Measuring Safety Through A 'Composite Safety Index'

Brijesh Dixit
Chief Safety Offficer
Western Railway
INDIAN RAILWAYS

Need for measuring Safety arises to asses the level of Safety on a Railway Network, to help management decide resources allocation by providing "what if" data and to identify weak links in the Safety Management system. Also as per Lord Kelvin "When you can measure what you are speaking about and express which in numbers you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind."

How to measure Safety:

What about Accident statistics as Safety performance indicator? They do provide a cost effective measure of performance, in terms of the cost associated with data collection but they suffer from several limitations, which should be taken into account while assessing an organization's safety performance.

The following remarks attributed to Disraeli often apply here "there are three kinds of lies- lies, damned lies and statistics". Statistics conceal a lot more than what they reveal are the most charitable remarks about statistics. Let us take an example on Indian Railways to illustrate this point:

On one Division of Western Railway which is one of the 16 Zonal Railways on Indian Railways (IR), there were 'nil' accidents in the year 04 & 05. Everybody thought they were doing very well on this front. They got all awards, rewards and accolades also. Then in April '06 there was a major accident of an Express train colliding with a stationary Freight train resulting into 16 nos. of deaths and 136 nos. injuries. All Safety norms and rules had been violated by staff of all concerned departments to cause this accident. The question arose whether the level of Safety in this Division in years 2004 and 2005 was of the level indicated by the accident statistics?

It is further argued that accident statistics measure only failures. And these are 'trailing indicators'.

Thus the utility of accident statistics as measure of Safety in a Railway Net work is extremely limited. Then how to measure the safety performance better? It is stated that for the purpose of measuring Safety 'leading indicators' will provide a better system.
Any system of measuring Safety must meet the following two criteria: i) Validity – the extent to which the measurement reflects the true ground conditions. ii) Reliability: the extent to which the system of measurement gives the same results on successive occasions of use.

Safety in any system a Railway Network or otherwise has to be an integral part of process, methods, equipment, materials, people etc. it employes for producing the services. Logically measuring safety should be concerned with the quantity and quality of the activity in these areas as well as measuring the events like accidents, averted accidents, other incidents, equipment failure etc. Safety is not a directly measurable entity in the same manner as for eg. profit or loss of an organization. It is more of a construct which reflects a sphere of activity concerned with the reduction of risk (defined as the probability of some unwanted events) and the reduction of the consequences of the unwanted events. As a concept it is very subjective. Therefore an objective definition of Safety is required.

Defining Safety:

In mathematical terms the level of safety is inversely proportional to the number of accidents. An accident is an unwanted event that results in physical harm to people or damage to property. There is a reasonable degree of consensus that an accident is some kind of unplanned event. Some authors use the term "incident" to describe such events where no injury occurs.

As a generic definition, an accident may be defined as: an unplanned event that has the potential to cause adverse consequences.

Defining an accident in such general terms is important as in reality we tend to measure those types of accident that we can easily measure. This limits our view of accidents (and therefore safety) to what we can see and measure.

It can be generally said from a process viewpoint, that accidents have multiple causes. They are the end result of one or more combinations of factors.

The above is in line with Heinrich's (1931) "Domino Theory". One of the earliest examples of the same was provided by Benjamin Franklin who wrote:

"For the want of a nail, the shoe was lost; for the want of a shoe the horse was lost; and for the want of a horse the rider was lost, being overtaken and slain by the enemy, all for the want of care about a horseshoe nail." (Poor Richard's Almanack 1758)

The above is very much true for Safety in a Railway Network. As stated above accidents are multicausal in nature. From prevention view point safety is concerned with eliminating these causal factors or interfering with relation between them.

Framework for measurement of Safety:

In this paper a framework will be presented for measurement of Safety of a Railway Network, by taking into account all the factors affecting it and by giving them suitable weightages based on the experience on IR. Thus a 'Composite Safety Index' for measurement of Safety will be arrived at.

Analysis of the causes of Accidents for 5 years on Indian Railways:

Data of causes of Accidents on IR for 5years was analysed to arrive at the list of causes which led to unsafe conditions. Averages of 5 years have been considered for this analysis. However for successive years 'moving averages need to be taken.

Apart from accidents which actually occurred on IR averted accidents, signal passing at danger, breach of safety rules while dispatching of a train into block section other unsafe incidents have also been considered as part of accident statistics.

On IR equipment failures of all types which viz. Track, Signal, Loco, Coaches, Wagons, Overhead Electrical line etc. are monitored on days, weeks and months basis. This is required as the Trunk Routes of IR are very intensively utilized to the extent of even 200% of theoretical Line Capacity and equipment failures in such situations affect both Safety as well as throughput of the sections. Further, on IR, because of heavy freight traffic on Trunk Routes along with Passenger Traffic freight trains' safety considerably affects over all safety of the Railway Network. Therefore, all Safety considerations related to freight trains have also been taken into account while assessing the level of Safety of a Railway system. Some of them are i) Violation of the maximum permissible 10 hours duty rule for Freight Train Crew, ii) Validation of brake power certificate of a Freight train at nominated points., iii) Intensive safe-to-run examination of Rolling stock after running specified no. of Kms.

It is seen from the analysis that 65% of accidents on IR take place due to **Human** Errors. Therefore, the aspects relating to the staff are closely monitored at higher level of management from the Point of view of Safety. Some of them are – i) Initial and Refresher Training courses of the staff. ii) Observations of duty hours regulation eg. repeated night duties, overtime beyond a limit, availability of minimum hours of rest between the two consecutive duties etc., iii) Initial Medical fitness and periodical Medical Examinations.

On IR, on an average one Levelcrossing is existing at every 1.5 Kms. A total of more than Forty Thousand No. of Levelcrossing are there. Out of these 60% are unmanned. It is seen that 20% of total accidents occur at the Levelcrossings. They however account for more than 50% of the total casualties which is disproportionately very high. Thus proper maintenance of L.C. infrastructure, observation of Safety norms by both train drivers in the form of frequent whistling & being vigilant, launching of campaigns by the Railway Network authorities for Awareness of road users, road regulation enforcement etc. are to be taken into account while measuring the level of Safety in the Network.

Safety Culture/Climate of the organization has also to be taken into account while measuring Safety:

Every organization has a culture that can be best described as 'the way we do things around here' "This culture is thought to be reflected in an organization's system of norms, & values, its history, the work process, physical environment, the modes of communication (i.e. its structure) and the style of management.

Safety Culture is a sub-system of an organization culture which alludes to organisations features that affect and influence safety. A good Safety Culture is believed to positively impact upon an organization's competiveness, quality and reliability.

The procedures and rules governing Safety within an organization are at the centre of Safety culture and as such will serve to construct a perceived image of risk, danger and Safety of the organization that is self sustaining.

The core features of Safety Culture/Climate: Since Safety Culture is a dynamic entity that is continuously changing, a clear understanding of the process and attitudes that have an impact upon Safety related behaviour is necessary to determine the prevailing Safety climate. Assessing an organizations safety culture/climate requires the measurement of a number of applicable contextual dimensions. The following 11 dimensions can be said to provide the main focus for ascertaining an organizations current Safety Culture/climate:

i) Management commitment, ii) Management actions, iii) Personal Commitment to Safety, iv) Perceived risk levels, v) The effects of the required work pace, vi) Beliefs about accident causation, vii) The effects of job induced stress, viii) The effectiveness of Safety communications within the organization, ix) The effectiveness of emergency procedures, x) Safety Training, xi) The status of Safety people and safety committees within an organization.

Although the above facets form the core of Safety cultureclimate, other prevailing features such as organizational change, de-manning, job redesign and insufficient resourcing may affect safety. As such perceptions of these features need to be measured through 'perception surveys' so that their effects on the prevailing safety climate can be ascertained.

Composite Safety Index:

The following is the composition of 'Composite Safety Index' arrived at on the basis of the above analysis.

Sr. No.	Safety Parameters	Weightage out of 100 marks
1.	**Accidents Statistics and follow up Actions:**	
	i) Accidents (Impact in terms of Causalities damages Detentions and disruptions to be considered.)	15
	ii) Averted Accidents (-----do------)	5
	iii) Other unsafe Incidents (-----do------)	5
	iv) Handling Of Accidents Rescue, Relief & Restoration	10
	v) Investigation/ Analysis of Causes	5
	vi) Corrective actions	5
	Sub Total	**45**

2.	**Safety Risk Management**	
	i) Identification of Safety issues & concerns and their evaluation.	2
	ii) Equipment Failures.	2
	iii) Cases of violation of safety rules/Regulations / Standards/Orders	2
	iv) Replacement / Renewal / Up gradation of Safety Assets	
	v) Safety Assets' Health Monitoring System	1
	vi) Action taken on the identified/ previously identified issues with reference to targets	1 1
	vii) Risk Control strategies adopted to reduce the probabilities and mitigate the consequences.	1
	Sub Total	**10**

3.	**Human Failure Risk management** i) Compliance to regulations regarding hours of working etc. ii) Trainings/Refresher Trainings/Promotional Trainings etc. iii) Medical Examinations/Medical Fitness etc. iv) Safety Gradation & Upgradations v) Counselling of staff.	 2 2 2 2 2
	Sub Total	**10**
4.	**Safety performance monitoring system** i) Frequency of performance review ii) Level of performance Review iii) Follow up Action on the Review iv) Compliance to Safety Inspection schedules. v) Compliance to decisions/ Observations during above reviews and inspections	 2 2 2 2 2
	Sub Total	**10**
5.	**Level Crossing Safety Risk Management** i) Levelcrossing infrastructure. ii) Levelcrossing upgradation as per requirement. iii) Levelcrossing closure/clubbing/replacement. iv) Public Awareness Drives & Compliance monitoring. v) Procedural improvements and Innovations.	 2 2 2 2 2
	Sub Total	**10**
6.	**Initiatives/ Innovations to reduce Safety Risks** i) Equipment ii) Materials iii) Procedures iv) Trainings v) System improvements	 1 1 1 1 1
	Sub Total	**5**
7.	**Safety Culture/ Climate prevailing in the Railway Network.**	**10**
	Total	**100**

As in any attempt to determine an accurate method of measurement for a complex subject, the Science of measuring safety is to a significant extent an art, due to the considerable subjective assessment involved. However, a more holistic picture of safety emerges from the above Index than from mere accident statistics.

The above framework is under use by the author who is the Chief Safety Officer of Western Railway on the IR. Its testing for reliability and validity is also being continuously done for its fine-tuning.

****