warning signs.

In 1997/98, level crossing accidents constituted 65 out of a total of 420 accidents (or 15 per cent) of all types on the Indian Railway network. However, in the same year, level crossing accidents accounted for 42 per cent (134 individuals) of all fatalities and 18 per cent (179 individuals) of all persons injured in railway accidents on the network.

In one year surveyed, 80 per cent of all level crossing accidents occurred at crossings which were unmanned.

Indian Railways have recently had a shift in their policy regarding level crossing to the effect that the decision has been taken to go for manning a large number of unmanned gates with a high level of usage by road and/or rail and not to construct any more crossings for unmanned operation. Subject to the availability of funds, level crossings which have reached a traffic moment (train movements x motor vehicle movements) of 100,000 per day or more are being replaced by the construction of road over or under-passes. However, these are very costly and only 50 per cent of the cost of their construction is being funded directly by the state government road authorities.

While the Indian Railways have contributed to motor vehicle driver and pedestrian education programmes, it is clear that these have had limited impact – perhaps a reflection of a lack of a safety awareness culture in India.

In future it is possible that the Indian Railways will have to embrace a fundamental policy change in relation to level crossing safety – one which might involve provision of automatic barrier and warning light/audible warning protection at some of the 24,313 unprotected crossings throughout India. With this possibility in view, the Indian Railways are pilot-testing train actuated barrier and road user warning systems for such applications.

2.2.2 Level crossing safety record

(a) Accidents

Level crossing accidents comprise a small but growing proportion of all railway accidents in India. In the last year for which data were available (1997/98) the total number of railway accidents in India was 420 and the number of recorded accidents at level crossings 65. The trend in level crossing accidents as a proportion of all railway accidents is shown in Table 2.1.

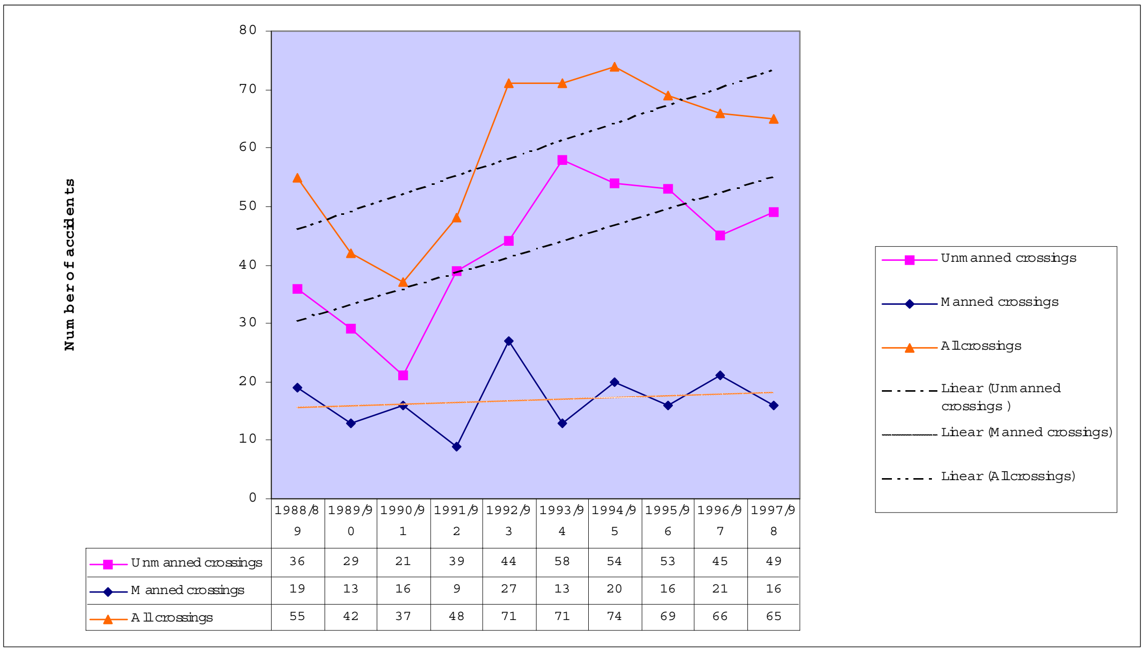
Table 2.1: Significance of and trend in level crossing accidents in India

Year	Total railway accidents (No.)	Accidents at level crossings (No.)	Level crossing accident %
1988-89	545	55	10.1
1989-90	541	42	7.8
1990-91	532	37	7.0
1991-92	742	48	6.5
1992-93	746	71	9.5
1993-94	675	71	10.5
1994-95	604	74	12.3
1995-96	440	69	15.7
1996-97	426	66	15.5
1997-98	420	65	15.5

Source: Indian Railways Country Paper.

Nearly two thirds of the total number of level crossing accidents occur at *unmanned* level crossings and this proportion has been increasing over the past decade as is shown in Figure 2.1.

Figure 2.1: Level crossing accidents in India, by type of crossing



	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
Unmanned crossings	36	29	21	39	44	58	54	53	45	49
Manned crossings	19	13	16	9	27	13	20	16	21	16
All crossings	55	42	37	48	71	71	74	69	66	65

Source: Indian Railways Country Paper.

(b) Fatalities

In 1996/97, fatalities in level crossing accidents comprised nearly 63 per cent of all fatalities in railway accidents in India, as is shown in Table 2.2. Although the share of level crossing deaths in all railway fatalities declined significantly in the following year (1997/98), over the decade it has shown a rising trend which is explained in part by increasing train speeds and in part by increasing motorization of rural communities. There is evidence to suggest that a majority of level crossing fatalities occur at unmanned (and therefore unprotected) level crossings in rural locations and involve slow moving farm vehicles driven by inexperienced drivers. There also appears to be a high number of accidents involving buses, *which would explain why the relatively low incidence of level crossing accidents results in a disproportionately high number of fatalities.*

Table 2.2: Significance of and trend in level crossing fatalities in India

Year	Total fatalities in railway accidents (No.)	Fatalities in level crossing accidents (No.)	Level crossing fatality %
1988-89	231	52	22.5
1989-90	239	51	21.3
1990-91	322	75	23.3
1991-92	235	104	44.3
1992-93	282	116	41.1
1993-94	369	168	45.5
1994-95	296	187	62.8
1995-96	589	138	23.4
1996-97	353	221	62.6
1997-98	316	134	42.4

Source: Indian Railways Country Paper.

(c) Injuries

With the exception of three years (1991/92, 1993/94 and 1996/97), over the past decade level crossing injuries have comprised a relatively constant proportion (about 20 per cent) of all injuries in railway accidents in India.

Table 2.3: Significance of and trend in level crossing injuries in India

Year	Total injuries in railway accidents (No.)	Injuries in level crossing accidents (No.)	Level crossing injury %
1988/89	736	134	18.2
1989/90	992	192	19.4
1990/91	888	175	19.7
1991/92	896	302	33.7
1992/93	908	222	24.4
1993/94	906	312	34.4
1994/95	676	159	23.5
1995/96	934	191	20.4
1996/97	610	264	43.3
1997/98	977	179	18.3

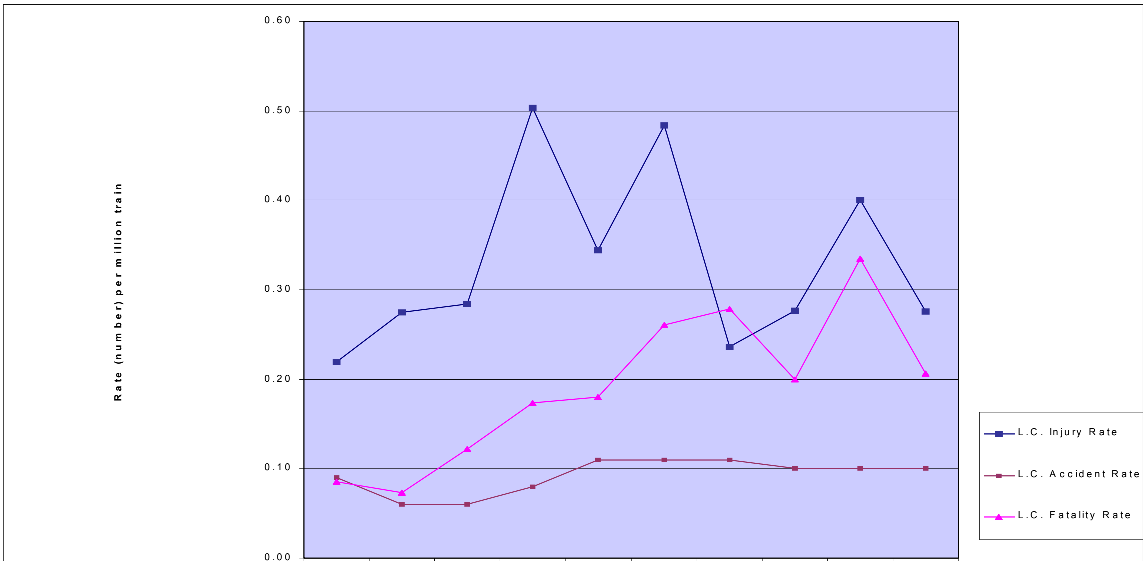
Source: Indian Railways Country Paper.

(d) Accident, Fatality and Injury Rates

In common with all types of railway accidents, accidents at level crossings and the deaths and injuries they cause can be expressed in terms of a rate per unit of railway traffic. The railway traffic unit most commonly used for this purpose is the train kilometre (expressed in terms of million train kilometres on a system-wide basis). This unit is also a measure of *risk exposure* for motor vehicles using level crossings.

Figure 2.2 shows the level crossing accident, fatality and injury rates for India during the past decade. These indicate stability in the accident and injury rates which in the case of the former remained almost constant at 0.10 per million train kilometres and in the case of the latter fluctuated around a long term rate of 0.35 per million train kilometres. By contrast, the level crossing fatality rate rose sharply, from 0.10 per million train kilometres in 1988/89 to more than 0.30 per million train kilometres in 1996/97, before dropping to 0.20 per million train kilometres in 1997/98. The factors mentioned in sub-section (b) above are mostly responsible for the rising trend in level crossing fatalities.

Figure 2.2: Level crossing accident, fatality and injury rates in India



	1988/89	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
L.C. Injury Rate	0.22	0.27	0.28	0.50	0.34	0.48	0.24	0.28	0.40	0.28
L.C. Accident Rate	0.09	0.06	0.06	0.08	0.11	0.11	0.11	0.10	0.10	0.10
L.C. Fatality Rate	0.09	0.07	0.12	0.17	0.18	0.26	0.28	0.20	0.33	0.21

Source: Indian Railways Country Paper.

2.2.3 Level crossing characteristics and effectiveness

(a) General characteristics

The Indian Railways network contains the greatest number of level crossings of any railway system in Asia. In general, the IR network has five different types of level crossings, these being: a manually controlled full width lifting barrier type; a mechanical full width swinging barrier type; a fixed warning sign without barrier type; an open type crossing, without barriers or warning signs; and a cattle crossing. The population of level crossings by type on the IR network is given in Table 2.4.

Table 2.4: Level crossings on the Indian Railways network, by type

Class of L.C.	***Type of L.C.***	***No on system***	***Brief description***
Manned	Special	296	Manually controlled full width lifting barrier. All crossings in category are signalled. Road regularly open. Carries road of minimum 7.5 metre width.
	A	1,406	Manually controlled full width lifting barrier. All crossings in category are signalled. Road regularly open. Carries road of minimum 5.5 metre width.
	B	3,858	Manually controlled full width lifting barrier/ mechanical full width swinging barrier. 1,918 crossings in category (50%) are signalled. Road regularly closed.
	C	10,509	Manually controlled full width lifting barrier/ mechanical full width swinging barrier. 1,879 crossings in category (18%) are signalled. Road regularly closed.
	Canal	63	Mechanical full width swinging barrier. Road regularly closed.
	Sub-total, manned	*16,132*	
Unmanned	C	20	Warning signal. Open crossing without barrier.
		20,508	Open crossing without barrier.
	Canal	948	Open crossing without barrier.
	D	2,837	Open crossing without barrier and without check rails (cattle crossing).
	Sub-total, unmanned	*24,313*	
Total		***40,445***	

Source: Indian Railways Country Paper.

Special, Class A and Class B level crossings essentially have the same type of equipment but are distinguishable from one another in terms of the types of roads they carry as well as their daily road and rail traffic density. Thus, Special Class crossings which mostly carry roads of National Highway standard are equipped with wider barriers than are Class A crossings, while Class A crossings will require wider barriers than Class B crossings, and so on. The top three categories, representing nearly 40 per cent of all level crossings on the IR system, have barriers which are fully interlocked with wayside signals. Normally, warning to train drivers of the need to stop before a Special-B Class level crossing is provided via distant signals placed at an interval of 1 kilometre from the crossing. A second distant signal is placed at a further interval of 1 kilometre from the first if train speeds exceed 120 km per hour. From the train driver's perspective each interlocked level crossing is protected by a "Gate Stop" signal with a black "G" on a yellow disc. When a level crossing becomes obstructed, the gatekeeper is required to protect the gate with detonator signals. A problem which exists throughout the IR system is that detonators (which have a lifespan of 10 years) are often life-expired and unserviceable.

At non-interlocked, but manned, level crossings warning of the impending arrival of a train is provided by telephone to the crossing keeper by the station master of the nearest station. The crossing keeper will then exchange a private number with the station master to indicate that he has closed the barrier and that the station master may now dispatch the train.

Canal crossings are level crossings provided across canal service roads, used by Irrigation Authorities for inspection and maintenance of canals. The gates across these service roads are operated and locked by Irrigation Authorities who also keep the keys.

Significant features of the level crossing inventory data provided in the Country Paper for India are that the existence of "unofficial" level crossings on the IR system is not acknowledged and that 16,132 out of 40,445 level crossings on the system (or nearly 40 per cent) are manned. This high manning ratio may largely explain why the Indian Railways, at least on the surface, appears to have a relatively good level crossing safety record, although the quality of the data relating to level crossing accidents and casualties has recently been criticized by the Commissioners for Railway Safety and by the Railway Safety Review Committee.[1] During one recent year, some 90 per cent of all level crossing accidents were estimated to have occurred at unmanned, and therefore unprotected, level crossings. This contrasts with the situation in Western Europe where by far the great majority of accidents occur at level crossings equipped with automatic barrier protection (see Chapter 3).

As may be observed in Table 2.5, IR safety statistics indicate that half of all accidents at manned level crossings were caused by "open or improperly closed or secured gates". The other main factors contributing to these accidents were negligence, irresponsibility or incapacity on the part of motor vehicle drivers. In an effort to prevent accidents caused by this factor, IR has adopted a plan to equip 1,063 level crossings with relay interlockings between now and the year 2003.

Table 2.5: Causes of accidents at manned level crossings,1993-94 to 1997-98

No	Causes	93-94	94-95	95-96	96-97	97-98	Total
1	Due to open or improperly closed or secured gates.	8	8	11	9	7	43
2	Road vehicles coming over the level crossings where barriers on the other side had been closed.	2	1	0	2	0	5
3	Road vehicles crashing into the lifting or swing type gates or breaking the lock and opening it.	1	4	5	5	4	19
4	Road vehicles breaking or opening the chains at level crossings closed by chains.	0	1	0	0	1	2
5	Road vehicles left at level crossings or infringing track.	0	0	0	0	0	0
6	Disregard of signals by drivers.	2	4	0	2	4	12
7	Non-issue of caution order to driver when gate telephone is out of order.	0	0	0	0	0	0
8	Other Causes.	0	2	0	3	0	5
Total		13	20	16	21	16	86

Source: Indian Railways Country Paper.

Another unique feature of level crossings on the IR system is that nearly 90 per cent of all protected (i.e. manned) level crossings, comprising those in Classes B and C, are normally closed against road traffic – that is, the barriers are only opened when there is a significant build-up of road traffic and are then closed again when the road traffic build-up is cleared. This procedure is rarely applied in other countries

[1] *Report of the Railway Safety Review Committee 1998,* New Delhi, August 1999.

and may also partly serve to explain the relatively good safety performance of IR level crossings.

A negative feature of level crossing operating procedures on the IR system is that barrier closure time on some level crossings is unusually long. An inspection of level crossings in the Agra area during the ESCAP mission to India in October 1999 revealed that at one "Class A" level crossing the maximum time of closure of the crossing barriers was 8 minutes, with an average of 5 minutes. Such closure times are much longer than those which would normally be tolerated by road users and could well result in barrier breakthroughs by motor vehicles and pedestrians. Excessively long barrier closure times tend to be a feature of the Absolute Blocking and Tablet systems of safe working in that these systems require barriers to be closed immediately after a train's departure from a neighbouring station. By contrast, typical barrier closure times encountered at mainline level crossings in Thailand and in Viet Nam were only of the order of 2 minutes.

The policy of the Indian Railways to replace Absolute Block with Automatic Block Signalling is therefore a major step forward, as for very little additional expense it can be expected to result in significantly shorter level crossing closure times with attendant benefits in terms of increased line capacity and a reduced risk of level crossing accidents and casualties as a result of barrier breakthroughs. The further move towards an ATCS (radio-based Advanced Train Control System) will produce even greater benefits, since it will allow crossing closure times to be adjusted in line with road traffic demand without compromising safety.

(b) Characteristics by zonal railway

The vastness of the country and its railway network has made regional autonomy in the management of this network essential. Consequently, the network is divided into nine operating regions or zones, each one having complete control over all aspects of railway operations on its territory, including safety. The characteristics and effectiveness of the level crossing systems in operation on each zonal railway may be gauged from Table 2.6 below.

It may be observed from this table that accident occurrences are much greater on the Southern Railway than on any other zonal railway, yet the Southern Railway is not significantly disadvantaged in terms of having a higher proportion of unmanned level crossings or a lower proportion of interlocked level crossings than any other zonal railway. The explanation of this difference might lie in the volume and composition of the traffic carried on this railway.

Table 2.6: Level crossing characteristics and performance, by zonal railway

Zonal Railway	No of Level Crossings	Proportion of Interlocked Level Crossings (%)	No. of unmanned Level Crossings	Proportion of unmanned Level Crossings (%)	Accidents at Level Crossings	Accidents at L.C./ 1000 L.C.	Accidents at L.C./1000 unmanned L.C.
Central R.	3,125	19	1,294	41	18	5.76	13.94
Eastern R.	2,264	22	987	43	10	3.06	10.13
Northern R.	6,748	18	3,517	52	75	11.11	21.32
North Eastern R.	4,038	7	2,585	64	42	10.40	16.24
Northeast Frontier R.	1,943	13	1,247	64	11	5.66	8.82
Southern R.	4,484	19	2,290	51	73	16.28	31.88
South Central R.	3,443	17	1,947	57	42	12.20	21.57
South Eastern R.	4,338	14	3,394	78	25	5.76	7.37
Western R.	7,098	10	4,128	58	49	6.90	11.87
Total	37,481*	15	20,389	54	345	9.20	16.92

Source: Indian Railways Country Paper.
* ***Note** that this total does not include cattle crossings (unlike the total shown in Table 2.4).*

2.2.4 Administration of railway safety regulations: role of the CRS

The Indian Railways Act assigns responsibility for any accident occurring at unmanned level crossings to the road user. This is also as per the provisions of the Motor Vehicle Acts issued by the State Governments. IR has traditionally not considered any fundamental policy changes with regard to unmanned level crossings where the density of traffic has been low. Two of the high level Rail Accidents Inquiry Committees, namely, the Kunzru Committee and Wanchoo Committee, have in the years 1962 and 1968 respectively, not recommended any fundamental policy changes and have also not recommended that IR takes over responsibility.

However, a system for independent investigation of railway accident has been adopted in India. This system involves the establishment of an office of Commissioner of Railway Safety (CRS) for each zonal railway. The CRS operates independently of the railway organization and actually reports to the Minister of Civil Aviation.

In essence, the functions of the CRS are similar to those of the Railway Inspectorate of the Health and Safety Executive in the United Kingdom in that the post provides an independent source of inquiry and advice concerning all railway safety matters. The CRS has three main functions, namely:

(i) inspection and operational certification of new railway lines;
(ii) operational certification of all new motive power and rolling stock; and
(iii) conduct of inquiries into railway accidents.

The last of these functions comprises 90 per cent of the workload of the CRS's. In general, the CRS will investigate an accident if it involves fatalities, property damage greater than 2.5 million rupees (or approximately US$ 57,000), or if the interruption to traffic is longer than 24 hours. The decision as to whether to conduct an inquiry rests with the CRS who may decide to delegate an inquiry to railway officers. If a judicial inquiry is subsequently ordered, the CRS is obliged to suspend his own inquiry.

While the CRS has the power to conduct an inquiry, to write a report and to make recommendations on each accident investigated, the executive authority for safety regulation resides with the operational managements of each zonal railway. Thus, these managements may decide to accept the recommendations of the CRS either in full or in part, or alternatively to reject them completely. In practice, however, the CRS works closely with the Executive Director Safety at the level of the Railway Board and with Chief Safety Officers at the level of the zonal railways.

Discussions with the CRS attached to the Northern Railway indicated that the role of the CRS has been effective in identifying a number of problems related specifically to level crossing safety. These include:

(i) a lack of information in official safety statistics about accidents involving pedestrians, at level crossings or elsewhere (it was estimated that in the Northern Railway these amounted to about 5-10 per day);

(ii) poor maintenance by the railways of the road approaches to level crossings carries with it the risk of vehicles being grounded on crossings and subsequently being struck by trains (such accidents were considered to be very frequent on the Northern Railway);

(iii) the inadequacy of manually operated swing gates on double track lines (due to the time taken to close these gates road users can enter the crossing from the "open side" and risk being caught in the middle); and

(iv) poor training and lack of professional competence among level crossing staff (the CRS's have been active in promoting the recognition of crossing keepers as an occupational grade with a career path and a proper training syllabus).

2.2.5 Level crossing system evaluation techniques

Systematic evaluation of level crossing safety performance and of justification for upgraded crossing protection is carried out by the Indian Railways. In general, the Train Vehicle Unit (TVU) is used as the criterion for identifying which level crossings will have priority for upgrading. The TVU as it is known in India is identical to the Traffic Moment (TM) indicators as applied in other countries in that it results from the multiplication of the daily road traffic volume at a level crossing by the daily number of trains passing through that crossing. The TVU criteria applied in India are as shown in Table 2.7.

Table 2.7: TVU criteria for level crossing type

Item	*Daily traffic density/ traffic movement*	*Type of crossing indicated*
1	TVU < 6,000	Unmanned level crossing
2	6,000 ≤ TVU < 10,000	All unmanned level crossings to be manned on programmed basis
3	10,000 ≤ TVU < 100,000	Manned level crossings
4	TVU ≥ 100,000	Road flyover / overpass

Source: Indian Railways Country Paper.

Visibility is also a criterion used in order to identify those *unmanned* (and hence unprotected) level crossings which are to be given priority for manning. All unmanned level crossings are required to have a clear visibility for road users of 600 metres as observed by them at 5 metres from the centre of the railway track. Level crossings not having visibility to road/rail traffic up to the prescribed distance are considered hazardous and are manned by the Indian Railways at its cost. The combined TVU and visibility criteria used to establish priorities for manning of unprotected level crossings are set out in Table 2.8. Throughout the network, a total of 4,449 level crossings have been identified as having priority for manning.

Table 2.8: Criteria for manning of *unprotected* level crossings

Priority Category	**Description**	**Number on system**
1	Level crossings having more than 10,000 TVU	123
2	Level crossings having more than 6,000 TVU, but which are hazardous on account of restricted visibility	57
3	Level crossings where traffic density is less than 6,000 TVU but where buses and other motor vehicles ply regularly.	591
4	Level crossings with TVU less than 6,000 and restricted visibility, but where motor vehicles do not ply	2,537
5	Level crossings where visibility is adequate but traffic density exceeds 6,000 TVU	1,141
Total		4,449

Source: Indian Railways Country Paper.

Another criterion used to establish priorities for manning of unprotected level crossings is the relative importance of the railway line in terms of traffic density and maximum train speeds. Seven classifications have been devised with descending manning priorities, from Group A to Group E as shown in Table 2.9.

Table 2.9: Measures of the importance of railway lines used to establish level crossing manning priorities

Group A	Speeds of up to 160km/h
Group B	Speeds of up to 130km/h
Group C	Suburban systems in Bombay and Calcutta
Group D-Special	Traffic density is very high or likely to grow substantially in future and the sanctioned speed is 100km/h at present
Group D	Speed is 100km/h at present
Group E-Special	Traffic density is very high or likely to grow substantially in future and present sanctioned speed is less than 100km/h
Group E	Sections and branch lines with a present sanctioned speed of less than 100 km/h.

Source: Indian Railways Country Paper.

2.2.6 Level crossing safety initiatives

(a) Manning of unprotected level crossings

The current five-year plan (covering the period 1999/2000 to 2003/2004) provides for the progressive conversion of unmanned/unprotected crossings to manned/protected status. Depending upon the assigned category of each crossing, this will involve installation of warning signs or lights and boom barriers of various types as well as construction of a crossing attendant's workstation at prioritised locations. Details of this programme are given in Table 2.10.

Table 2.10: Annual plan of level crossing conversion to manned status

Year	No of level crossings proposed for manning	Route Group	Priority Category
1999~2000	391	A, B&C	I~IV
2000~2001	1,000	D-Special	I~IV
2001~2002	950	E-Spl, D&E	I~IV
2002~2003	967	E	I~V
2003~2004	1,141	A, B, C, D-Spl,D, E-Spl, E	V
Total	4,449		

Source: Indian Railways Country Paper.

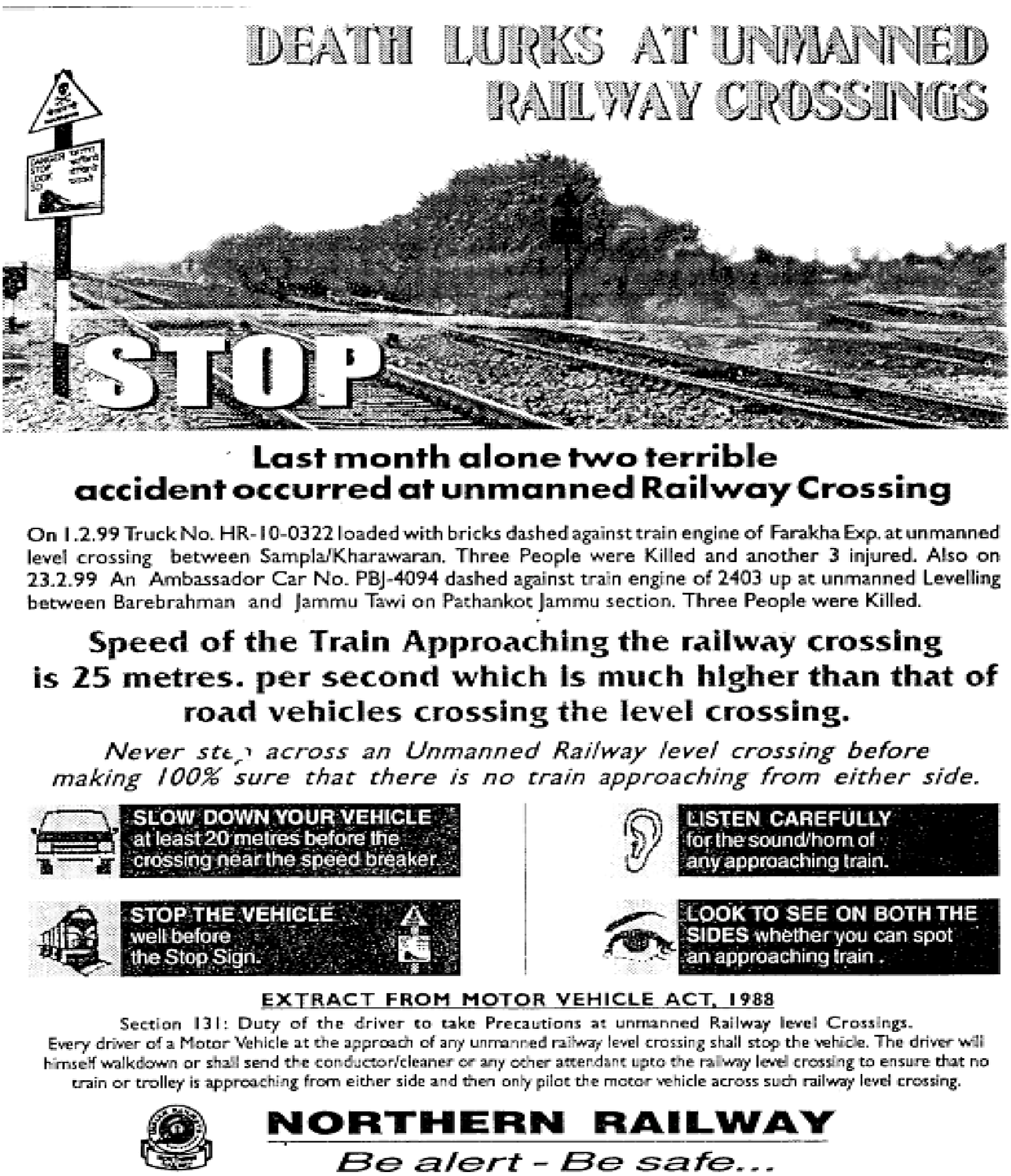
(b) Other level crossing upgrading measures

In addition to conversion of unprotected level crossings to manned status, the Indian Railways has a plan to grade separate or to relay interlock some of the more densely trafficked crossings on its network.

During the current five-year plan (1999/2000-2003/2004), it is proposed to interlock a total of 1,063 level crossings, while road under or over-passes are currently under construction at 339 locations throughout India. Owing to the high cost of these initiatives and (in the case of grade separation) to the necessity of sharing the cost with road authorities and/or private developers, progress has been slow.

(c) Road user education

The Indian Railways has only a very small budget for road user education but does make use of the mass media (mainly television and newspapers) to promote public awareness of the need for caution when using level crossings. One effective means of disseminating this message is the use of notice boards in *punjayat* (or local village) offices to display safety posters. Since residents of rural areas tend to regularly visit their *punjayat* offices, this initiative has the potential to reach a wide section of the community. One such poster used to promote caution by the public when using level crossing is shown hereafter.



2.2.7 Level crossing safety impediments

Apart from a lack of adequate capital funds to upgrade level crossings, the main factors considered to be working against an improvement in level crossing safety in India are:

(i) *the lack of priority* given by road authorities to improving level crossing safety (no doubt explained by the fact that level crossing accidents represent an insignificant proportion of all road traffic accidents in India);

(ii) the *lack of funding priority* in the Indian Railways budget for level crossing improvement/upgrading (unlike the situation which applies in other countries of the region, level crossing accidents account for only a small proportion – only 15 per cent in 1997/98 – of all railway accidents in India);

(iii) *increasing disposable incomes and motorization* in India, leading particularly to an increasing incidence of level crossing accidents in rural areas where general levels of education and safety awareness are poor; and

(iv) the *predominance of Absolute Block and Tablet systems of safe working* on the less densely trafficked railway routes in India means that lengthy delays to road traffic at level crossings will persist for some time into the future, adding to the possibility of an increasing incidence of barrier breakthroughs at manned level crossings.

2.3 Level Crossing Safety in the Islamic Republic of Iran

2.3.1 Summary

The Iranian Islamic Republic Railways operates a route network with a total length of 5,995 kilometres. This network is subdivided into five main routes and thirteen operating regions or districts. Within this network there are 344 official level crossings of all types and 74 unofficial level crossings giving a total of 418, or roughly one crossing for every 14.3 route-km on average. Thus, overall, the network cannot be said to have a particularly dense concentration of level crossings.

The region with the greatest level crossing density is the Shomal region to the east of Tehran with 381 route-km and 85 level crossings, or one for every 4.5 route-km. At the other extreme is the Jonobesharg region in the southeast of the country, with 685 route-km and only 14 level crossings, or one for every 49 route-km.

Of the 344 official level crossings in the network, 217 (or 63 per cent) are equipped with road warning lights and barrier protection and the remaining 127 (37 per cent) are simple open crossings with no form of road warnings and barrier protection whatever.

To a large extent level crossing safety is a function of the number and density of level crossings on a rail system. The relatively low density of level crossings on the railway system of the Islamic Republic of Iran is reflected in small numbers of accidents, fatalities and injuries on this system. In 1998, accident, fatality and injury rates for the system respectively stood at 0.64, 0.11, and 0.17 per million train-km, demonstrating that the Islamic Republic of Iran has one of the better level crossing safety records in Asia and one which is indeed superior to that of more than a few developed countries.

The Iranian Islamic Republic Railways has a policy to eliminate as many of the level crossings as possible through *grade separation.* However, although about 47 level crossings have been nominated for replacement by road overpasses, the construction cost of these overpasses has so far proven prohibitive, and other cheaper forms of safety enhancement have been pursued. These have included: provision of cement barriers along railway lines (especially in the exit areas of cities), in order to prevent road users from crossing the tracks at other than the officially designated level crossings; installation of electrically operated barriers to replace mechanical barriers, thereby reducing the time for closure of crossings to road traffic; replacement of older level crossing staff by younger, fitter staff; and replacement of defective signs and other road warning devices with state-of-the art audible and visible warning systems.

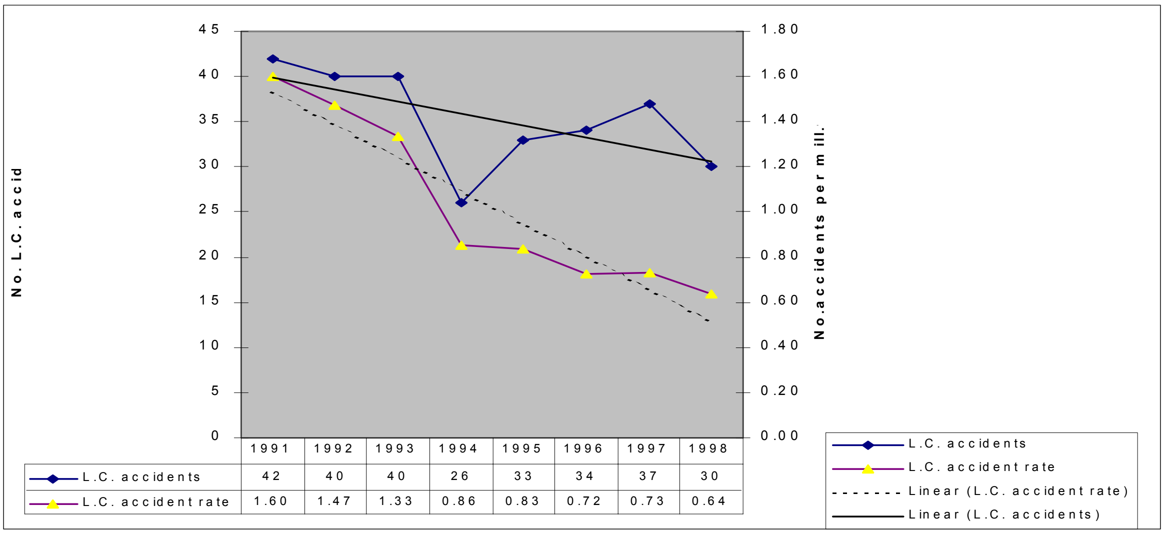
2.3.2 Level crossing safety record

(a) Accidents

Prior to 1997, data on railway accidents in the Islamic Republic of Iran were not available. Each region collected accident information in a form which suited its own requirements. However, data appear to be available on a consistent basis over the period 1991-1998.

Over this period, accidents at level crossings appeared to represent only 6-8 per cent of all railway accidents. As may be observed in Figure 2.3, the number of level crossing accidents during this period fell from 42 in 1991 to 30 in 1998, and the accident rate from 1.6 to 0.64 accidents for every million train-kilometres run.

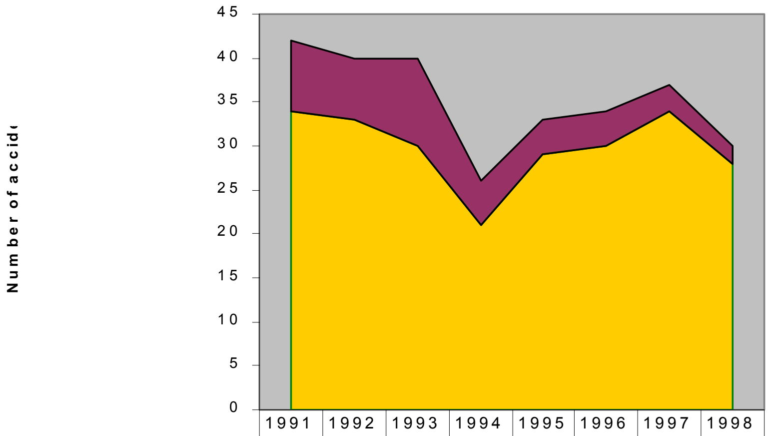
Figure 2.3: Level crossing accidents in the Islamic Republic of Iran



Source: Country Paper for Islamic Republic of Iran.

By far the greatest proportion (80-90 per cent) of the total number of level crossing accidents on the system occurred at unprotected level crossings, as is shown in Figure 2.4.

Figure 2.4: Number of accidents by type of level crossing in the Islamic Republic of Iran



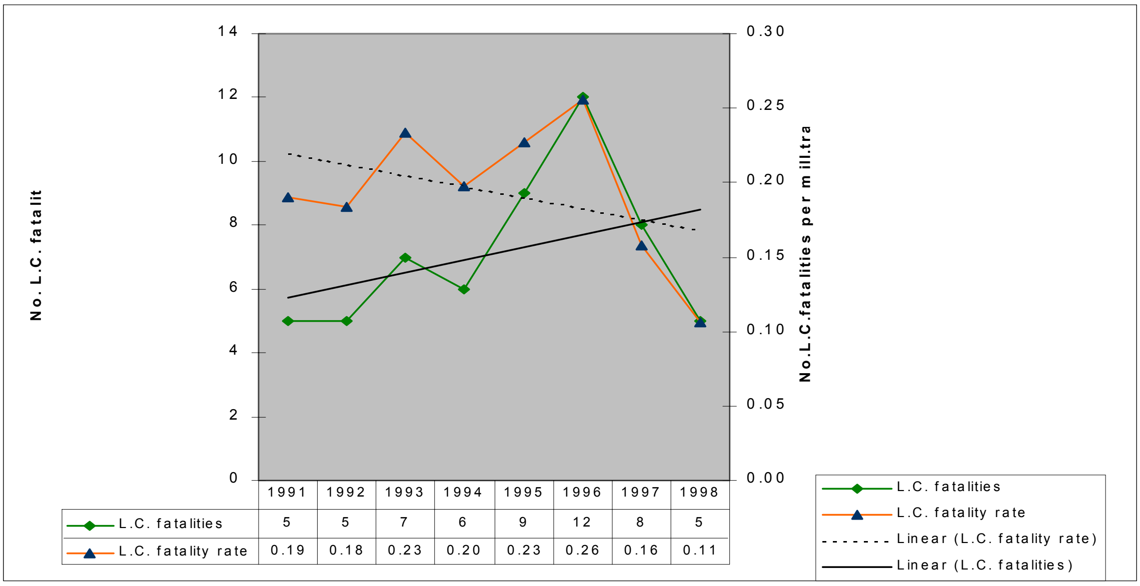
	1991	1992	1993	1994	1995	1996	1997	1998
Accidents at protected L.C.s	8	7	10	5	4	4	3	2
Accidents at unprotected L.C.'s	34	33	30	21	29	30	34	28

Source: Country Paper for Islamic Republic of Iran.

(b) Fatalities and injuries

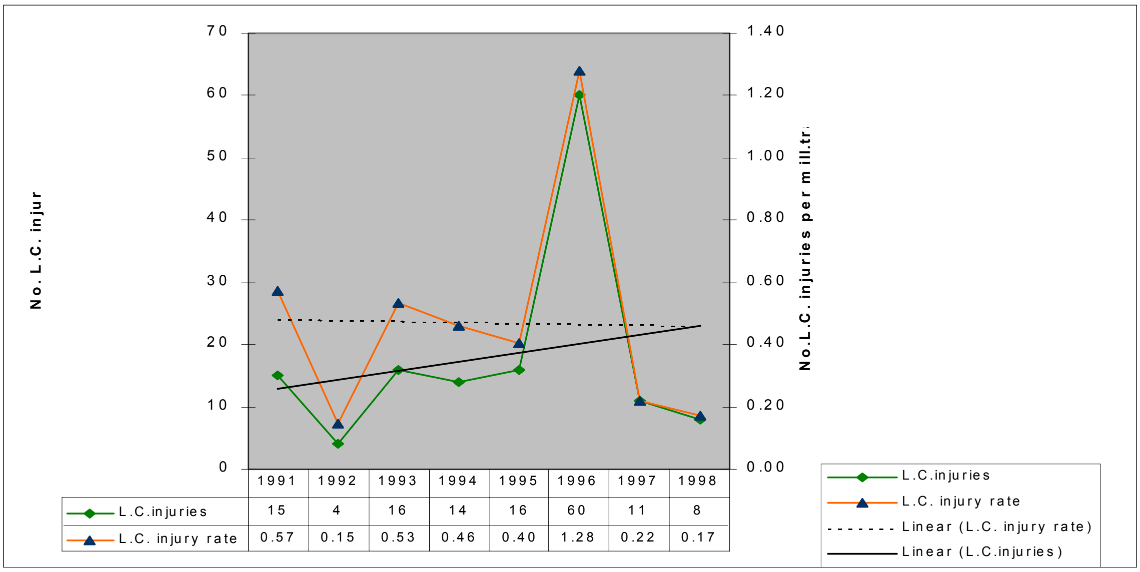
Unlike accident occurrences, the number of persons killed (see Figure 2.5) and injured (see Figure 2.6) in level crossing accidents have been on a rising trend over the past 7-8 years, despite dramatic improvements in these statistics during the last two years of the review period (1997 and 1998). However, the fatality and injury rates corresponding with the absolute statistics have been declining steadily and at 0.11 persons killed and 0.17 persons injured per million train-km in 1998 compare quite favourably with many western countries.

Figure 2.5: Level crossing fatalities in the Islamic Republic of Iran



Source: Country Paper for Islamic Republic of Iran.

Figure 2.6: Level crossing injuries in the Islamic Republic of Iran



Source: Country Paper for Islamic Republic of Iran.

2.3.3 Level crossing characteristics and effectiveness

Protected level crossings on the system of the Iranian Islamic Republic Railways are equipped exclusively with mechanically operated barriers. These are of two types: full width and half width lifting barriers (see Table 2.11).

In terms of the level of protection they afford, these barrier installations can be said to be safe, since accidents occurring at protected level crossings are clearly very few in number (only 2 in 1998). However, concern was raised in the country report that mechanical barriers may be incompatible with crossing closure times of short duration, since staff require more time to operate manually deployed barriers than they might if the barriers were electrically deployed. No information was provided on average crossing closure time for the system.

Table 2.11: Level crossing installations by type, Islamic Republic of Iran

Class	Type	Brief Description	Number on system	Associated Rail Signalling	Associated Road Signalling
Manual	Single Barrier (full width)	Mechanical full width lifting barrier	200	Fixed rail level crossing warning board	Fixed road level crossing warning board; flashing red light against road users.
Manual	Double Barriers (half-width)*	Mechanical half width lifting barrier	17	Fixed rail level crossing warning board	Fixed road level crossing warning board; flashing red light against road users.
Unprotected	-	Open crossing	127	None	None
Unofficial	-	Open crossing	74	None	None
Total			418		

Source: Country Paper for Islamic Republic of Iran.

* These are understood to be of the European design whereby half barriers are placed alternately across the road carriageway on either side of the track.

2.3.4 Administration of railway safety regulations

In the absence of any indication to the contrary in the country paper, it was assumed that the Iranian Islamic Republic Railways has sole responsibility for the administration of all safety regulations on its system.

In terms of its liability for human casualties and property damage resulting from level crossing accidents, the railway is not liable for compensation unless such accidents occur at protected level crossings *and* the railway has been deemed responsible by the courts system as a result of negligence on the part of its staff or of failure of its equipment. In such cases, the railway is required to pay compensation of up to US$ 10,000 for each person killed or injured, this amount being varied every year in accordance with Islamic Law. In common with most railways, the Iranian Islamic Republic Railways has absolute priority to operate within its own right-of-way, which is defined as the interval between boundaries fixed at 8.5 metres on either side of the track centreline. Road users are not permitted to encroach on this right-of-way except with the permission of the railway and at the appropriate crossings provided by the railway.

2.3.5 Level crossing system evaluation techniques (technical and financial)

The Iranian Islamic Republic Railways assesses level crossing upgrading priorities in relation to the following characteristics:

(i) location of the crossing;
(ii) rail and road traffic densities; and
(iii) width of the road crossing the rail tracks.

Thus, if a level crossing is within a city and has a wide road carriageway (e.g. double lane, dual carriageway), it will be equipped with double barriers either side of the tracks. If the level crossing carries a normal two lane road, it will be equipped with a single barrier either side of the tracks. If the level crossing is located outside a city and does not carry a main road, it will normally not be protected, i.e. it will have only fixed road warning boards at its approaches.

The Iranian Islamic Republic Railways is in the process of developing guidelines for use in assessing the case for upgrading its level crossing installations. While no official traffic density criteria yet exist as a basis for determining when and to what extent level crossings should be upgraded, a recent study by staff of the Railway Research Centre has indicated the following TM (Traffic Moment = daily number of road vehicles x daily number of trains) values for typical level crossings in each of the three categories in the system:

(i)	*Class "a"* crossings.	Minimum road vehicles per hour:	600
		Minimum trains per day:	20
		TM = 600 x 24 x 20 =	*288,000*
(ii)	*Class "b"* crossings.	Minimum road vehicles per hour:	450
		Minimum trains per day:	20
		TM = 450 x 24 x 20 =	*216,000*
(iii)	*Class "c"* crossings.	Minimum road vehicles per hour:	300
		Minimum trains per day:	10
		TM = 300 x 24 x 10 =	*72,000*

It must be noted that the Iranian Islamic Republic Railways does not, as a matter of routine, take counts of road vehicles using its level crossings. Neither are these counts taken by the government agencies responsible for road construction and management. The above data were based on "one-off" counts of traffic using the busiest roads in each province.

Based on the above results of the Research Centre study, the railway proposes to establish criteria for the assessment of level crossings as follows:

Proposed level crossing assessment criteria, Islamic Republic of Iran

TM value	Indicated crossing type
TM < 72,000	No protection – simple fixed road warning signs at crossing approaches only
72,000 ≤ TM ≤ 288,000	Mechanical or electrically operated lifting barriers; fixed warning board and flashing warning lights against road users; fixed level crossing warning board against train drivers
TM > 288,000	Road overpass or underpass

Source: Country Paper for Islamic Republic of Iran.

It is government policy to replace level crossings with grade separated crossings wherever this may be justified by the frequency of accident occurrences and the combined volume of road and rail traffic at the crossing locations under assessment.

Responsibility for determining priorities and for undertaking grade separation and other level crossing upgrading works resides with the Deputy Minister of Railway Construction and Development.

The Deputy Minister's department will carry out economic evaluations of grade separation proposals taking into account the following factors:

- The *present annual value* (*PAV*) of the required investment in the grade separation works;
- Salary and maintenance cost of the level crossing to be replaced;
- Savings to road users resulting from reduced fuel consumption, vehicle depreciation and personal delay time; and
- Savings to the railway through elimination of speed restrictions.

It must be noted that these evaluations do *not* include allowances for benefits arising from reduced loss of life, injury and property damage, possibly because of the difficulty of identifying valid costs for these elements.

In the case of evaluations of major level crossing protection proposals, the major benefit assessed is the reduction of accidents at the level crossings involved. Again, such evaluations appear to exclude consideration of the benefits associated with reduced loss of life, personal injury and property damage, and are likely to be limited to the financial savings accruing to the railway in the form of reduced property damage and traffic disruption, as well as line capacity expansion resulting from removal of speed restrictions.

2.3.6 Level crossing safety initiatives

One of the major safety threats to the railway arises from the presence of unofficial level crossings which very often take the form of "distributed crossings" along a broad right-of-way frontage in the exit areas of cities. The Iranian Islamic Republic Railways has attempted to eliminate this problem by constructing concrete barriers alongside the railway tracks at some of the more critical locations.

2.3.7 Level crossing safety impediments

The Iranian Islamic Republic Railways has nominated the following factors as major impediments to the improvement of level crossing safety on its system:

(i) *Limited finance.* Construction of grade separated crossings is likely to cost anywhere between US$ 1 million and US$ 7 million per crossing depending upon the length of bridge spans required, while barrier protection and warning light installation is estimated to cost US$ 18,000 per crossing (suggesting a total of about US$ 3.6 million if all 201 of the existing unofficial and official, but unprotected, crossings are upgraded). The railway currently faces severe restrictions on its capital spending and indeed has no specific fund for level crossing improvement;

(ii) *Unfavourable social environment.* High risk level crossings tend to be located in the exit area of cities where the poor education and lack of personal discipline of local communities are factors in the high frequency of level crossing accidents;

(iii) *Problem of unofficial "distributed" level crossings.* As previously mentioned, the increasing usage of these unofficial crossings by local communities seeking to avoid delays at official crossings contributes to the high frequency of level crossing accidents on the margins of cities;

(iv) *Poor road signalling.* Installation of road warning signs at the approaches to level crossings is the responsibility of road construction/management authorities since these signs are located outside of railway rights-of-way. Many of these signs have deteriorated due to lack of adequate maintenance;

(v) *Inefficient and ill-trained crossing staff.* The use of older, less efficient and generally untrained crossing protection staff has been a factor contributing to some accidents on the system. The inability to replace these staff with younger, more efficient and trained personnel impedes safety enhancement at some crossing locations; and

(vi) *Careless and negligent motor vehicle drivers.* Lack of respect for road traffic rules is estimated to explain 40 per cent of all level crossing accidents in the Islamic Republic of Iran. The quality of driver education and qualification programmes available in the country may require re-evaluation and reform if this is to be eliminated as a major contributory factor.

2.4 Level Crossing Safety in the Russian Federation

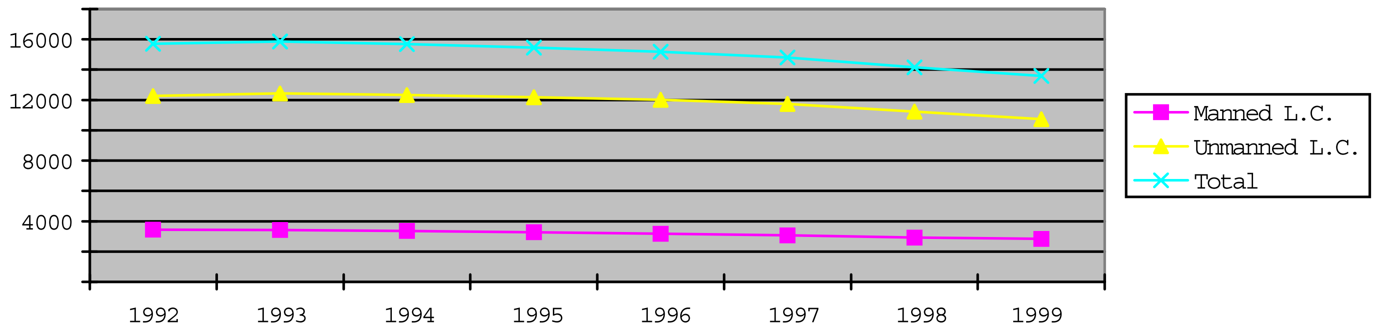
2.4.1 Level crossing characteristics and effectiveness

Data provided by the Russian Ministry of Railways (see Table 2.12 and the accompanying diagram) show that the number of level crossings in the Russian Federation has been declining steadily since 1992. The total number of crossings declined by an average of 2.1 per cent per year between 1992 and 1999, while the annual rates of decline during the same period for manned and unmanned level crossings averaged 2.7 per cent and 1.9 per cent respectively.

Table 2.12: Trend in level crossing numbers

	1992	1993	1994	1995	1996	1997	1998	1999
Manned Level Crossings	3,443	3,425	3,370	3,273	3,171	3,062	2,921	2,844
Unmanned Level Crossings	12,270	12,437	12,329	12,186	12,011	11,739	11,238	10,737
Total	15,713	15,862	15,699	15,459	15,182	14,801	14,159	13,581

Source: Ministry of Railways Country Paper.

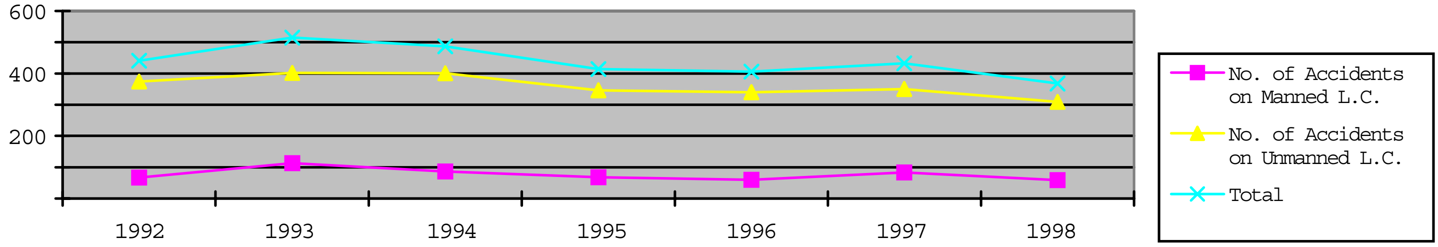


During the same period, the number of accidents at level crossings declined by an average of 2.6 per cent per annum, with the decline in the number of accidents at manned level crossings averaging 1.8 per cent per annum and at unmanned level crossings 2.7 per cent per annum.

Table 2.13: Trend in level crossing accidents

	1992	1993	1994	1995	1996	1997	1998
No of Accidents on Manned L.C.	67	113	86	68	60	83	59
No of Accidents on Unmanned L.C.	374	402	401	346	340	350	309
Total	441	515	487	414	406	433	368

Source: Ministry of Railways Country Paper.

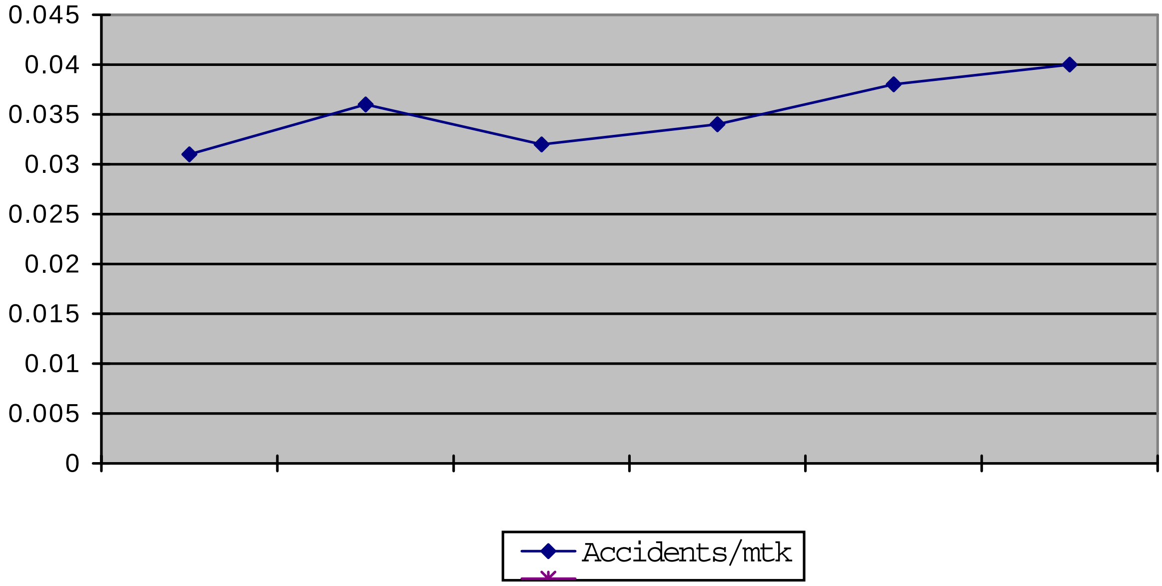


However, *accident rates* (i.e. accidents per million train-km) are increasing as shown in Table 2.14 and the accompanying diagram. The declining traffic task as reflected in the train kilometre trend was not matched by the decrease in the number of level crossing accidents.

Table 2.14: Trend in level crossing accident rates

	1993	1994	1995	1996	1997	1998
Million train-km	16,400	13,600	13,100	12,100	11,300	9,300
Accidents per million train-km	0.031	0.036	0.032	0.034	0.038	0.040

Source: Ministry of Railways Country Paper.



Details of the types of level crossings currently in operation on the railway system of the Russian Federation are given in Table 2.15, the trend in installations of each type of manned crossing is given in Table 2.16, and the trend in the numbers of each type of unmanned crossing is given in Table 2.17.

Trends in the numbers of manned crossings by type indicate that the numbers of all types of installations except types “B” and “H” have been declining over the past seven years. In particular, there was a steady reduction in the numbers of the most advanced “A” type crossing which, apart from being manned, is equipped with automatically operated barriers and full warning light protection against road and rail traffic. By comparison, over the same period, there was a decline in all types of unmanned level crossings, except type “J”, which now represents 40 per cent of all level crossings in the Russian Federation. Significantly, “B” type crossings, while equipped with automatically operated warning lights against road traffic, have no warning signals against train drivers.

Although there is insufficient evidence available, the decline in the “A” type crossing (averaging 3.2 per cent per annum), coupled with the increase in the “J” type crossing (averaging 2.3 per cent per annum) may have contributed to the deteriorating trend in level crossing accidents per million train-kilometres over the seven year period reviewed. It must also be noted that accident rates have increased ***despite*** a decline (averaging 4.2 per cent per annum) in the number of unprotected crossings on the system.

Table 2.15: Types of level crossings operational in 1999

Category	*Number on system*	*Manning status*	*Type of level crossing signalling system for road vehicles*	*Type of signalling system for railway transport*
A	1,170	Served by duty worker	Automatic barriers with automatic traffic light signal system.	Level crossing protection light. Signal provided but the automatic blocking system signals can also be used as crossing protection signals.
B	1,135	Served by duty worker	Semi-automatic barriers with automatic traffic light signal. Barriers are closed automatically and are opened by pressing button.	The signals for arrival and departure of trains at station are used for level crossing protection, but in reasonable cases, level crossing protection signals will be provided.
C	281	Served by duty worker	Electro pushbutton barriers with annunciator and manual light signal system.	Special signals with red and white alarm lights are controlled by the on duty worker.
D	67	Served by duty worker	Electro pushbutton barriers with annunciator signal system (no light system).	As above.
E	42	Served by duty worker	Mechanized barriers with annunciator and manual light signal system.	As above.
F	35	Served by duty worker	Mechanized barriers with annunciator signal system (no light system).	As above.
G	99	Served by duty worker	Mechanized barriers without annunciator or light systems.	As above.
H	355	Served by duty worker	Horizontal rotary Barriers only.	As above.
I	1,342	Not served by duty worker	Automatic traffic light signal system with blinking white light.	In reasonable cases on double track sections, special protection lights will be provided.
J	5,522	Not served by duty worker	Automatic traffic light signal system.	Not provided.
K	398	Not served by duty worker	Traffic light signal system using shunting signal with red and white lights as a protection.	Special signals with alarm lights are controlled by shunting or locomotive crew, or operate automatically.

Source: Ministry of Railways Country Paper.

Table 2.16: Trend in the numbers of each manned crossing type

Type of crossing	1992	1993	1994	1995	1996	1997	1998	1999
A	1,472	1,487	1,462	1,429	1,412	1,282	1,219	1,170
B	1,012	1,038	1,046	1,054	1,088	1,136	1,127	1,135
C	481	432	434	410	376	346	298	281
D	127	130	117	100	80	83	78	67
E	62	58	57	51	44	34	48	42
F	57	61	55	48	45	39	32	35
G	219	196	192	154	164	131	107	99
H	296	404	405	360	341	372	418	355

Source: Ministry of Railways Country Paper.

Table 2.17: Trend in the numbers of each unmanned crossing type

Type of crossing	1992	1993	1994	1995	1996	1997	1998	1999
I	2373	2092	2013	1869	1775	1642	1405	1342
J	4680	5435	5538	5695	5774	5752	5663	5522
K	517	564	562	520	453	454	441	398
No device	4700	4346	4216	4102	4009	3892	3729	3475

Source: Ministry of Railways Country Paper.

2.4.2 Level crossing evaluation system

The Russian Federation Railways has classified its level crossings in accordance with a matrix system, which relates the intensity of passing rail traffic to the intensity of passing road traffic within a 24 hour period. This system is described in Table 2.18.

Table 2.18: Level crossing classification in the Russian Federation

Intensity of rail traffic on mainline (total number of passing trains per day in both directions)	Intensity of road traffic (total number of passing vehicles per day in both directions)				
	Less than 200 inclusive	201-1000	1001-3000	3001-7000	More than 7000
Less than 16 inclusive, and also on all station and access tracks	4th Class	4th Class	4th Class	3rd Class	2nd Class
17-100	4th Class	4th Class	3rd Class	2nd Class	1st Class
101-200	4th Class	3rd Class	2nd Class	1st Class	1st Class
More than 200	3rd Class	2nd Class	2nd Class	1st Class	1st Class

Source: Ministry of Railways Country Paper.

The distribution of all the level crossings within this classification system is given in Table 2.19.

Table 2.19: Distribution of all level crossings, by traffic density class

Traffic density class	Manned, protected level Crossings*	Unmanned, unprotected level crossings**	Total
1	474	0	474
2	906	247	1,153
3	762	1,045	1,807
4	707	9,445	10,152
Total	2,849	10,737	13,586

Source: Ministry of Railways Country Paper.

* Indicates full barrier protection.

** Indicates no barrier protection.

The level crossing grading criteria adopted by the Russian Federation Railways *appear* to indicate that all crossings of the first traffic density class should in future be manned and that crossings of the 2nd to 4th traffic density classes should be unmanned and equipped with various types of automatic signal warning systems, but ***without barriers***.

This classification represents a departure from present practice in the sense that there is a higher percentage of protected crossing than would be indicated by the traffic density classification system, yet there has been a worsening of the accident rate over the seven year period reviewed.

However, the Ministry of Railways Country Report also indicates that "at present, obligatory requirements to the equipment of railway level crossings depending on their type on the Russian Federation Railways are not established. The specific choice of the equipment is determined by railways depending on conditions of operation; visibility of train and vehicle, traffic density of vehicles and trains, availability of electric supply for the equipment of level crossings with the level crossing signal system devices and other factors". From this it might be inferred that the Russian Federation Railways decide on the upgrading of level crossings from unprotected to protected status on a case-by-case basis and do not actually apply the criteria indicated in Table 2.17 above.

2.4.3 Level crossing safety impediments

The Russian Federation Railways has identified the following factors as the main causes of level crossing accidents:

(i) *low level of public discipline* and, as a consequence, mass violations by vehicle drivers of the rules relating to passing of level crossings;

(ii) *motor vehicle driver misjudgements* concerning road conditions and the approach of trains on level crossings;

(iii) *motor vehicle driver misjudgements* of vehicle speed and braking capabilities during the winter months;

(iv) *technical malfunction of road vehicles*;

(v) *non-compliance by highway authorities* with the standards of road maintenance at the approaches to level crossings;

(vi) *poor maintenance* of level crossing warning and protection devices; and

(vii) *human error* on the part of level crossing staff.

In accordance with these primary accident causation factors, the Russian Federation Railways has nominated the following as the remedial measures which should have priority for implementation in future throughout its railway network:

(i) improve road discipline of vehicle drivers and observance of law and order on level crossings;

(ii) improve reliability of devices operating on level crossings;

(iii) modernization and improvement of technical devices installed at level crossings;

(iv) introduction of improved methods for maintenance of level crossings;

(v) better organization of traffic safety control on level crossings;

(vi) accelerated grade separation of level crossings within the highest traffic density classification;

(vii) improvement of motor vehicle driver education programmes;

(viii) enhancement of training and qualification requirements for motor vehicle drivers and railway level crossing personnel;

(ix) refinement of level crossing classification system;

(x) improvement of materials informing the public about level crossing safety rules; and

(xi) giving greater priority to level crossing improvement in capital works budgets.

The difficulty with these remedial measures is that, by and large, they are abstract and do not focus on the apparent major factor contributing to a worsening of the level crossing accident rate, i.e. *a reduction in the number of manned, protected level crossings*. This is not to suggest that all crossings should be manned in future. However, it may be argued that there is a strong case for providing barrier protection at all but the least densely trafficked crossings. It must be emphasized that under present arrangements, none of the official unmanned level crossings, representing more than 50 per cent of the official crossings on the Russian Federation's railway network, has any form of barrier protection whatever. In addition, there are another 3,475 crossings on the network without any form of warning or protection device. These are presumably designated by the Ministry of Railways as "unofficial" crossings, but no indication has been provided as to the traffic density of such crossings and of their status in the programme for level crossing improvement.

Finally, there is no indication that the Ministry of Railways has yet adopted a particularly efficient system for recording and disseminating level crossing accident statistics. An initiative to improve the dissemination of knowledge about level crossing safety performance is seen as an essential component of any policy to improve level crossing safety.

2.5 Level Crossing Safety in Viet Nam

2.5.1 Summary

The railway system of Viet Nam with a total route length of only 2,712 km has an estimated 4,842 level crossings, or an average of one crossing for every half a kilometre of route length. Thus Viet Nam has one of the densest level crossing systems in Asia, with more than three times the level crossing density of India.

Of the total number of level crossings, some 3,600 (or 75 per cent) are unofficial, i.e. not officially provided by Vietnam Railways and, by definition, have no form of protection against infringement by road users. Unofficial crossings combined with official, but unprotected, crossings comprise nearly 93 per cent of all level crossings in Viet Nam. This group has been estimated to account for 90 per cent of all level crossing accidents in Viet Nam. This report incorporates *estimates* for Viet Nam of accident, fatality and injury rates per million train kilometres. It was necessary to make these estimates as train kilometre statistics are not maintained, at least at the level of the railway headquarters. *Train-kilometre estimates were based on information supplied by the railway in respect of the number of trains and average distances run.*

Since accidents at level crossings represent nearly two-thirds of all railway accidents and account for more than 75 per cent of fatalities and more than 81 per cent of injuries in all types of railway accidents in Viet Nam, it becomes a matter of crucial importance to enforce new safety measures which can eliminate or minimize accidents of this type. However, the techniques available for automated level crossing protection are not affordable for Vietnam Railways and, given the relatively low cost of labour, it is likely that any safety enhancement programme would have to focus on extension of manual protection to currently unprotected crossings. Exceptions would be a limited number of crossings in Hanoi and Ho Chi Minh City, where both road and rail traffic volumes and potential time savings for road users would justify consideration of automatic protection systems with delay minimizing features.

To assist the process of prioritising measures to improve level crossing safety, it will be essential for Vietnam Railways to improve the system for safety data capture and to re-define the criteria used for determining which level crossings should qualify for grade separation or equipment upgrading. The present “Traffic Movement” indicator used to identify those crossings for which grade separation should be provided is only 20,000 per day, as compared with 100,000 per day in India. Further, road traffic counts are not taken as a matter of routine, or indeed *eve*r, and accident statistics are manually maintained only at the level of each of the three administrative divisions (usually called “Union Railways”). It is therefore impossible for headquarters staff to decide upon priorities when they have neither the ability to determine which level crossings have particularly poor safety records, nor the ability to determine the trend in road traffic density for individual crossings.

2.5.2 Level crossing safety record

(a) Accidents

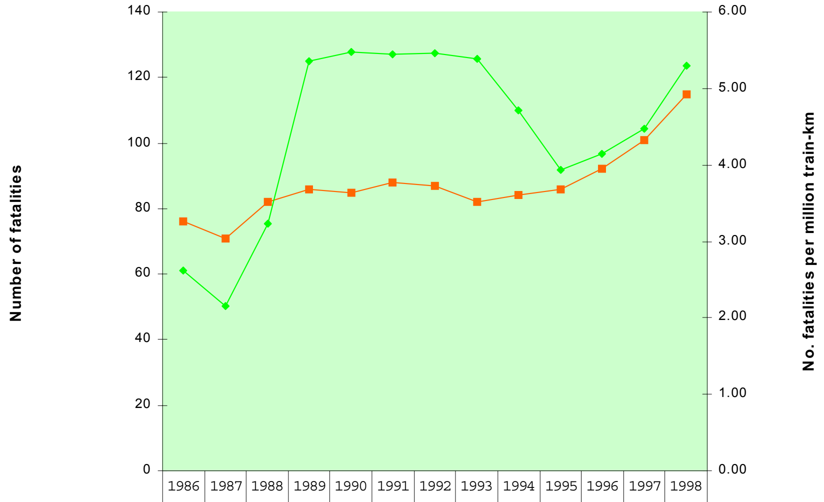
No trend information in respect of level crossing accidents was made available, but for the period 1988-1998 the number of level crossing accidents was recorded as 2,595 (representing 66.3 per cent of all railway accidents during this period). It is likely that there has been a rising trend both in the number of level crossing accidents and in their share of total railway accidents. Expressed as a rate per million train-km, accidents over the period 1988-1998 averaged 12.34 per million train-km. This was greater than the accident rate in India by a factor of more than 100 and greater than the accident rate in Canada by a factor of 4. By these measures, Viet Nam has a disturbingly high incidence of level crossing accidents.

It has been estimated that 60 per cent of all level crossing accidents occur at unofficial crossings, with 30 per cent occurring at unprotected official crossings and 10 per cent at protected crossings.

(b) Fatalities

The trend in the number of fatalities and in the fatality rate per million train kilometres is shown in Figure 2.7. This indicates that the number of fatalities in level crossing accidents increased by an average of 3.5 per cent per year between 1986 and 1998, but that between 1996 and 1998 the rate of increase had risen to 11.8 per cent per year. During the latter period, the average speeds of express passenger trains were estimated to have increased from 48 km per hour to 54 km per hour (12.5 per cent), which is likely to have had some influence on increases both in the numbers of level crossing fatalities and the associated number of fatalities.

Figure 2.7: Numbers and rates of level crossing fatalities in Viet Nam



	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
L.C. fatalities	76	71	82	86	85	88	87	82	84	86	92	101	115
L.C. fatality rate	2.62	2.16	3.23	5.36	5.47	5.45	5.47	5.39	4.72	3.94	4.15	4.48	5.29

Source: Country Report for Viet Nam.

Figure 2.7 also indicates a dramatic increase in the rate of level crossing fatalities per million train kilometres between 1988 and 1989 and again between 1997 and 1998. This is explained by the fact that the number of fatalities continued to rise while *rail traffic*, measured in terms of train kilometres, declined. No information in respect of trends in the volume and composition of road traffic over these two periods was available. Nevertheless, it is likely that over these periods road traffic volumes increased significantly, especially in the Hanoi and Ho Chi Minh City urban areas which have by far the greatest concentration of level crossings within Viet Nam's railway network.

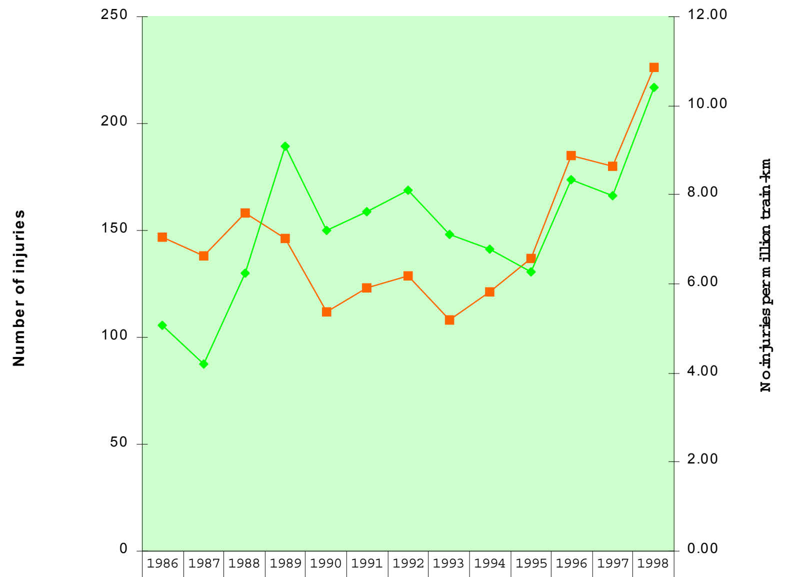
Over the past decade, the level crossing fatality rate averaged about 4.9 per million train-km, which was greater than the corresponding rate in India by a factor of 25 and greater than the corresponding rate in Canada by a factor of 11.

While no information on the corresponding trend in fatalities in all types of railway accidents was made available, over the past decade level crossing accidents accounted for 988 (or 75.2 per cent) out of a total of 1,313 persons killed in all railway accidents in Viet Nam. Clearly, *level crossing accidents claim by far the greatest loss of life in railway operations in Viet Nam.*

(c) Injuries

The trend in the number of injuries and in the injury rate per million train kilometres is shown in Figure 2.8.

Figure 2.8: Numbers and rates of level crossing injuries in Viet Nam



	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
L.C. injuries	147	138	158	146	112	123	129	108	121	137	185	180	226
L.C. injury rate	5.07	4.19	6.23	9.10	7.21	7.62	8.11	7.10	6.79	6.27	8.34	7.98	10.40

Source: Country Report for Viet Nam.

Over the period 1986-1998, the number of injuries sustained in level crossing accidents rose by an average of 3.6 per cent per year, but during the three year period 1995-1998 the average annual increase was 18.2 per cent. In common with level crossing fatalities, it is considered that increasing train speeds contributed to the recent dramatic growth in level crossing injuries. Expressed as a rate per million train kilometres, the number of level crossing injuries averaged 7.7 over the past decade. This was 24 times greater than the rate recorded in India and about 20 times greater than the rate recorded in Canada over the same period.

2.5.3 Level crossing characteristics and effectiveness

(a) General characteristics/overall density

Grade separated intersections between road and rail exist at only 11 locations throughout Viet Nam. Six of these are located within the Greater Hanoi area, of which five date back to the early part of 20th century when the French colonial administration constructed a railway viaduct to link up with the Long Bien Bridge across the Red River. Level crossings are therefore the predominant form of road/rail intersection in Viet Nam and are likely to remain so for some time into the future.

Details of the density and number of level crossings by type, as supplied by Vietnam Railways are given in Table 2.20.

Table 2.20: Number and density of level crossings in Viet Nam

Number of route-km	Total no. of level crossings	Level crossing density (no. per route-km)	No. of official level crossings		No. of unofficial level crossings
			Protected	Unprotected	
2,712	4,842	1.8	367	833	3,642

Source: Country Report for Viet Nam.

Official level crossings are those which have been authorized (and most often) designed and constructed by Vietnam Railways. As may be seen in Table 2.20, they comprise only one quarter of all level crossings in Viet Nam. They are of two types, protected and unprotected.

Protected crossings are those which have some form of barrier protection facing road vehicles in order to prevent their intrusion onto crossings when trains are passing. The types of barriers most commonly used are simple full width lifting barriers and trolley gates.

Both are manually operated, requiring 24 hour per day manning of all protected crossings.[2] While all official crossings have warning boards facing road traffic, only some have manually operated red light warning signals against road traffic. In most cases these are steady light signals, although a set of flashing red light signals was observed at one major crossing in Hanoi. Audible warning mechanisms (mostly in the form of warning bells) are installed at a minority of protected level crossings. These, also, are operated by railway crossing staff. As reported by Vietnam Railways, warning signals against trains are installed at only 7 locations on the system, although at least 3 locations at which these signals are installed were visited during the ESCAP mission to Hanoi. When activated by level crossing staff, these signals display a steady white light against train drivers to indicate the presence of an obstruction on the crossing. Warning of the departure of a train from the nearest station and of its impending arrival at a protected level crossing is mostly given to the crossing keeper by telephone, although it is possible that at some protected crossing locations on the system this warning would be received by block telegraph. In general, the railway system of Viet Nam is not equipped with relay interlocked signals, although Alstholm, through French government assistance, are currently engaged in a project to install interlockings at 32 stations between Hanoi and Vinh. As part of this project, a level crossing near Dong Giao (130 km south of Hanoi) is being interlocked with the block system on a trial basis.

By definition, the 3,642 unofficial crossings (representing 75 per cent of the total number of level crossings on the system) are unprotected. These are crossings which have been established illegally by local communities. They range from fairly sophisticated constructions made from paving blocks placed either side of the track to rudimentary paths built across the tracks from rubble or earth fill. In Viet Nam, their number is fairly fluid – they can be constructed one day and removed the next. While train drivers may be aware of their existence, their safe use is totally dependent upon the judgement and safety awareness of local road users.

(b) Level crossing types and density by area

The railway system of Viet Nam is divided into three administrative divisions, known as “Unions”. Union I, incorporating that part of the system between the border with China and Dong Hoi (south of Vinh on the Hanoi-Ho Chi Minh City trunk line), contains 54 per cent of the system’s route kilometres, but some 75 per cent of its unofficial level crossings. Union II (Dong Hoi-Dieu Tri) has 22 per cent of the system’s route kilometres but only 6 per cent of its unofficial crossings, while Union III (Dieu Tri-Ho Chi Minh City) with 24 per cent of the system’s route kilometres contains 19 per cent of its unofficial crossings. If 60 per cent of level crossing accidents are thought to occur at unofficial crossings, then clearly the area covered by Union I has a major level crossing safety problem.

As might be expected, level crossing density is greatest in the urban areas of Hanoi and Ho Chi Minh City. Hanoi with a rail route kilometrage of 34 has no fewer than 305 level crossings, or an average of one crossing every 110 metres. Of these, 32 are manned, 55 are equipped only with road warning boards and 218 are

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[2] One exception is the crossing at the major Dai Co Viet/Le Dzuan road intersection about 3 km south of central Hanoi. Here, a total of 11 electrically powered trolley gates is provided for road/rail traffic separation. When this crossing was visited during the course of the ESCAP mission, however, the electric motors used to power the trolley gates were unserviceable and the trolley barriers were manually deployed by some of the 9 railway staff per shift assigned to this location.

unofficial. No information was provided on the number of official level crossings in Ho Chi Minh City, but the number of unofficial crossings is estimated at 52.

Unfortunately, accident and associated casualty details were not available by area, so that it was not possible to identify the relative extent of the safety problem in urban versus non-urban areas of Viet Nam, nor indeed to identify "hot-spots" with high accident frequencies and casualty rates. This is indicative of the lack of any systematic approach to railway safety data collection and analysis within Vietnam Railways, an issue which is discussed in greater depth in Section 2.5.7. As a consequence, it is only possible to *infer* a relationship between the dense concentration of level crossings (and especially of unprotected level crossings) and the frequency of road/rail collisions at level crossings in urban areas.

(c) Relative efficiency of different types of crossing protection

Level crossing efficiency may be measured in two ways: in terms of the effectiveness of different types of protection systems in preventing accidents and in terms of the capability of each type of protection system to minimize the delay to road traffic waiting for the passage of trains (and sometimes to minimize the delay to trains, where there is a requirement for low speed operation of trains through level crossings).

For the reasons of data non-availability, as indicated earlier, it was not possible to conclude whether the barrier protection systems in use in Viet Nam had been effective in preventing accidents – although it may be reasonable to make such an inference.

In terms of their efficiency in minimizing delay to road users, observations made during the course of the ESCAP mission to Hanoi revealed that barriers were closed on average for *not longer than two minutes*. Such a delay is likely to be acceptable even with the heavy road traffic experienced at some intersections in Hanoi, since average rail traffic in the section observed (between Hanoi and Gia Bat), at about 8 pairs of trains per day, is comparatively light. Nevertheless, it appears that the management of Vietnam Railways has adopted a future target of a one minute delay for all protected level crossings. This it hopes to achieve by installing train-actuated barrier protection at crossings which do not carry sufficient traffic to justify grade separation.

2.5.4 Administration of safety regulations in relation to level crossings

In Viet Nam, there is no supra-railway organization which is responsible for administration of safety regulations. Vietnam Railways is itself responsible for ensuring that government regulations relating to railway safety are enforced.

The current government decree which governs safety at road/rail crossings is "Governmental Decree 39/CP ensuring safety and security for railway transport" of 5 July 1999.

Five articles of this decree are relevant to level crossing safety. These are as follows:

- *Article 31*, which requires all organizations and individuals having a need to open a level crossing to be responsible for the cost of installation, management, maintenance and repair of road signs and equipment necessary for security and safety at that place;

- *Article 32*, which requires that level crossing installation must be "commissioned" and carried out in conformity with established standards and specifications;

- *Article 44,* which contains a number of provisions relating to occupation of level crossings by trains and to action to be taken when accidents occur at level crossings. Specifically, it states that: the railway is forbidden to stop trains inside level crossings except in the case of a sudden accident; that the delay to road traffic arising from the shunting or stopping of trains inside a level crossing should not exceed three minutes for a Class 1 or 2 crossing and five minutes for a Class 3 crossing; and that in the case of an accident at a level crossing the Head of Train Staff, railway drivers and other rescue staff must determine action needed to restore through road and rail traffic as soon as possible;

- *Article 45,* which states that level crossing barriers must be closed at least one minute before the arrival of a train in the case of an electrical barrier and at least one and a half minutes before train arrival in the case of a manual barrier. Similarly this article limits the closure of level crossing barriers to not more than 3 minutes before train arrival in the case of Classes 1 and 2 crossings and to not more than 5 minutes before train arrival in the case of Class 3 crossings; and

- *Article 46*, which states that: (a) the railway mode has priority of passage; (b) pedestrians and other road users must comply with warnings be they instructions of level crossing keepers, signal indications by means of lamps, flags or signs, or deployment of protective barriers; (c) at barrier-equipped level crossings, pedestrians and other road users must immediately respond to stop signals by halting on the right-hand side of the road at least 3 metres in front of the stop sign; (d) at non-barrier equipped level crossings, pedestrians and other road users have a duty to keep a look-out for trains and if one is approaching to stop on the right hand side of the road at least 5 metres from the nearest rail; (e) in situation (d) pedestrians and other road users must accept responsibility for any accidents; and (f) that pedestrians and other road users are forbidden to open barriers themselves.

The Country Paper for Viet Nam contained no specific mention that unofficial crossings were prohibited by Decree 39/CP, but as such crossings were described as illegal in the Country Paper, then it might reasonably be assumed that the decree does contain such a prohibition.

2.5.5 Level crossing system evaluation techniques (technical and financial)

No systematic evaluation of level crossing safety performance or of the need/justification for upgraded crossing protection is carried out by Vietnam Railways. However, some technical evaluation is undertaken, as is indicated by the current programme to pilot test the Westinghouse system of train actuated warning signals and protective barriers on the Viet Nam railway network.

To a large extent, the absence of systematic evaluation of safety performance and enhancement is due to the lack of an effective information system, but the fragmentation of management responsibility for safety must also have an impact.

While the Union Railways and lower levels of the organization exercise day-to-day management responsibility for operation of level crossings and for adherence to government safety regulations, the headquarters unit of Vietnam Railways has responsibility for the planning and mobilization of capital expenditure, including the expenditure on upgraded level crossing protection systems. The safety statistics supporting the case for capital spending on safety enhancement are maintained manually (generally in disaggregated form) at the level of the Union Railways and are not as yet assembled into a computerized database at headquarters level.

Despite the absence of any systematic and regular evaluation by Vietnam Railways of level crossing safety, rules issued by the Ministry of Transport, Communication and Post contain criteria for setting level crossing upgrading priorities. These criteria, as shown below, essentially distinguish between three categories (or classes) of level crossing on the basis of their combined road and rail traffic density, the categories of roads involved, the location (i.e. urban/non-urban), and their visibility rating:

First class level crossings are those where

- railway lines intersect with roads of first, second or third class classification;
- railway lines intersect with urban roads carrying a dense mix of private and public transport; and
- the "Traffic Movement Indicator", or TM (number of trains per day x number of road vehicles per day) is greater than 20,000.

Second class level crossings are those where

- railway lines intersect with roads of fourth or fifth class classification;
- railway lines intersect with urban roads carrying a relatively less dense mix of private and public transport; and
- the TM is between 5,000 and 20,000 if there is sufficient visibility or between 1,000 and 5,000 if there is insufficient visibility.

Third class level crossings are those which do not satisfy any of the above criteria.

The road classifications used as the basis for these level crossing criteria are given in Table 2.21.

Additional criteria specified in the level crossing rules are that: Class 1 and 2 level crossings having a rail traffic density of at least 16 trains per 24 hours require barrier protection; level crossings with at least 12 trains per 24 hours, but with restricted visibility require barrier protection; and branch lines having a traffic density of not greater than 4 trains and 150 road vehicles per 24 hours do not require barrier protection.

Table 2.21: Road classification system in Viet Nam

Factor ↓ Class →	I	II	III	IV	V	VI
PCU * per day	> 6000	3000 – 6000	1000 – 3000	300 – 1000	50 – 300	≤ 50
Speed (km/hour) – Flat or plateau areas – Mountain/highland areas	120 -	100 -	80 60	60 40	40 25	25 -

Source: Vietnam Railways.

* PCU = passenger car unit. Other vehicles are converted into PCU's using the following factors: bicycle 0.2; motorcycle 0.3; buses and medium trucks 2.0; three axle trucks 2.5; prime movers and semi-trailers 3.0.

It is further stipulated in the level crossing rules that *Class I crossings should be grade separated.*

Two main difficulties are associated with the practical application of these criteria for the upgrading of level crossings.

The first is that the traffic density criteria are not realistic. For example, Class 1 crossings are identified as those with a TM of at least 20,000 and a train density of at least 16 per 24 hours, giving a road traffic density of only 1,250 vehicles per day (20,000/16). This figure is likely to be exceeded at most of the level crossings in Hanoi and very possibly at a large number of crossings outside urban areas. It must also be noted that a road traffic density of 1,250 vehicles per day is close to the extreme lower limit of the traffic density criterion for a class 3 road, when in fact Class 1 level crossings have been indicated as intersecting with road classes between 1 and 3, for which an upper traffic density limit in excess of 6,000 per day has been indicated. It is hardly likely that traffic amounting to 16 trains and 1,250 road vehicles per day would produce sufficient benefits in terms of accident prevention and reduced delay to road users to completely offset the costs of constructing road overpasses in place of Class 1 crossings.

The second difficulty is that Vietnam Railways do not take counts of the road vehicles using level crossings. Neither are such counts taken on a regular basis by the responsible road management authorities. Therefore, there is no objective basis upon which the TM value for any crossing can be determined and upon which level crossing upgrading priorities may be set.

2.5.6 Level crossing safety initiatives

The management of Vietnam Railways properly attaches greatest priority to converting unofficial level crossings to official crossings with at least some form of warning signage facing road users and with an adequately surfaced roadway across the tracks.

Construction of road overpasses in place of the most densely trafficked crossings has so far been beyond the capacity of the railway to finance, although this is considered the most desirable option in the long term[3].

In late 1999, Vietnam Railways submitted to the Ministry of Transport, Communication and Post a request for funds and an expenditure programme, with the following principal objectives.

- progressive conversion to official status and upgrading of the estimated 3,642 unofficial level crossings on the railway system;

- progressive installation of barrier protection and flashing road warning signals at 833 official, but currently unprotected, crossings; and

- installation of manual or train-actuated road warning signals at all 367 protected crossings on the railway system.

Initial priority in the programme, which would have a total cost estimated at VND 831,690 million (US$ 64 million), would be given to the officialization of, and installation of barrier protection and flashing road warning signals at 431 unofficial crossings with a particularly poor safety record. It was expected that the programme would be undertaken in 3 phases, the elapsed time of each phase depending upon the level of funding assistance to be provided by the government. Funding was expected to be sourced mainly from local government authorities as well as from local community level crossing users (although the form of funding by the latter, be it from tax revenues or direct charges, was not specified). To date, the central government has not indicated its approval of the programme.

Details of the elements and costs of the programme are given in Table 2.22.

[3] Recent construction of a road overpass bridge on the Hanoi-Ho Chi Minh City mainline with a total length of 33.84 metres was estimated to cost VND 95,117 million (US$ 7.3167 million). This cost is equivalent to VND 2,811 million (US$ 216,215) per metre.

Table 2.22: Proposed Level Crossing Upgrading Programme, Viet Nam

Programme objective	Type of installation	Number	Unit Cost VND Mill. (US$ Mill.)	Total cost VND Mill. (US$ Mill.)
Officialization/upgrading of unofficial level crossings	Manual lifting barrier (with flashing road warning signals)	31	410 (0.0315)	12,710 (0.9777)
	Automatic lifting barrier	217	300 (0.0231)	65,100 (5.0077)
	Automatic road warning signals (steady light)	3,394	127 (0.0098)	431,038 (33.1568)
	Sub-total	*3,642*		*508,848 (38.1422)*
Upgrading of official unprotected crossings	Trolley gates (manual) with flashing road warning signals	29	550 (0.0423)	15,950 (1.2269)
	Manual lifting barrier (with flashing road warning signals)	138	410 (0.0315)	56,580 (4.3523)
	Automatic lifting barrier	666	210 (0.0162)	139,860 (10.7585)
	Sub-total	*833*		*212,390 (16.3377)*
Upgrading of official protected crossings	Road crossing resurfacing	367	30 (0.0023)	11,010 (0.8459)
	Flashing road warning signals (for manual lifting barriers)	367	210 (0.0162)	77,070 (5.9285)
	Service roads along railway lines	44,744 (m)	0.5	22,272 (1.7209)
	Sub-total	*367*		*110,452 (8.4963)*
TOTAL PROGRAMME				*831,690 (63.9762)*

Source: Vietnam Railways.

Upgrading of the initial tranche of 431 unofficial crossings would be undertaken during phases I and II, for a total cost estimated at VND 101,051 million (US$ 7.77 million). Vietnam Railways has also proposed an alternative programme under which all elements in the above table would be undertaken except installation of automatic road warning signals at unofficial crossings other than the priority group of 431. The overall cost of the alternative programme has been estimated at VND 423,893 million (US$ 32 million), or about half that of the preferred alternative.

In addition to the above, Vietnam Railways recently took a series of technical and administrative measures to improve level crossings safety. Thus, 579 level crossings have recently been paved with concrete panels, 172 have been bitumen-surfaced and another 374 have been gravelled. Furthermore, in an effort to increase the vigilance of gatekeepers, their working rules have been amended. While they previously worked a 12-hour shift and went off duty for 24 hours, they now work an 8 hour shift before going off duty for 16 hours.

Other initiatives taken by the Vietnam Railways to improve level crossing safety have been focused on community awareness broadcasts on national television and provision of assistance to education authorities in the preparation of materials for dissemination in schools. However, the railway administration lacks an effective budget for activities of this type.

2.5.7 Level crossing safety impediments

In common with other Asian countries, Viet Nam suffers from a general lack of a safety ethos, or of an awareness in the wider community of the crucial importance of safe living and working practices. This is perhaps the biggest impediment faced by the railway in seeking to reduce the incidence and consequences of accidents at its level crossings, since this factor is likely to frustrate the efforts of the railway to reach the community through public safety education programmes. The indiscipline of some road users in Viet Nam was exemplified by visits to several level crossing locations where road vehicles continued to proceed through crossings even as the barriers were being closed (see Photograph 1 showing the large trolley-gate protected crossing at the Dai Co Viet/Le Dzuan intersection).

Photograph 1

To some extent poor general education levels may also constrain the effectiveness of public safety education programmes, but there is no evidence of a necessary link between the overall level of education and safety awareness. While a strong case exists for augmenting Vietnam Railways' budget for and role in public safety education, it has to be accepted that the benefits of this measure are unlikely to be achieved in the short term.

The second major impediment is the apparent failure of the railway to prevent the illegal construction of level crossings by local communities. Viet Nam has one of the greatest proliferations of unofficial level crossings in Asia and Vietnam Railways has indicated that unofficial crossings account for about 60 per cent of all level crossing accidents. The fact that most of the railway right of way in Viet Nam is not fenced and (for reasons of cost) is impractical to fence, exacerbates this problem. There is no certainty that the railway's plan to install automatic road warning signals at all current unofficial crossings will be approved and even if it is there are doubts about the effectiveness of this measure (unaccompanied by some form of barrier protection) in reducing the frequency of level crossing accidents. For this reason, there appears to be no realistic alternative to strengthening the powers (and the resolve) of railway staff to enforce the government's safety directives and rules in order to eliminate further proliferation of unofficial level crossings.

A third impediment relates to the poor physical layout of many level crossings (even official crossings) in Viet Nam. An inspection of level crossings south of central Hanoi, during the ESCAP mission, indicated:

- severely restricted track visibility at the approaches to most of the crossings visited. In some cases, it was not possible for motorists to have a clear view of the track in both directions until they had nearly entered the crossing (see Photographs 2 and 3, page 43); and

- placement of road warning signboards too close to the track to be able to provide motorists with adequate advance warning of a crossing. In the case of some of the crossings visited only one warning sideboard was provided either side of the track and it was situated not more than 1.5-2.0 metres from the nearest rail (see Photographs 3, 4 and 5, page 43-44).

The combination of these two factors at unprotected level crossings could produce a potentially life-threatening situation. Indeed, at the unprotected crossing featured in the photographs, the study team were informed that there had recently been accidents involving fatalities at that location and that the railway had recently been requested to install barrier protection there.

The restricted visibility of the track at some locations was clearly caused by the dense concentration of shophouses too close to the track (see particularly Photograph 2). If existing building regulations do not provide for adequate spatial separation of buildings from the boundary of the railway right-of-way, the railway would be well advised to urge the relevant authorities (through the Ministry of Transport and Communications) to have these regulations amended accordingly.

The placement of road warning signs is a matter falling within the responsibility of road authorities who must provide signage, as well as the road approaches, located outside the railway right-of-way (the railway being responsible for all items located within the railway right-of-way, including barriers and warning signals as well as the road pavement across the tracks). Photograph 2 also provides a good example of how road warning signboards located too close to the tracks can be obscured by commercial signage located a further distance from the track.

Photograph 2

Photograph 3

Photograph 4

Photograph 5

2.6 Level crossing safety in Bangladesh, Philippines and Thailand

2.6.1 Level crossing safety record

(a) Accidents

Table 2.23 shows data on level crossing accidents for the railway organizations of Bangladesh, the Philippines and Thailand.

Table 2.23: Level crossing accidents, 1988-1998

Year	Bangladesh	Philippines	Thailand
1988	15		
1989	7		
1990	10		
1991	7		
1992	9		
1993	10		
1994	14		
1995	15		
1996	9		
1997	23		
1998	17		
Total	136	466	4,688

Source: Questionnaire responses, Bangladesh, Philippines and Thailand.

Level crossing accidents represent a substantially high proportion of all railway accidents in Thailand (94.6 per cent between 1988 and 1998), but a minor proportion of all railway accidents in the Philippines (29.6 per cent between 1988 and 1998), and an even more modest proportion of all railway accidents in Bangladesh (3.8 per cent between 1988 and 1998).

When compared with the volume of traffic, as represented by train-kilometres, the rate of level crossing accidents in Bangladesh is quite high (0.74 per million train-km for the seven year period 1988-1995), but is insignificant as compared with Thailand (12.9 per million train-km for the five year period 1991-1995). No comparable data were available for the Philippines.

(b) Fatalities

In Thailand, fatalities in level crossing accidents represent the vast majority (92 per cent) of all deaths in all types of railway accidents throughout the railway network. In Bangladesh, fatalities in level crossing accidents represent 46 per cent of deaths in all types of railway accidents – a much higher proportion than the proportion of level crossing accidents in total railway accidents, possibly because of the heavy incidence of bus accidents in the railway accident total. In the Philippines, however, level crossing accidents account for only 5 per cent of the total number of fatalities in railway accidents.

Table 2.24: Level crossing fatalities, 1988-1998

Year	Bangladesh	Philippines	Thailand
1988	4		
1989	8		
1990	5		
1991	4		
1992	12		
1993	4		
1994	16		
1995	25		
1996	16		
1997	10		
1998	18		
Total	122	4	414

Source: Questionnaire responses, Bangladesh, Philippines and Thailand.

Again, when related to traffic volumes, the level crossing fatality rate in Thailand is disturbingly high – 1.05 per million train kilometres – but even at this level, the Thai fatality rate is only about one fifth of the rate experienced by Viet Nam, which has the worst level crossing safety record of any country reviewed in this study. In Bangladesh, the fatality rate averaged 0.66 per million train kilometres, somewhat lower than the accident rate. No comparable data were available for the Philippines.

(c) Injuries

In Thailand, the number of persons injured in level crossing accidents represents the major proportion (76 per cent) of all persons injured in all railway accidents throughout the system, while in Bangladesh the percentage injured in level crossing accidents is 44 per cent and in the Philippines 31 per cent.

Table 2.25: Level crossing injuries, 1988-1998

Year	Bangladesh	Philippines	Thailand
1988	19		
1989	16		
1990	37		
1991	36		
1992	39		
1993	19		
1994	60		
1995	63		
1996	30		
1997	37		
1998	58		
Total	414	462	1,088

Source: Questionnaire responses, Bangladesh, Philippines and Thailand.

The comparative analysis of level crossing safety performance in these three countries and also in Viet Nam has to be tempered by the fact that motorization levels in Thailand are many times greater than they are in Bangladesh and in Viet Nam and several times greater than they are in the Philippines.

2.6.2 Level crossing characteristics and effectiveness

(a) Number and density of level crossings

Data provided by the railway systems of Bangladesh, the Philippines and Thailand indicate the following level crossing populations, by type, on each network:

Table 2.26: Density of level crossings and number, by type

Route length/type of level crossing	Bangladesh	Philippines	Thailand
Route-km	2,734	484	4,041
Official – protected, no.	402	49	467
Official – unprotected, no.	926	161	1,145
Unofficial (unprotected), no.	821	98	625
Total	2,149	308	2,237
Level crossing density, no. per km	0.79	0.64	0.55
Level crossing spacing, one every _ km	1.3	1.6	1.8

Source: Questionnaire responses, Bangladesh, Philippines and Thailand.

Of the three countries reviewed, Bangladesh has the greatest density of level crossings (one every 1.3 km) and the highest percentage of unofficial crossings (38 per cent). Curiously and conversely to what might be expected, these characteristics are not reflected in higher accident, fatality and injury rates – which might suggest that the safety performance data are understated. For example, it has to be questioned whether railway safety statistics capture full details of the numbers of ***road users***, as distinct from railway passengers, killed or seriously injured in level crossing accidents.

None of the above three railway systems has what might be considered an acceptable percentage of protected level crossings. However, it is significant that Thailand with only 21 per cent of its level crossings protected had unacceptably high accident and casualty rates.

(b) Technical characteristics of level crossings

Table 2.27 provides details of the level crossings of Bangladesh, Philippines and Thailand classified according to their equipment and manning status. ***Nearly all protected crossings in these countries are manned.*** Only Thailand has a significant number of open crossings equipped only with flashing lights and audible warning devices.

No details of the accident/casualty histories of these various types of level crossings were provided, so that it was not possible to make any definitive comment on their safety effectiveness.

During 1999, Thailand brought into service the first 14 of a new type of level crossing equipped with barriers, flashing lights and audible warning devices and closed circuit television (CCTV) allowing control from a remote location. It is understood that this system is similar to the British MCB/CCTV (Manually controlled barriers with CCTV) style of crossing. The apparent advantage of this system is that it would permit ***manual control*** of one or more crossings from a single location, resulting in staff savings and reduced operating cost. Its disadvantage might arise from the fact that level crossing staff would not be on hand to respond in an emergency.

Table 2.27: Level crossing population, by technical classification

Country/Railway System	Crossing type – description	Number on system (as at June 1999)
Bangladesh*	Mechanical full width lifting barrier (manned)	123
	Mechanical half width lifting barrier (manned)	22
	Electrical and mechanical half width lifting barrier (manned)	6
	Mechanical full width swinging gate (manned)	251
	Total, protected	*402*
Philippines	Mechanical barrier with flashing lights, bells and fixed road signs (manned)	4
	Mechanical barrier with bells and fixed road signs (manned)	8
	Mechanical barrier with flashing lights and fixed road signs (manned)	1
	Mechanical barrier with fixed road signs (manned)	14
	No barrier, bells and fixed road signs only (manned)	3
	Fixed road warning signs only (manned)	18
	Total, protected	*48*
	Fixed road warning signs only (unmanned)	135
	Automatic lifting barrier and fixed road warning signs (unmanned)	4
	No barrier, automatic flashing lights and bells with fixed road signs (unmanned)	1
	Automatic barrier and bells only (unmanned)	1
	No equipment or signage (unmanned)	119
	Total, unprotected	*260*
	Grand Total	***308***
Thailand	Electrical full or half width lifting barrier with remote control and CCTV (manual)	14
	Electrical full or half width lifting barrier (manual)	104
	Mechanical full or half width lifting barrier (manual)	34
	Mechanical full or half width hoisting barrier (manual)	230
	Sliding trolley gate (manual)	16
	Automatic half width lifting barrier (unmanned)	64
	Total, protected	462
	Open crossing with automatic flashing warning light only (unmanned)	31
	Fixed road warning signs only (unmanned)	1,113
	Total, unprotected	1,144
	Grand Total, official crossings	***1,606***

Source: Questionnaire responses, Bangladesh, Philippines and Thailand.

* *In the absence of details of unprotected level crossings in Bangladesh, it was assumed that they are all unmanned without any form of equipment or signage.*

2.6.3 Level crossing system evaluation techniques

In Bangladesh, level crossing installation and upgrading priorities are established on the basis of the ***assumed*** road and rail traffic volume likely to use crossings in future. The Bangladesh Railway does not take counts of road traffic and consequently road traffic density at individual crossings is known only from local experience.

Similarly, in the Philippines railway staff do not take road traffic counts – neither is this information forthcoming from the highway authorities. Consequently, priorities for the installation of new level crossings or the upgrading of existing crossings are not established on the basis of expected road and rail traffic density. Rather, the Philippine National Railways applies criteria based on the location of a crossing. For example, if the crossing is located inside Metro Manila it must be staffed and at minimum equipped with lifting barriers flashing lights and fixed road warning signs. On the other hand, if the crossing is located in a rural area it is provided with fixed road warning signs only. Altogether, the PNR classifies its level crossings into eight groups having homogeneous locational characteristics.

In Thailand, an index of road and rail traffic, called a Traffic Moment (TM) indicator is used to establish priorities for level crossing installation or upgrading. State Railway of Thailand staff presently take road traffic counts on an as required basis, but for the future plan to take counts at least once a year for the busier road/rail intersections. The decision criteria used by the SRT and based on TM indicators for individual crossings are as follows:

TM Range	**Indicated type of crossing**
$TM \leq 10{,}000$	Fixed road warning signs only
$10{,}000 < TM \leq 100{,}000$	Manual barriers
$100{,}000 < TM$	Road overpass or underpass

It appears however that these decision criteria have not been rigorously applied due mainly to funding shortages. The decision taken nearly three years ago to cancel a massive track elevation project for Bangkok (the Hopewell project) has compounded the problem of resolving road and rail conflicts inside one of Southeast Asia’s most congested cities.