Research Paper Management

The Human Intervention in Train Safety on Indian Railways

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ABSTRACT

The Indian Railways are under pressure to meet the transportation demand due to enhanced economic growth in the country. Accidents in transportation industry happen every day and given bad impact to the industry. Public transports become an alternative to the urban people, as the traffic congestion getting worse today which will results on increasing number of locomotives, as to fulfil the service demands, at the same time will increase number of train drivers, shifts, rail traffic congestion and other challenges. Another important issue will rise from this situation; safety. Safety is important as technology advancement increasing daily. It is important for us to understand and investigate the performance of the train driver in order to ensure safety. Human performance and reliability become very important today when error and accident causation sometimes were blamed to the human. Human element continues to be the major contributing factor for train accidents. The overall message from this paper is that railway accident investigations provide a useful source of data on human factors issues and their impact on railway safety, from this we have to learn the lessons and take appropriate measures and avoid the accidents.

KEYWORDS

INTRODUCTION

Indian Railways are not so aggressive in launching the high speed trains; IR is running the trains with a maximum speed of 150 Km/hr ensuring safety. Indian railways have a strong net work of loyal and committed workforce. Safety of travelling public and Goods has always occupied a centre stage in Indian Railways and a Safety Action Plan directed towards continuous reduction in risk level to customers has been envisaged in the form of Corporate Safety Plan (2003-13), which advocates for inculcation of safety culture on all fronts and development of man power using simulation, advanced multimedia & interactive training aids and also by conducting regularly safety seminars.

SAFTETY PERFORMANCE ON INDIAN RAILWAYS:

Indian Railways has delivered excellent safety performance during the past few years through its preventive safety measures to restrain collisions & derailments. The accidents rate decreased during the last five years.

ACCIDENTS IN INDIAN RAILWAYS:

Consequential accidents on Indian Railways during 2005-06 to 2009-10, indicate a total of 965 cases. Out of which 832 accidents recorded on human failure i.e. 86.21 percent. This need to be curbed.

For statistical and analysis purposes, the accidents are classified as "Consequential accidents", "Indicative accidents", "Other train accidents" and "Yard accidents". The first three categories of accidents involve trains, but the last category deals with accidents occurring at shunting, loco and marshalling yards and do not involve trains. Though both consequential and other train accidents involve trains, the difference between the two categories is based on whether the repercussions of the accident – cost of damage, period of disruption and injury to persons – exceeded the specified threshold values.

These are further categorised as follows:

Consequential Accidents: Collisions
Fire cases
Level Crossing accidents
Derailments
Miscellaneous cases

Indicative Accidents: Averted collisions
Breach of block rules
Signal passing at danger

A study of the consequential accidents which occurred on the Indian Railways for the five year period from 2005-06 to 2009-10 indicates a total of 965 cases. Out of these total of 965 cases, accidents recorded due to human failure is 832 cases i.e. 86.21% were attributed to human failures. Railway employees were responsible for 431 cases (44.66% of total 965 cases) and balance 401 cases (41.55% of total 965 cases) were attributed to outsiders, failure of other than Railway staff.

The accident cases attributed to failure of equipment is 32 (3.31% of total), cases recorded under sabotage are 48 (4.97% of total), accidents recorded on combination of factors are 6 (0.62% of total), cases of incidental accidents are 35(3.62% of total) and 12 cases (1.24% of total) recorded were could not be established conclusively.

Table 2: Consequential Train Accidents during 2005-06 to 2009-10

Type of Accident	2005-06	2006-07	2007-08	2008-09	2009-10
Collision	9	8	8	13	9
	3.85%	4.10%	4.12%	7.34%	5.45%
Derailments	131	96	100	85	80
	55.98%	49.23%	51.55%	48.02%	48.48%
Manned Level Crossing Gate Accidents	10	7	12	7	5
	4.27%	3.59%	6.19%	3.95%	3.03%
Unmanned Level Crossing Accidents	65	72	65	62	65
	27.78%	36.92%	33.51%	35.03%	39.39%
Fire in Train	15	4	5	3	2
	6.41%	2.05%	2.58%	1.69%	1.21%

Miscellaneous	4	8	4	7	4
	1.71%	4.10%	2.06%	3.95%	2.42%
Total	**234**	**195**	**194**	**177**	**165**
Accident per million Kilometers	**0.28**	**0.23**	**0.22**	**0.2**	**0.17**

Table 3: Causes of Accidents during 2005-06 to 2009-10

Cause	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**
Failure of Railway staff	120	85	87	76	63
	51.28%	43.59%	44.85%	42.94%	38.18%
Failure of other than Railway staff	86	84	81	75	75
	36.75%	43.08%	41.75%	42.37%	45.45%
Failure of equipment	8	9	9		6
	3.42%	4.62%	4.64%	0.00%	3.64%
Sabotage	6	8	7	13	14
	2.56%	4.10%	3.61%	7.34%	8.48%
Combination of factors	0	1	0	4	1
	0.00%	0.51%	0.00%	2.26%	0.61%
Incidental	11	7	8	5	4
	4.70%	3.59%	4.12%	2.82%	2.42%
Could not be established conclusively	3	1	2	4	2
	1.28%	0.51%	1.03%	2.26%	1.21%
Under Investigation	0	0	0	0	0
	0.00%	0.00%	0.00%	0.00%	0.00%
Grand Total	**234**	**195**	**194**	**177**	**165**

*** Provisional**

Rail passengers deserve safe and comfortable travel. Safety is a necessary mandate for running trains. With the untiring endeavour of the railway family to address human failure and technical deficiencies, there has been a significant reduction in the incidence of rail accidents. Even though the volume of passenger and freight traffic increased manifold, the number of consequential train accidents per million train kilometre has decreased from 0.41 in 2003-04 to 0.13 at the end of 2011-12. The target of bringing this figure to 0.17 by 2012-13, stipulated under the corporate safety plan introduced since 2003 was surpassed in the year 2011-12 itself. Railways strive to work towards a zero accident situation.

The Committees headed by Dr. Anil Kakodkar and Sh. Sam Pitroda have laid down a roadmap for improving safety and bringing about modernisation of Railways. While some of the recommendations of the two Committees have been taken up for implementation, the rest are under active consideration of the Ministry.

HIGHLIGHTS OF THE RAILWAY BUDGET 2013-14 PARTICILARLY IN TERMS OF SAFETY

- Making a corporate safety plan for a ten year period (2014-2024)
- Elimination of 10,797 level crossings during the 12th Plan and no addition of new LC's to the IR system henceforth.
- Introduction of Train Protection Warning System (TPWS) on Automatic Signaling Systems.
- Rigorous trials of the indigenously developed Train Collision Avoidance System.
- Using 60kg rails, 260 meter long welded rail panels and improved flash butt welding technology.
- Introduction of Self Propelled Accident relief Trains (SPART) with speed potential of 160/200 Kmph on trial basis with a view to putting in place a fast and reliable disaster management system.
- Introduction of crash worthy LHB coaches with anti-climb feature.
- Rehabilitation of identified 17 distressed bridges over next one year.
- Provision of comprehensive fire and smoke detection systems.
- Provision of portable fire extinguishers in Guard-cum-Brake Vans, AC Coaches and Pantry Cars in all trains.
- Use of fire retardant furnishing materials in coaches.
- Four companies women RPF personnel set up and another 8 to be set up to strengthen the security of rail passengers, especially women passengers.
- Recruitment of RPF with 10% vacancies reserved for women.
- Five fellowships in national universities to be instituted to motivate students to study and undertake research on IR related issues at M.Phil and Ph.D. levels.
- Setting up of a chair at TERI promoting railway related research to reduce carbon footprint.

HUMAN FACTORS AND ERGONOMICS

- Ergonomics is the design and engineering of human-machine systems for the purpose of enhancing human performance. Ergonomics is the scientific study of human work conditions, especially the interaction between man and machine. Ergonomics is a term taken from the Greek work "ergon," meaning work, and "nomos," meaning natural laws. The goal of ergonomics is to make work more comfortable and to improve both health and productivity. Psychology, industrial engineering, computer science, biomechanics, and safety engineering all play a role in ergonomics.

Human Factors

- The study of human factors examines how humans interact with machines and other people (pilots, air traffic controllers, or design and acquisition personnel) and determines whether procedures and regulations take into account human abilities and limitations.
- Ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data, and other methods to design in order to optimize human well-being and overall system performance.
- The discipline is rooted in understanding how people use tools, products, and systems to accomplish desired tasks, and it seeks to eliminate or, at least, manage the human errors that sometimes do occur.
- Human factors engineering is the application of human factors information to the design of tools, machines, systems, tasks, jobs, and environments for safe, comfortable, and effective human use.

REASONS FOR OCCURANCE OF ERRORS

- Bench marking system in railways to decide the number of staff required for train operation ignored the quality of work
- Vacancy syndrome
- Economy and efficiency override the main aspect of Safety in the Train Operations
- Optimum utilization of crews and thereby extended run increased the work load
- Hours of employment
- ill equipped facilities at rest rooms (running rooms)
- Work-life balance of Loco Pilots and Train Safety
- Sleep debt / Health / well-being issues of loco pilots
- Issues of Circadian rhythms of Loco Pilots
- Ergonomical issues of loco pilot
- SPADs (Signal passing at danger) are the major causes for collisions in railways

- Safety monitoring
- Physical /Mental Stress/Fatigue of loco pilots lead to passing signal at danger (SPAD)
- High Attrition rate of Loco Pilots and that lead to high turnover of Loco Pilots in the railway industry lead to shortage of hands in safety category staff
- Communication Problems
- Inadequate level of training of railway staff
- Applying the Short-cut methods by the staff
- Who went wrong approach rather than what went wrong approach

Benchmarking and vacancy syndrome

In recent years, during annual cadre review, bench mark system is used as basic principle to decide the number of staff required for train operation. In which the quality of work is totally ignored. The less number of staff utilized in one of the areas of Indian Railways will be applied to all other areas blindly without assessing the actual requirement. Result of which, even in safety categories like station masters, loco running staff etc. required leave reserve and trainee reserves are not maintained. Despite mandatory Refresher Courses, Pre Promotion Courses, Loco Running Staff like categories have to undergo training on various locomotives. Hence minimum 10% trainee reserve must be maintained apart from leave reserve. Recruitment and other HRD issues for train driving crews often dominate discussions in operational management. Required man power should be assessed as and when new trains are introduced. Any lapse in Man Power Planning will lead to human failure.

On the name of economy and optimum utilization of crews

In recent days, the crew links of mail and express trains are tightened in the name of optimum utilization of crews and thereby extended run increased the work load. The reduction of rest period in between two spells of duties, less availability in the head quarters/home causes accumulated fatigue among the drivers causes micro sleep. Lack of sleep due to continuous night duties lead to cumulative sleep deficit. To overcome the effect of these night shifts require at least two days rest and should avoid an early shift on their return to work.

Number of respondents has opined that on the pretext of implementing bench marking lot of pressure is being imposed on workmen. Respondents were of the opinion that as they are working under stress and other compulsions there is every possibility of committing serious errors.

Hours of Employment

Hours of Employment Regulation is part and parcel of the Indian Railway Act. All railway employees are guided by these Rules in the subject of their hours of duty and rest. Under the pretext of the exceptional of work, employees especially field staff in whose hands are reposed the safety of the trains are forced to work even beyond 12/16 hours mainly due to short of hands. Drivers, Guards, Station Masters, Cabin men, etc are some of the categories to whom working even beyond 12/16 hours is nothing unusual. Various Committees were formed to go into the Railway Accidents whenever major rail accident occurs and these committees have laid due and adequate emphasis that a limit must and should be laid in regard to maximum limit of working hours to Loco Running Staff.

Hours of daily duty (duty hours extended) vary due to various factors like

- duration of train runs
- Locations of loco depots and running rooms
- Irregular running of goods trains
- Train schedules and operational delays due to crossings (on single lines)
- Precedences involved

Work-life balance of Loco Pilots and Train Safety

No exact calendar day rest is provided to loco pilots in IR. Loco Pilots are failing in fulfilling their family and social obligations. Loco pilots in IR are always missing quality time with his family and friends because of out station nature of work. All their personal work has to be done by availing leave, or between short spells in between duties, where little time is available at home station, which creates mental agony, losing concentration in running duties. Loco pilots attending the duties from home station (head quarters) are attending the duties without taking proper rest due to loaded domestic work at home, this is again a cause of concern for train safety.

Sleep debt / Health / well-being issues of loco pilots

Loco pilots regularly experience with sleep disorder and sleep debt since they have to work against the biological cloth. Research has shown that shift work, in particular night work, can have negative effects on the health, safety and well-being of workers. (US Congress OTA, 1991 Waterhouse et al 1992)

The Short term Effects include disturbed sleep, stress, fatigue, irritability, psychosomatic illnesses, family problems and accidents. The Long term effects are increased risk of gastrointestinal, cardiovascular and psychoneurotic diseases. Sleep debt leads to impaired alertness, which in turn lowers reaction time, reduces concentration and perception, and decision making. Together, this is usually defined as fatigue. Sleep debt is accumulative and over several nights, the effects are compounded. When working nights, by the fifth night, the loss of sleep accumulates, and you can be 8 to10 hours 'in debt'. "Sleep debt" can cause lapses in concentration and alertness leading to slower reaction and decision making times leading to errors and accidents. 'Micro sleeps' You can fell yourself "nodding off" and your brain does not react to what you see or hear around you. Lack of sleep can also lead to irritability and negative moods, and can cause conflicts both at work and at home.

Issues of Circadian rhythms of Loco Pilots

This is a 24 hour cycle that virtually all bodily functions have, with a high and low point over the day. Body temperature and alertness both have a cycle for example. We are programmed to sleep at night and be alert in the day. For shift workers, this means that it is very difficult to fall asleep in the day, or keep awake at night – our bodies just do not work that way. The hours between 23.00 and 06.00 are when the body naturally wants to go to sleep, with maximum sleepiness between 03.00 and 05.00. Early afternoon between 15.00 and 17.00 is another period when the body naturally wants to sleep.

The internal circadian clock also receives external cues from changes between day and night, and between work and your social life. **"Jet lag"** is a well know example of body rhythms being upset, but working shifts and suffering sleep debt can also produce chronic fatigue and worsening safety performance at work.

Erganomical issues of Loco Pilots (ergonomic design of loco cabs)

A Driver needs higher degree of alertness and concentration throughout the journey as he is running a train in higher speeds on track where sudden obstruction is very much a possibility and the train has no chance to stop suddenly like road vehicles. Inadequately maintained and designed driving cabs with louder noise, uncomfortable seating arrangement, non-functional safety equipments like speedometer, wiper, insufficient focusing of head light etc., are a sufficient distraction. Mainly absence of toilet in locomotive (not even Urinal) make the crew to control natures call for longer time and this will result in distraction of Driver is anybody's imagination.

The uniformity of driving equipments like A9, SA9, Throttle and Speedometers and the side of driving control stand develops a reflex among the Loco Pilots and if disturbed the reflex action is also disturbed. A Loco Pilot regularly driving right hand side has an assessment of distance of sighting the signals first but when driving from left occasionally the first sighting point and distance is lost and the reflex action also is delayed which is a safety hazard. Both horns are to

be located above the headlight at extreme ends of the loco to avoid noise pollution in the driving cab and rebound echo sound with coaches. The seats with back rests should be fitted in position such as the A9, SA9 are reachable for operation from driving seat like a car. While operating Electric locomotives, they perform his duty in always standing position, because visibility effected due to bad seat position. Track not seen properly in seating conditions. Due to high speed and continuous running train Loco-Pilots are extremely tired. Their eyes are more affected due to constant attention for hours together. The long hood working of WDP4 locos should be avoided as there is no visibility. An ergonomic design of loco cab has been developed to provide easy approach to various control handles/buttons. Providing new features would ensure fatigue-free driving for long hours.

Signal Passing at Danger (SPAD)
In recent accidents, SPADs are the major causes for collisions. Whenever there is SPAD a case Railway Administration widely spreads "the drivers were well within their stipulated duty hours and had proper rest before they commenced duty. On Indian Railways, all trains other than the suburban services (diesel or electrical multiple units) are provided with a driver and an assistant, which greatly reduces the chances of the driver passing a signal at danger due to carelessness or lapse of concentration."

But there have been cases across the world where the drivers under stress or other compulsions have committed serious errors. In the case of the train crew, one wonders what is that makes the drivers pass a signal at danger. As it is quite obvious that locomotive crew very well know that they may themselves be the first victim of their own mistakes and there cannot be a greater deterrent than the fear of losing one's own life, they figure in a quite few accidents. It stands to a reason therefore that a driver would not consciously pass a signal at danger and one is lead to conclude that there must be some other factors beyond his control when he does so. Fatigue is likely to remain a significant issue for rail industry to manage.

Safety monitoring
Current Indian railways procedures include gradation of drivers into A, B, and C categories for the safety assessment, with C staff considered a safety risk and to be monitored. Assistant drivers are the best judges of the safety profile of a driver but are never consulted. Internally recruited (from diesel and electric loco sheds maintenance staff) drivers were reportedly involved in 53 (out of 66) cases of SPAD, even though this cluster is limited to less than 10% of total strength. This is a surprising revelation that needs expert evaluation for the cause.

"Who went wrong approach" rather than "what went wrong approach" of Railways across the world

In Railways across the world accident enquiry system ends with "Who went wrong" approach and instead it should be "What went wrong" approach. Human Failure may include absent mindedness, forgetfulness, an error of judgment, or drowsiness (due to audio-monotony of the sounds of the running train or other similar factors); at times it may be momentary mental blankness or fatigue due to inadequate rest, in yet other cases it may be mental anxiety of some kind, possibly arising from family worries or other domestic problems of stresses and tensions on the mind on account of the fast changing matrix of their living conditions.

Short-cut methods
Short-cut methods are generally resorted to by the train operating staff mainly for the three following reasons or a combination of these:

- to save time
- to avoid complicated procedures
- to avoid physical work

With a great deal of importance being attached to punctual running of trains and statistics being monitored on various causes leading to loss of punctuality to train services, there is a general tendency to resort to short-cut methods to save time. Such short-cut methods are predominantly observed when there is an equipment failure and following the laid down procedures for train operation under such circumstances involve more time. Those found deficient in knowledge or adopting short-cut methods are suitably counselled and taken up.

Communication problems
India is a large country containing many regional languages, staff in IR is recruited from different regions. Employee from a certain region is posted at the place where the regional language is completely different. Particularly the safety category staff like loco pilots, station masters lacking the basic knowledge on local regional language may face problem in delivering a message and understanding the message from other side, this cause miscommunication and affects the safety of train. There are many accident cases recorded earlier due the miscommunication between the loco pilots and operating staff like station masters/points men/gatekeepers/shunting staff/guard even there is no issue of regional language. The issue of communication becomes more important when there is any equipment failure. Necessary information should be shared timely between loco pilots and station masters and they should act accordingly. Any miscommunication at that moment may leads to either delay or safety hazard.

High Attrition rate of Loco Pilots:
The attrition rate is very high in safety category post like Loco pilots, being the present Y-generation is more ambitious in career and also the lucrative jobs in the market, competitive pay packages attract the Y-generation to leave the railways. Majority ALPs leaving are the Engineering Graduates. The reason for high attrition is the nature of work in terms of unusual duty hours and lacking work-life balance. If we provide a good job description to ALPs we can retain them. That's the reason Indian railways are preferring to take only ITI candidates as ALPs. But here due to lack of technological knowledge possessing by this ITI qualified ALPs railways is facing trouble in training them. Abundant engineering graduates available in the Indian job market. The knowledge of ITI qualification to loco pilot is not sufficient to meet the requirements in the technological knowledge point of view. To meet the knowledge requirements in terms of technology, it is better to take only engineering Graduates as Assistant loco pilots, so that they can cope-up to the latest technologies and they can be better utilised for the future requirements like running the high speed trains by ensuring safety.

Case Studies:
Few case studies of recent major accidents are taken to study the human intervention which led to major accidents. The causes for the accidents have also been discussed in the following case studies:

The introduction of Shadabdhi/Rajdhani/Duranto Express trains forces the Loco Pilot(Mail) to run between the stations even without a scheduled stopping for a minute for longer distance about 400 Kms at a stretch.

Case Study.1:
When loco pilot working on high speed train, he have to work for 400 to 500 km at a stretch without any halt. During the run he cannot even release his urinal pressure. In NAGPUR DIVISION, when loco pilots booked to work RAJDHANI EXPRESS ex Nagpur to Bhopal, there are 265 signals and the running time given is 330 minutes. It means averagely after every 1 minute & 22 seconds loco pilots must ready to observe signal. There are 296 gates (manned/ unmanned) in the same

section. It means after every 1 minutes &11 seconds loco pilot must be prepared to observe gates condition. In addition to this loco pilot must also observe self train track, over head equipments as well as adjacent track and check the train if passing on adjacent track. He must also sharp attention on his locomotive performance. Loco pilot must take learning of road and signals with their proper locations, stations halts, level crossing gates (signaled and non- signaled gates, manned or unmanned gates).

Case Study.2:
Rear-end Collision of Train No.3148 Dn Uttar Banga Express with Train No.3404 Dn Vanachal Express at Sainthia Station of Bardhman – Rampurhat Station of Howrah Division of Eastern Railway on 19-07-2010.

Cause of Accident:
As per findings of CRS in the inquiry report, the accident was caused due to (a) failure of train crew of 3148 Dn to control the train on the face of home signal at 'ON' position and overshooting it at high speed and (b) the failure of the cabin master of west Cabin of Sainthia to isolate the occupied line by setting the points.

- Passengers died -66 Injured -90, LP and ALP of 3148 Dn had expired in the accident, the cabin master was removed from service, and the Guard of 3148 Dn was suspended.

Case Study.3:
Rear-end collision of 16591 Hubli – Bangalore City Hampi Express with a Stationary Goods Train at Penukonda Station of Bangalore Division of South Western Rly on 22-05-2012

Cause of Accident:
As per the findings of CRS/Southern circle, the accident was caused due to train no.16591 express passing the Home signal of Penukonda station at 'danger' and due to non-setting of point no.63 on Road-2 against the line which was occupied by MNGT 'N' Goods train. This accident is classified under the category of 'Failure of Railway Staff'.

- Persons died -25, injured -54.
- Primary responsibility: LP and ALP/mail of 16591/Exp and SM/Penukonda

" Train driver tasks are without doubt psychologically demanding "

Case Study.4:
For instance, the Railways driver roster for Hampi Express which collided with a stationary train suggests that the driver had run 23 trains in 19 days of which 12 were full-night, three half-night and seven full-day duties. This means the driver had undisturbed sleep is only seven days in the past three weeks. They (Railway's Drivers) are not allowed to break for food, refreshment or answer nature's call during duty hours**.** Duty of loco pilots is very much strenuous (www.indian railway driver information, 2012).

Case Study.5:
The Chennai Beach-Vellore Electric Multiple Unit (EMU) Train No 66017 hit the Arakkonam-Katpadi passenger Train No 56007, waiting for a signal at the Chitheri station around 9.30 p.m. Tuesday dated **13th Sep 2011.** The accident happens on Arakkonam – Katpadi Section of Chennai Division of South Eastern Railway.

Cause of accident:
Southern Railway General Manager said the MEMU driver had apparently ignored the signal and speed restrictions.

Case Study.6:
In the recent SPAD cases, it has been observed that Drivers who have been inducted departmentally and who are performing duty after availing head quarter rest are more prone to commit SPAD. The inquiry revealed that the loco pilot had remaind absent for about a month and that (On the duty day when he commits SPAD) was his first trip after joining duty. It has been observed that drivers who are performing duty after availing head quarter rest or joining after prolonged leave or absence are prone to commit SPAD.



DEPENDENCE ON HUMAN ELEMENT
- Limited Financial Resources
- Contract Works Executed by Outside Agencies
- Frequent failures due to poor quality of assets
- Level Crossings
- Contribution of Passengers and Others
- Lack of awareness of consequences

Limited Financial Resources
One of the primary and major reasons for dependence on human element in train operations is limited financial resources and technology. The Railways have to necessarily meet the bill for wages, operating expenses, pension obligations, materials for maintenance of assets dividend liabilities etc., and at the same time provide for replacement of over-aged assets. Next priority is the funding for on-going/new projects. With the Indian Railways being fully under the control of the Government and funding cleared by the Parliament, demands from various quarters will need to be accommodated while these projects are approved. Most of the advanced technologies for reducing dependence on human element will need to be imported, funds for which are limited. The major revenue to IR is getting from Goods trains. Goods trains are golden trains in IR.The immediate competitor to railways in passenger segment is buses running by the state transport corporations. It is observed that there is huge gap between the railway fairs and bus fares. It is observed that IR is increasing the fares of AC Chair Car, 1st AC, 2nd AC, 3rd AC and Non AC reservation category. It should increase the fares in the intercity like expresses, superfast passengers and also in local trains (which is the large revenue segment area) to meet the safety expenditure. It is better to run the railways like joint sector, so that IR can also go for FDIs. And at the same time some more non-core areas in IR are urgently need to be outsourced. But out sourcing the core safety areas is again a hazard to safety issues.

Frequent failures due to poor quality of assets
Many accidents due to human error are preceded by failure of asset. Performance of frontline operating staff becomes key to the safe operation during such abnormal working conditions. By improve the reliability of assets we can bring down the vulnerability of human element.

Contract Works Executed by Outside Agencies
Many works associated with the running tracks are getting executed by outside agencies through works contracts. These include works connected with track doubling, electrification, signalling and telecommunication etc. Most of the works are further sub-contracted by the main contractors. Many of the contract staff engaged for such works have limited knowledge or understanding of the railway safety related precautions. Even after incorporating sufficient clauses in the contract agreements to ensure protection of running trains, if adequate level of supervision from the Railways' side is not provided, there could be lapses and careless working which could en-

danger the safety of trains.

Level Crossings
Automatic horns should be provided at the **gate and stations** and these horns should be made operated by sensors, so that we effectively avoid the accidents at the gate and stations. The sound frequency of horns of locomotive should also be altered by taking the advices from sound engineers.

Lack of awareness of the consequences
Generally such cases are associated with persons other than Railway staff, who are not fully aware of the consequences of certain acts, which they may not consider as a serious safety hazard. There have been cases of Railway staff also creating accidents through their acts without realising the consequences.

ISSUES TO ADDRESS TO ELIMINATE HUMAN ERRORS
- Technology Up- gradation to minimise human intervention in train safety
- Training , but not on rails (simulator training)
- Safety related voluntary retirement scheme should be encouraged
- Restrict the crew to work extended hours and ensure safety
- Advanced technologies should not increase stress and strain on loco pilots
- It should be ensured that the running staffs (loco pilots) are booked on all the routes so that their LR does not become overdue.
- To ensure safe train working, there should not be more than two consecutive nights working with an interval of 2 days between them.
- The duty hours of Mail / Express/Pass crews/Motorman should be confined to 6 hours. There should be a break of at least one hour for Motorman in a spell of 6 hours duty.
- The duty hours of the freight crew excluding the time allowed i.e. 30 minutes ON/OFF for preparatory and complementary work shall be 7 hrs.
- Weekly limit of 40 hours for Loco Running Staff.
- Motivation is kept at a high level by the system of awards and punishments.
- Increased interaction with the family of crew for bringing about an awareness of the need for proper rest at the home station. The working of the welfare inspectors deputed for each lobby (crew booking depot) to be closely monitored.
- The new dawn?

Technology Up-gradation
One way of controlling the human element in accidents is to eliminate the need for human intervention in train operations and bring in more of automation. Quite a few such steps have been taken on Indian Railways and several more have been identified for implementation in a phased manner. Some of the items which are under trial/development prior to their large scale adoption are mentioned below:

- Train Protection and Warning System (TPWS)
- Train Actuated Warning Device (TAWD)
- Anti-Collision Device (ACD)
- Block Proving Axle Counters (BPAC)
- Vigilance Control Device (VCD)

With more sophisticated equipments and automation coming in, there is also a need for the following parallel activities to make these works effectively and reliably:

- Proper technical specifications, vendor development and quality control for better reliability of the equipments.
- Proper systems of periodic and break-down maintenance attention for these items.
- Adequate training facilities for the staff engaged in operation and maintenance of the equipments.

Simulator Training

A simulator is a computer based replica of a machine, taking the form of an imaginary train that gives a real feeling of in-field train working. Loco motive simulator is a mathematical model of train over a railway track with associated synchronized audio sound and recorded vision. In the quest for continuous improvement in service training to running staff, this important training aid is being utilized for educating fresh drivers and sharpens the skills of serving drivers. This helps driver to improve over-all performance and confidence, reduce energy consumption and break wear, minimize coupler damage by adopting correct driving techniques, minimize stalling cases and judicious brake application, reduce in-train coupler forces reducing train parting and derailments.

Safety related voluntary retirement scheme should be encouraged
The Railway Board themselves states that why Safety related Voluntary Retirement Scheme introduced to Running Staff. The reasons quoted reads as - The scheme will to safety categories viz, Drivers (excluding Shunters) and Gangmen whose working has a critical bearing on safety of train operations and track maintenance. The scheme has been framed on the consideration that with advancing age, the physical fitness and reflexes of staff of these categories deteriorates, thereby causing a safety hazard.

Restrict the crew to work extended hours and ensure safety
And sometimes it is unavoidable situation, because in the middle of the section it is difficult to arrange the relief crew, due to the non-availability of roadway to reach the station. Such situation compelled the crew to work extended hours. Of course the interest of the crew (loco pilot) is also there in some cases in continuing the long hours of duty due to the monitory benefit getting in the form of over time (OT) allowance. Here rail industry has to take the appropriate steps and avoid the extended hours in the interest of public safety.

Advanced technologies should not increase stress and strain on loco pilots
There is a hypothesis that the technological up-gradation in Railway has lessened the work of Railway Staff generally. But in no way this modernization has helped the Loco Running Staff and reduced their work load and responsibility attached to the job but increases it many fold. The Loco Pilots managing super fast trains at a speed ranging from 120 to 160 kmph require very quick reflexes than earlier. Added to these, most stringent safety norms and procedures also increase the work load considerably. Therefore modernization in Railways has in no way lessened the work load and responsibility of Loco running staff rather skill work, stress and strain has increased manifold than earlier; and more modernization is going to be introduced. A reasonable job evaluation ought to be undertaken to assess increase in work, stress and strain.

The new dawn?
Driving methods and traction technologies have changed. Times have changed. The social aspirations of train drivers have changed. New paradigms are now needed again for managing the work situations for train driving crews. Old methods seem to be wearing thin and a new approach is called for.

VARIOUS STUDIES AND REPORTS REGARDING NIGHT DUTIES:
Psycho-Technology on Indian Railways – RDSO, Ministry of Railways, Lucknow:

"The element of stress or fatigue caused to Mail Express Drivers due to high speed and hours of duty was investigated in an experimental study. The 39 findings indicate that mid night – early morning time zone produces greatest stress on Drivers as their mental alertness shown slackening during these hours. The working on the Second Consecutive night has been found to further dampen the mental alertness, making Drivers vulnerable to operational lapses".

Encyclopedia of Social Science, Pfizer Ltd., (V) its workmen (SC) LLJ 1963. I page 543:

"Persons working during day light hours is normal and those who are working during nights is abnormal".

Conclusion

Since human error contributes to a major part of accidents, IR should strictly ensure that the modernization and up gradation of training facility to the staff is completed on time. Further IR should take immediate action to fill up all the vacancies in safety category posts and also take necessary steps to reassess the requirement of staff, in view of introduction of modern technology, to bring down the requirement to realistic level. It is observed from the results of the study that there is a positive and significant association between working unusual hours by pilots and its impact on the health and work life balance of loco pilots. The financial constraints shouldn't be an impediment to grant duty hours, rest and periodical rest not only for the benefit of the worker but for the safety in train operation and public good.Railways trying to solve these serious issues, but it is still continuing and more effort needed. Work life-balance of a railway driver is most important for the safe journey of passengers. So that, Crores of passengers reach their destination safely.

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