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An Asset Management Model for Indian Railways Safety

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Abstract: Railway Safety is an organization that coordinates the activities of the fragmented railway industry in India with respect to safety. This study describes the Asset Management model, which is one of a suite of tools developed in recent years to improve the targeting of the industry"s efforts in safety improvement in an impartial and scientifically supportable manner. The model uses fault tree analysis and cause/consequence techniques to predict residual levels of safety risk, after the industry"s current safety control measures are applied, using observed safety performance data. The model can also be used to test the effect of proposed new controls on risk levels. The research is aimed at suggesting an asset management model for the Indian Railway safety. Asset management approaches may allow Indian Railways to allocate spending on rail safety to maximum economic effect. Asset management here means a holistic, systematic and optimal way of managing assets to achieve desired outcomes in a sustainable way. This research and discussions with rail stakeholders suggests that such an asset management model does not exist either for any rail systems. Investigating suitable asset management models, the work was unable to find a truly strategic model either from other sectors nor a generic model capable of being applied to rail. The research suggests that a strategic gap exists, and that other sectors that are highly dependant on the performance of physical assets may benefit from such a model to enable them to more effectively and efficiently deploy assets for both operational and safety performance.

Key words: Indian railways safety, asset management, safety tool

INTRODUCTION

Brief introduction to asset management: At face value, ‘asset management’ is exactly what it says: managing assets. However, it is often used in a more restrictive way and for the purposes of this work may be usefully taken as the definition: ‘the optimum way of managing assets to achieve a desired and sustainable outcome’ and as only applying to physical assets such as track, rather than, for example human resources or intangible assets (e.g., reputation).

The key point is that it refers to optimising the management of assets, which implies a holistic, systematic and structured approach. Essentially, the approach comes from recognising that whilst doing too much maintenance is overly expensive, cutting back on maintenance or making too little capital investment can be a false economy because of increased and unexpected failure of equipment or reduced quality of products. Thus the optimum is to be found somewhere in between these 2 extremes (BSI, 2004a).

The main driver for developing the techniques has been more effective performance for organisations, whether through cheaper unit costs or more consistent (or higher) quality products. However, since failures are likely to cause accidents if they occur in safety critical equipment, an asset management approach can be applied to controlling safety risk. As will be discussed later in the report, safety will often be an aspect of described asset management approaches but is usually not the main focus (BSI, 2004b).

Interest in asset management: Policies for obtaining and maintaining physical assets on the Indian railways have evolved over the last 150 years or so (the approximate age of the national rail network). Currently, Government spending on the railways is around 60,000 crore rupees a year, when other income such as ticket sales are considered, it becomes clear that running the Indian railways is expensive and thus the money available needs to be allocated carefully. It appears that the rail industry, and particularly Network Rail as the infrastructure controller, are recognising a strategic gap on asset management. A suitable strategy would ensure that resources are effectively and efficiently deployed in a systematic way to deliver outputs on operational and safety performance across the railways system. Given that the available budget is limited and represents a large amount of money, even a proportionally small gain in performance is attractive.

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Since, the railways are to be run such that the safety risk is As Low As is Reasonably Practicable (the requirement to be 'ALARP'), in the absence of such a model it is difficult to be sure whether the rail network as a whole is 'ALARP'; that is, whether spending on safety is optimal. Hence, efficiency gains are a motive for investigating the application of asset management techniques to railway safety.

However, a more important reason from a strictly safety point of view is that Indian Railways wish to be able to demonstrate that they have confidence that railway safety is being properly managed. An asset management approach, which would demonstrate what performance was required of assets and why particular safety standards were set, would go some way to satisfying this wish. As will be discussed, there is common ground here with the role of railway safety cases (Fig. 1).

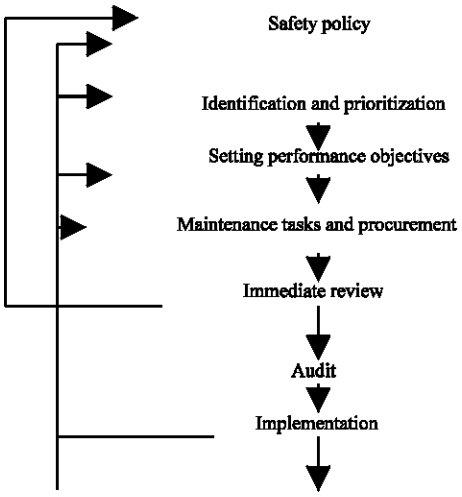

Fig. 1: Outline asset management model

Literature review: Safety is the prime concern of Indian Railways and considerable progress has been made in the execution of works sanctioned under Special Railway Safety Fund (SRSF). A non-lapsable SRSF of Rs. 17000 crore is operational since October 2001. Safety works worth Rs. 14,912 crore have already been completed upto 31.03.07 and another Rs. 1882 crore is targeted to be utilized in the financial year 2007-08. The Corporate Safety Plan for the period 2003-2013 lays down the objectives, targets and strategies which Indian Railways would be pursuing as financial schemes, involving huge investment of Rs. 31,835 crore including SRSF. The action plan indicates broad time frames for safety related works, rehabilitation and modernization of assets, induction of appropriate technologies to bring qualitative changes and reduced human dependence to prevent accidents.

Anti Collision Device (ACD), which is an on-board train protection device and also the first ever device in the world indigenously developed by Konkan Railway, will be in place by 2013 on the entire Indian Railway network so as to reduce chances of collisions. Pilot implementation of ACD, indigenously developed by Konkan Railway, has been successfully commissioned on the Northeast Frontier Railway this year. Survey for expanding the system to another 10,000 route kilometres falling on the critical and busy sections of the network is almost completed. The installation of this device will go a long way in preventing accidents due to collision, which is more fatal in nature.

The application of this device has been refined to not only prevent mid section collisions but also to preempt their occurrences in station yards. The newly engineered solution is integrated with the signalling systems and

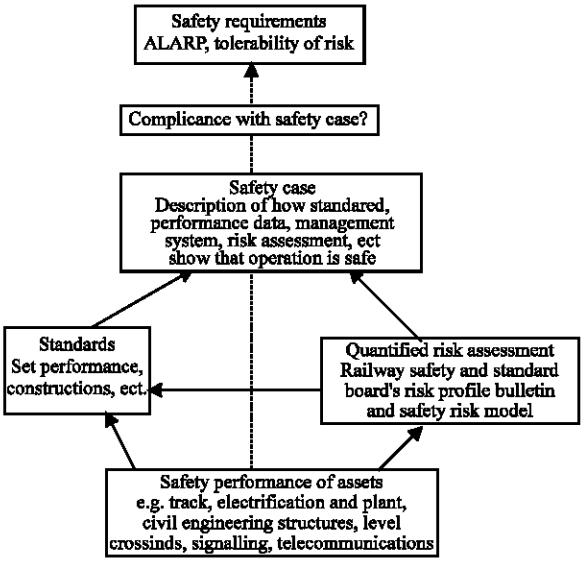

Fig. 2: Rough Representation of how safety is managed on the railway network

interlocking to react appropriately in case collision like conditions are perceived at the time of reception and dispatch of trains from a station (News@indlaw.com).

Figure 2 gives a crude representation of how safety is ensured on the railways and where asset management could help, from a purely safety point of view. The top of the figure shows the 'Safety Requirements' that the railway must meet and the bottom of the figure shows the safety performance of assets (e.g., how often tracks fail). Thus poor safety performance of assets means the safety requirements are not met. The middle ground concerns how safety is controlled and managed on the railways- 'quantified risk assessment' represents analysis of safety

performance, showing where the highest risks are and 'standards' represents the way required performance of assets is specified. What is not always clear is how safety performance and its analysis is used to set standards, which is a connection that an asset management approach would make. Another key question, both for the operator and the regulator, is whether the safety case is being complied with. An asset management approach (which would be recorded) would make it easier to ascertain that an operator was efficiently managing their risks.

An important point to note is that an asset management approach implies tackling these two areas-of optimisation and safety management-in a strategic, global manner rather than in an isolated manner for particular assets (a more tactical approach). That is, the railway infrastructure is treated as a single system taking into account the many interconnections between various assets and associated procedures. There are (at least) 2 other key questions that, as will be argued in later sections, an asset management approach can help to answer:

- How safe is safe enough?
- How can spending resources on safety be in conflict with spending resources on improved performance?

These issues will be discussed later but it is worth noting that, for (1), a factor to be considered is whether there is agreement (do the operator, regulators and other stakeholders have the same views) and for (2), that there is a large synergy between performance and safety (since a reliable, punctual service implies a safe service).

The following key dimensions of asset management are given:

- Holistic-taking a larger view.
- Systematic-a methodological, consistent, justifiable and auditable approach.
- Systemic-optimising the system as whole, rather than individual assets.
- Risk based-identifying risks and associated costs/ benefits and prioritising accordingly.
- Optimal-establishing the optimum balance between performance, cost and risk.
- Sustainable-taking a long term and life cycle approach.

These dimensions are consistent with other literature read in the preparation of this review and are thus proposed as a good summary of the general approach required for effective asset management. Performance requirements and risks should be costed to facilitate comparison. The guidance suggests that in cases where this is difficult, costs could be estimated by asking 'what would we be prepared to pay to avoid harm to our reputation?' One of the important findings of various authors is that the rate of breakage is found to increase with the age of the rail and other factors, such as track geometry, were found to be important (Dick, 2003). There is a strong emphasis on prioritising maintenance from a safety risk-type assessment rather than a business risk-type approach. From the physical asset management pint of view, Asset management is defined as 'systematic and coordinated activities and practices through which an organisation optimally manages its assets, and their associated performance, risk and expenditures over their lifecycle for the purpose of achieving its organisational strategic plan' and more succinctly, as 'the optimum way of managing assets to achieve a desired and sustainable outcome' (Hughes, 2002).

MATERIALS AND METHODS

Asset management for railway safety: This study discusses the application of asset management to rail safety. It is beyond the scope of this report to recommend a definitive model for asset management to rail safety; nevertheless, this study gives an outline of what such a model might look like and gives some prerequisites for such an approach.

The Indian rail system is large and complex meaning that application of asset management would be a large exercise, therefore attention is given to making use of existing information. Implicit in the smooth and effective application of asset management to railway safety is the ability of the various departments and organisations that form the Indian rail industry to work closely together. Therefore, whilst the initial brief for this research was to focus on Network Rail, the following discussion is framed in terms of the rail industry i.e. including train operating companies and train leasing companies. Note also that successful application of asset management to the railway network is consistent with what should be described in a railway safety case, since it is a structured system for ensuring an organisation does what it (reasonably) can to improve safety. That is, the safety case should contain an organisation's asset management arrangements. An effective asset management system should lead to an integrated approach to risk management on the railways i.e., treating the railway industry as a single system, allowing the wider effects of an asset procurement or maintenance decision to be appreciated.

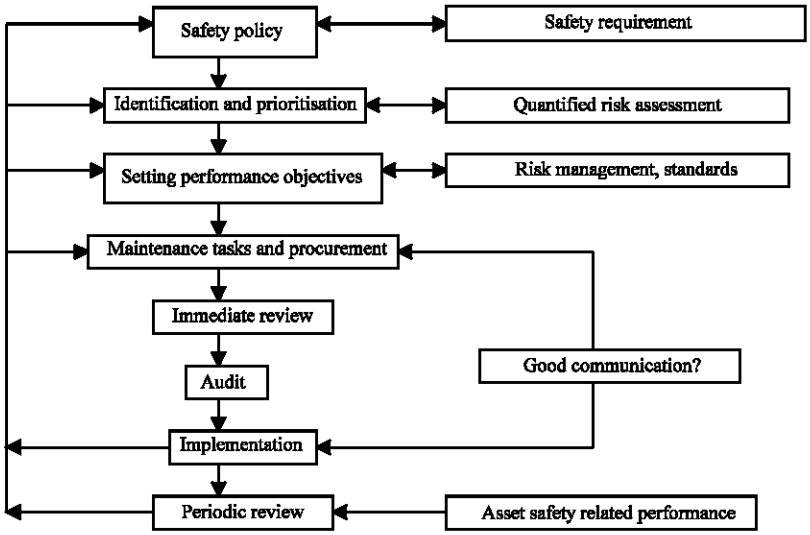

Fig. 3: Schematic of the proposed asset management approach

Proposed outline model: An outline of the proposed asset management model for railway safety is shown in Fig. 3. The proposed model is by no means definitive but more a basis for further work and discussion. As noted earlier, much of this is in common with what might be expected from a railway safety case so that a more immediate use may be as a checklist for evaluating safety cases. The following sections describe each step in more detail, with an overview at the end.

Safety policy: As noted, a key part of asset management is knowing what an organisation wants to achieve. Therefore, a vital first step is the establishment of high level safety targets for the Indian rail industry which will necessarily require top management commitment.

This target setting approach is very much in vogue and, to a certain extent, already in place but may present tensions with ALARP. ALARP is based on individual practices and assets, which each must be ALARP, rather than on the global approach implied by asset management. That is, asset management is about optimising spending on the whole system whereas broadly speaking ALARP is currently interpreted as ensuring that each asset is as safe as is reasonably practicable. Thus ALARP is a 'safety first' approach, whereas an asset management approach is more suitable for a situation where the problem is one of allocating a fixed budget in an optimal way. Since it is suggested that an asset management approach is applied in a prioritised way, this tension may not be a large problem in practice.

If one were to accept a globally optimised system (within a fixed budget) as representing ALARP there lies a problem in setting targets. Targets are the driving force for the asset management approach and thus should be set first. When an asset management model is applied, certain targets will imply a certain level of spending which may or may not correspond to the budget available. Thus the immediate review stage, described below, will be important in fine-tuning the targets to the budget available. The targets need to cover those areas of safety of interest to the railway industry which are broadly incidents giving rise to particularly high levels of societal concern and those that are more classically risk based or equity based.

Identification and prioritisation: Based on the high level safety targets, a set of performance objectives needs to be set. To give efficiency gains and particularly given the size of the Indian rail system, prioritisation will be needed. This will depend on identifying assets that are critical to achieve the high level safety targets. For example, it may be that a certain type of level crossing and (say) broken rails on curves on high speed track are the key contributors to multiple fatality incidents. Since, the rail network is extensive, for useful application of asset management, it will need to be broken down to a more detailed level than generic asset categories (such as 'level crossings', 'track'), as implied in the examples given in the previous sentence.

Setting performance objectives: This step involves taking the output from the previous section and deducing the performance required of an asset in order to meet the high level safety targets. Thus this step requires a detailed understanding of how the different assets making up the rail system behave and interact with respect to safety.

This is a somewhat daunting task but already exists in the form of the Railway Safety and Standards Boards' quantified Safety Risk Model. However, since this has been developed at the national level more work would probably be needed to provide sufficient detail for particular types of sections of track, types of level crossings etc. to be identified and targetted.

Maintenance tasks and procurement: Having identified and prioritised assets and specified their required performance, the next stage is to identify how to meet the performance objectives. This is the stage where different approaches to maintenance and procurement i.e. life-cycle assessment should be considered. Although, interaction between safety and commercial aims will be discussed in a later section, it is worth noting that this step in particular is likely to require a large interaction, since a large part of the constraint on maintenance will not just be the cost of maintenance itself but the cost of reduced equipment availability (e.g., requiring a section of line to be closed and replacement bus services to be used). This stage is also where good interaction between different maintenance functions and train operators and leasers is required: what is the cost and availability of maintenance time for train operators? if equipment is unavailable for on maintenance function can another maintenance function be carried out at the same time (thus avoiding the need to make the equipment unavailable twice)? what are the best trains to purchase (e.g., cost, required maintenance, demands placed on other assets)?

Immediate review: This stage is to provide a 'feedback loop' to previous stages in the asset management model. It allows a 'reality check' on what is being proposed and as discussed, allows fine tuning of high level targets. This step allows a high level ALARP assessment to be made: as noted, ALARP currently is assessed at the level of individual practices or asset groups rather than at a global level. That is, for effective asset management both the regulator and industry would need to take a global view. Under some circumstances, this global approach might not be consistent with the absolute criteria applied for ALARP, but would allow the best safety related asset performance in the face of a fixed budget. Thus potentially ALARP could be demonstrated by:

- Demonstrating that the asset management approach used optimised safety spending for the Indian rail system; and
- Arguing that India could not (or would not) spend more on rail safety.

This apparently simple picture would be complicated by the fact that performance and safety are inter-related thus money spent on safety would in many cases contribute to improved performance and vice versa. Despite the potential policy difficulties highlighted, this approach to ALARP is not necessarily problematical, since it could be viewed as a structured, prioritized work programme for becoming ALARP.

Audit: An auditing function is suggested to give confidence that the model has been implemented consistently and correctly across the rail system.

Implementation: One of the key features of applying an asset management approach to railway safety is that such an approach may imply doing less maintenance on particular assets, which implies that safety levels may be reduced, albeit by a small amount, for certain assets. Such cases might be cases of 'reverse ALARP' e.g., demonstrating that knowledge of failure behaviour or technology have improved such that less maintenance is required. Currently this argument is not recognised but this may be less of an objection in the face of a clear asset management strategy, which demonstrates exactly how less spending in one area is spent in another area to greater effect. Presuming that there continues to be a large amount of public money spent on the railways, the outcome of applying asset management may suggest altering the way this is distributed e.g., the programme might identify that it was better to spend more money on new trains than on new track. However, it is expected that this last point will not be a major issue in practice. The rail industry would probably need to re-visit its standards to either (i) define them so that they are applicable in a prioritized way or (ii) only apply to specific parts of the system. In the latter case, this could be done by applying priority 'bands' within an asset category (e.g., heavily used, high speed track might be 'red' whereas a lightly used branch line might be 'blue'). For example, to ensure that high specification material is used only on high speed track on curves a standard could: State that it only applies to curved track with certain line speeds and State that it only applies to category 'red' track.

Periodical review: This step involves reviewing the asset management study at suitable intervals to ensure that it is still relevant, for example, every three to five years, or when there are major changes to the rail system e.g., introduction of new regulations, drastic changes in budget or priority, new infrastructure.

RESULTS AND DISCUSSION

The advantages of the model described (or similar) is that it allows an optimal approach to managing assets to be developed, with great potential for either saving resources or deploying them more effectively. A further advantage is that it should be relatively easy to inspect an asset management approach since the approach requires much documentary evidence such as asset registers, records of meetings and decisions and should give a clear audit trail between such decisions and maintenance and procurement. Moreover, since effective application would require good communication between different parts of the industry, inspectors may be able to test whether there is a supportive organizational structure by ascertaining the level of communication and familiarity between different departments and/or organisations.

The disadvantages are that to apply it to the Indian railway network will require much work; 4 identified areas in particular that may be resource intensive are:

- An understanding of key features affecting assets' safety performance, perhaps requiring further development of the Safety Risk Model and/or more research.
- An asset register sufficiently detailed to resolve critical assets (e.g., particular characteristics of track such as geometry, age, usage), which is spatially enabled.
- Consistent and accurate costs for procurement, maintenance and downtime (e.g., line or station closed).
- Currently, the interface between safety and commercial aims is not covered.

CONCLUSION

Applied to the rail network as a whole, asset management offers a way to ensure that the railway industry is carrying out the right tasks for a safe and effective railway and carrying them out in the most efficient, economic way. An effective asset model would establish a firm basis for safety standards on the rail network. The literature survey carried out in this work did not identify a suitable, strategic asset management model for use on the Indian railways system. However, based on the literature survey, an outline approach has been proposed. The suggested approach requires an asset register with sufficient detail to allow the most critical parts of the network infrastructure to be identified and targeted. The approach also would require use and probably development, of the Safety Risk Model. Full application of asset management would also require Indian Railways to ensure that it was content with the policy (and possibly legal) implications surrounding 'ALARP'. These points imply that full scale adoption of asset management would be a major undertaking (albeit with potentially large benefits), yet an understanding of the approach may be beneficial in a more modest way. Therefore, the represents possible alternative approaches. It is worth noting that such an asset management model would give a generic approach that could be applied to other major hazard sectors in India and beyond.

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