CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 General

This chapter presents the conclusions and main recommendations flowing from the analysis of level crossing systems and safety performance in several developed and developing countries. Among other things, this analysis compared and contrasted level crossing safety performance in selected countries of Western Europe, in North America and in Japan against the corresponding performance in the developing countries of the ESCAP region in an effort to establish whether lessons could be drawn from the experience of the former group of countries.

5.2 Conclusions

5.2.1 Comparative level crossing safety performance

Table 5.1 presents a comparison of the level crossing characteristics and safety performance of a selection of developed and developing countries.

The principal conclusions, which may be drawn from this comparison are that:

(i) those countries which performed best in terms of having a low incidence, per rail traffic unit, of accidents, fatalities and injuries at level crossings are countries which have a high proportion of their level crossings protected against infringement by road traffic, either by manually operated or automatic barriers;24;

(ii) automatic barriers are not always a fully effective form of protection against collisions between trains and road vehicles at level crossings (the relatively high rates of accident and casualty occurrence in the Netherlands due to S-moves through half barrier protected crossings provide ample evidence of this);

(iii) of the seven countries participating in this level crossing study, the three which have both the greatest level crossing density and the lowest percentage of protected level crossings (Viet Nam, Thailand and Bangladesh) also have the highest accident and casualty rates; and

(iv) those participating countries which have a relatively high proportion of manned level crossings (i.e. India and the Islamic Republic of Iran) also perform best in terms of level crossing accident and casualty occurrence.

5.2.2 Comparative costs of level crossing systems

In addition to the conclusions drawn from the comparative analysis, the study demonstrated that the costs of installing manually operated barriers are significantly lower than those associated with the installation of automatically activated barriers.

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24 The major exception to this observation is the Russian Federation, which ostensibly has the lowest accident and casualty rates of any of the countries compared, yet has more than half of its level crossings without any form of barrier protection.
There are two main reasons for this – that automatic barriers will require the installation of costly level crossing obstruction detectors and that simple manual barriers can usually be manufactured domestically, whereas the more sophisticated automatic barrier equipment will usually need to be imported.

Based on Japanese data, the cost of installing automatic full width barriers with road and rail warning lights and crossing obstruction detectors at a level crossing on a single track section is approximately US$ 77,000, whereas the cost of installing manually operated barriers with flashing warning lights at the same crossing (based on Indian data) is approximately half this amount, or US$ 39,000. Based on Indian data, the annual costs of operating and maintaining automatic and manual barrier installations are about US$ 1,100 and US$ 6,300, respectively. If the capital cost of these installations is to be written off over a period of 15 years, the saving in O&M cost associated with an automatic barrier system would be insufficient to cover its additional capital cost.

5.2.3 Do the railway systems of the region have an adequate information base for setting level crossing upgrading priorities?

In general, the answer to this question is “no”. In none of the railway systems participating in this study was it apparent that any regular analysis of risks was undertaken in respect of level crossings, or indeed of any other type of railway accident.

Moreover, few of these railway systems appear to have an adequate safety information system, which would support any rigorous assessment of safety hazards and risks. While several appear to have a computerized inventory of their level crossing installations, very few if any appear to have an accident reporting system capable of providing detailed accident information in respect of individual level crossings.

Regular risk assessment is an essential foundation for establishing priorities for level crossing grade separation or protection works. This is especially true for railway systems, which face severe capital funding restrictions, but have both a high level crossing density and a low proportion of protected level crossings. Such systems do not have the resources to be able to grade separate or to protect a majority of their level crossings and must therefore concentrate their expenditures on safety enhancements which will produce the greatest returns in the form of reduced safety risk and accident occurrence. Thus, they need to be able to identify and prioritise these projects on the basis of systematic risk assessments. For this, they will need at minimum an information system which can provide updated information on: the physical environment and equipment of individual level crossings; the daily level of road and rail traffic through individual crossings; and the detailed accident histories of these crossings.

5.2.4 Are the railways of the region committed to road user education programmes and potentially how effective are these programmes?

The overwhelming majority of all collisions between trains and road vehicles at level crossings are caused by the negligence, incompetence or incapacity of road vehicle drivers. That fact having been established, it would appear that education of road vehicle drivers should have priority in the expenditure budgets of railway organizations. However, at this point in time, such is not generally the case.
Table 5.1: Comparative analysis of level crossing characteristics and safety performance in selected developed and developing countries

<table>
<thead>
<tr>
<th>Country/Railway System</th>
<th>Route – km</th>
<th>Number of level crossings</th>
<th>Level crossing density (crossings/km)</th>
<th>Predominant type of level crossing</th>
<th>Accident rate (per mill.train-km)</th>
<th>Fatality rate (deaths/mill. Train-km)</th>
<th>Injury rate (per mill.train-km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>31,200</td>
<td>17,514</td>
<td>0.56</td>
<td>Automatic half width barrier, unmanned (64%)</td>
<td>0.33</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2,808</td>
<td>2,964</td>
<td>1.06</td>
<td>Automatic half width barrier, unmanned (68%)</td>
<td>1.01</td>
<td>0.28</td>
<td>0.29</td>
</tr>
<tr>
<td>United States</td>
<td>212,400</td>
<td>259,435</td>
<td>1.22</td>
<td>Unprotected and unmanned, equipped only with fixed road warning signs</td>
<td>2.01</td>
<td>0.25</td>
<td>0.75</td>
</tr>
<tr>
<td>Japan</td>
<td>27,230</td>
<td>37,326</td>
<td>1.37</td>
<td>Automatic full width barrier, unmanned (83%)</td>
<td>0.36</td>
<td>0.10</td>
<td>0.12</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>2,734</td>
<td>2,149</td>
<td>0.79</td>
<td>Official unprotected, unmanned (43%)</td>
<td>0.74</td>
<td>0.66</td>
<td>2.46</td>
</tr>
<tr>
<td>India</td>
<td>62,495</td>
<td>40,445</td>
<td>0.65</td>
<td>Official unprotected, unmanned (51%)</td>
<td>0.10</td>
<td>0.21</td>
<td>0.28</td>
</tr>
<tr>
<td>Islamic Republic of Iran</td>
<td>5,995</td>
<td>418</td>
<td>0.07</td>
<td>Manual full width lifting barriers (48%)</td>
<td>0.64</td>
<td>0.11</td>
<td>0.17</td>
</tr>
<tr>
<td>Philippines</td>
<td>484</td>
<td>308</td>
<td>0.64</td>
<td>Official, unprotected and unmanned, equipped with fixed road warning signs (52%)</td>
<td>Not available</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>86,151</td>
<td>13,581</td>
<td>0.16</td>
<td>Official, unprotected and unmanned, but equipped with automatic flashing road warning lights (41%)</td>
<td>0.04</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>Thailand</td>
<td>4,041</td>
<td>2,237</td>
<td>0.55</td>
<td>Official, unprotected and unmanned, equipped with fixed road warning signs (51%)</td>
<td>12.9</td>
<td>1.05</td>
<td>3.00</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>2,712</td>
<td>4,842</td>
<td>1.79</td>
<td>Unofficial, unprotected, and unmanned (75%)</td>
<td>Not available</td>
<td>5.29</td>
<td>10.40</td>
</tr>
</tbody>
</table>

Sources: Country reports; UIC; Railway system information booklets; “Operation Lifesaver” website; AAR website.
Notes: (1) “Protected” level crossings are at grade rail over road crossings which have some form of barrier protection against road vehicle infringement.
(3) US accident and casualty rates were derived from Association of American Railroads (AAR) data which for 1998 show an overall railway accident rate of 3.6 accidents per million train-miles and about 90 per cent of all railway accidents occurring at level crossing.
The Indian Railways, for one, participates in driver safety education programmes with an emphasis on level crossing safety. However, level crossing accidents account for only 15 per cent of all railway accidents in India and an infinitesimally small proportion of all road traffic accidents. Consequently, there is little incentive for the Indian Railways, and even less incentive for the Indian highways authorities, to allocate a large budget to level crossing user education programmes.

Additionally, low levels of general education and safety awareness throughout the developing countries of Asia have tended in the past to minimize the effectiveness of level crossing user education programmes. Nevertheless, increasing disposable incomes and motorization levels in India and in the other developing countries of the region suggests that these education programmes should receive greater priority in future.

5.2.5 Traffic threshold criteria for level crossing improvement

Most of the region’s railways apply traffic threshold criteria as a basis for determining the type of level crossing installations, which should be provided at individual road/rail intersections. In most cases, these criteria are based on the combined daily rail and road traffic passing through level crossings and are designated “Traffic Moment” indicators. They are computed as the product of daily train numbers and the daily numbers of road vehicles using the crossing. At the bottom end of the TM scale, minimal level crossing installations are indicated. At the top end of the TM scale, grade separation of crossings is indicated.

In some cases (for example in Viet Nam) the TM indicators have been set at unrealistically low levels and consequently are not capable of practical application. In other cases (for example in India), while the TM indicators have been set at realistic levels, budget restrictions have prevented full application of the TM criteria. Thus, in India for example, where a TM value of 100,000 indicates that a crossing should be grade separated, there are many level crossings which have long since passed this threshold level, yet have still not been grade separated.

In Japan, the JR West Railway Company has recently introduced a composite index based on allocated scores to determine the standard of level crossing protection required at individual locations. In addition to road and rail traffic densities, other factors to which scores are assigned include the accident histories and physical characteristics of individual crossings. High aggregate scores will indicate priority for grade separation. Low aggregate scores will suggest minimal standards of level crossing protection. Still other criteria have been developed which incorporate scores for level crossing closure time (high = low closure time; low = high closure time). While a case may be made out for improving the criteria applied to level crossing improvement, it is unlikely that there would be a better substitute for TM indicators set at realistic levels, supplemented by accident risk assessments.

5.2.6 Level crossing safety and operational efficiency

While level crossing safety must be a paramount consideration for railway managements, it is equally important that they should not loose sight of their operational objectives, including making most efficient use of the line capacity provided by current infrastructure and signalling configurations. Thus, it should be the objective of railway managements to ensure that train speed restrictions at level crossings do not unduly restrict a system's train throughput capacity. Barrier closing
devices and warning systems should be compatible with the operation of trains through crossings at normal speeds.

On the other hand, long barrier closure times can have an adverse impact on safety on densely trafficked crossings, if they produce road traffic build-up to such an extent that crossings cannot be cleared of road traffic before the next train arrival. Long barrier closure times can also incite driver impatience and lead to barrier breakthroughs, which might easily result in collisions.

Invariably, a requirement for reduced barrier closure times will mean that existing manually operated barriers should be converted to electrical operation. It may also mean that signalling systems requiring long barrier closure times (such as the outdated Absolute Block systems) should be replaced by more modern signalling systems which can accept shorter crossing closure times.

5.3 Recommendations

From these conclusions a number of possible courses of action may be identified. The following recommendations are offered as guidelines for consideration and possible application by the railway managements of the region in dealing effectively with their level crossing problems:

(i) The railway managements of the region should re-evaluate their approach to monitoring level crossing safety and to setting priorities for implementing safety enhancement measures for level crossings on their respective systems.

In particular, they should give careful consideration to introducing effective Safety Management Systems along the lines of the model system described in Chapter 4.

(ii) Wherever justified by the combined density of road and rail traffic, the railway systems of the region should give first priority to the grade separation of their level crossings.

While grade separation is undeniably the most effective means of enhancing level crossing safety, the cost of constructing road under or over-passes is very high and often beyond the financial means of some of the railways of the region. Choice of this solution must therefore be influenced strongly by a realistic assessment of the combined density of the road and rail traffic likely to use current road/rail intersections.

(iii) Desirably, all railway systems of the region should carry out regular safety audits and risk assessments for all of their level crossing installations.

Use of a Safety Management Information System supplemented by application of risk evaluation techniques along the lines of those described in Chapter 4 will improve the capability of railway managements to identify and prioritise level crossing safety enhancement measures.
(iv) **Railway managements should take action either to close, or to provide effective protection for, all “unofficial” level crossings on their systems.**

In the case of some railway systems of the region (notably that of Viet Nam) substantial improvement of level crossing safety will simply not be possible unless the unofficial crossing problem is addressed effectively.

(v) **Rather than committing scarce capital funds for the acquisition of sophisticated automatic systems of level crossing protection, railway managements should adopt a policy of manning currently unprotected crossings and equipping them with inexpensive locally manufactured barrier and warning systems wherever this is indicated by assessments of traffic density and/or adverse physical factors at specific crossings.**

While labour costs are still inexpensive in most countries of the region, manually operated level crossing barriers and warning systems (perhaps complemented by electrical activation mechanisms) provide the most cost effective method of providing a maximum level of safety at all but the most densely trafficked crossings, which in any event would normally qualify for grade separation. Alternative automatic protection systems (especially the half-barrier systems widely used in Europe) do not have a particularly good record of safe operation and, in the absence of crossing protection staff, require the installation of expensive crossing obstruction detectors in order to guarantee minimum levels of safety.

(vi) **Railway managements should actively seek funding assistance for level crossing improvements or grade separation from road authorities.**

There is a particularly strong argument for such an approach when road traffic is shown to be growing at a faster rate than rail traffic.

(vii) **Railway managements should be prepared to develop carefully targeted campaigns directed at the education of level crossing users and to ensure that adequate priority is attached to the funding of these campaigns.**

Particularly as disposable incomes and motorization levels are increasing throughout the region, the railways of the region should intensify their efforts to improve level crossing safety awareness throughout the communities they serve. While wide use should be made of the mass media (newspapers and television), note should be taken of simpler, but effective, methods of delivering public education programmes. In India, the use of punjayat, or local village council, offices as a vehicle for disseminating level crossing safety information appears to have proven effective and is recommended as a model for adoption by other railways of the region.