A Critical Evaluation of Impact of Human Error: In Rail System Failure with a View to Enhance Safety

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Abstract. Modern Transportation is a 24x7 industry, fraught with the risk of occasional accidents/incidents. This makes every mode of transport a risky business. With perennial pressure for becoming faster, safer & better with every passing day, greatest challenge for the industry is to eliminate & manage all possible risks to ensure an incident/accident free operation to meet the growing demand of the society. Modern society cannot be conceived without an efficient & safe transport system. Amongst all modes of transport, rail transportation occupies a unique place being the bulk carrier of people & cargo at an affordable cost with least adverse impact on environment.

Despite massive modernization & induction of state of art technology, the safety of rail-road transportation depends largely on the operator. A railway accident always makes a big news across societies & has a particular impact on the psyche of public. There is always a cause most of the time trivial.

The bright side of railway accidents that all misfortune has been turned to profit with evolution of technology based on the lessons learnt. In fact, the modernization of railways so far has greatly depended & progressed on the accident investigation knowledge. Railways growth since its evolution almost two centuries ago is nothing short of a revolutionary technical adventure unique in human history.

In the paper a comprehensive study of all human factor issues involved in working of employees at sharp end of safety has been attempted with critical analysis of more than 1200 incidents/accidents over a period of decades in Indian Railways.

The study revealed many hidden areas & contributing factors in lowering the human performance limit, leading to unsafe acts & unpredicted tragic accidents/incidents. Many findings have belied the traditional knowledge, belief & logic.

The knowledge emerging from this study may help develop counter measures against risks in all transport sectors which may accrue immense societal benefit. Further study could be undertaken by researchers, academician, administrators and regulators in greater public interest.

Keywords: Human Error, Human Factor, Crew. Station Master, Rail-road crossing, Front line staff, Risk management.
1. Introduction
Rail transport accidents are sad example of ‘Human Error’ in full view, sometimes exposing the organization to a shameful situation. Systems are not basically safe. It is therefore wrong to assume absolute system safety. It is the people who create safety while negotiating multiple layer of system goals with time and resource constraints. What one think should have/have not been done, cannot explain people’s behavior. The unsafe act is an observable error such as choice of wrong procedure, task prioritization, violation of rules, violation of methods etc.
New technologies do not remove ‘human error’. It only changes it. Human error is not the conclusion of an investigation it is the starting point. Why he did what he did that made sense to him then is the big question. There is always a mismatch between rules and practices. Do then one should write more rules as the practices have little option for change.
There is a constant ‘tug of war’. If one concludes ‘human error’ then it is worthless to have spent money on investigation. One of the problems with safety is that one can do things in an unsafe manner and still get away with it, but not always. Railways suffer from this complacency syndrome. Sub optimal human performance often result in unsafe work. To understand conditions that yield error it is necessary to evolve beyond limited scope of tracing the erroneous action of individuals to its root. For every detected error in the system, there are countless undetected errors which might have already taken place or waiting to take place in some form or other to breach the system safety.
Seeing the invisible hidden error trap is the skill which the front-line staff to be motivated and trained to acquire. This perhaps can be strongest antidote to ‘human error’. Each human failing is an opportunity for learning. Human error is a function of (I-Mechanical Error). Symbolic express can be
\[ HE = \int (I - ME) \]
With a view to assess all the possible human error that has potential to lead to unsafe situation/accident are identified hereunder with a detailed analysis of accidents statistics of Indian Railway from 1980 to 2010 particularly the accidents attributable to human error. The generic errors committed by front line staff are identified as under.

2. Identification of Error
Working of four categories of front line staff and their vulnerability of committing error have been analyzed based on available data.

2.1 Crew:
Crew is one of the most critical safety staff. The various type of error committed by them are primarily for the following reasons.
Signal Passed at Danger - HFCR1, Failure to observe speed as per signal aspect – HFCR2, Failure to check Auto signal – HFCR3, Failure to clear Fouling mark - HFCR4, Unauthorized backing of train - HFCR5, Excess speed – HFCR6, Poor risk assessment during abnormal work – HFCR7, Psychological depression – HFCR8, Excessive speed under abnormal working – HFCR9, No tail lamp – HFCR10, Failure to switch on flasher – HFCR11, Poor response to danger signal – HFCR12, Failure to protect train – HFCR13, Non-securing of train leading to Rolling back of train – HFCR16, Taking unauthorized people in cab/footboard – HFCR17, Poor knowledge of brake system – HFCR18, Not observing speed/over speeding – HFCR19, Rolling down of train after pantry – HFCR20, Over speeding after passing auto signal/IB signal danger – HFCR21, New assets acquaintance – HFCR22, Passing semi-automatic signal at danger – HFCR23, Over speeding on turn out. – HFCR24, working without BPC – HFCR25, Violation of rules to pass auto signal at danger – HFCR26, Alcoholism – HFCR27, Fatigue related failure – HFCR28, Lack of alertness – HFCR29, Delayed action in brake application – HFCR30.
These causes have been accordingly illustrated in the diagram.
2.2 Station Master

Station Master role is very critical in train running. Generic error committed by them are primarily for the following reasons.

Wrong reception of train – HFSM1, Shunting in face of approaching train – HFSM2, Wrong operation/inattention – HFSM3, Wrong reception of train (no track circuit) – HFSM4, Wrong procedure followed which issuing PLC – HFSM5, Failure to observe rules – HFSM6, Wrong procedure in reception of train in two-line station with no isolation – HFSM7, Gradient of station yard and seeing of stabled train – HFSM8, Non-reversal of point in rear after receipt of train – HFSM9, Wrong system of simultaneous reception – HFSM10, Parted goods train rolled down and collided with stabled train – HFSM11, SWR incomplete – HFSM12, Reception without ensuring clearance of line – HFSM13, Not changing point to normal in rear after reception of train – HFSM14, Starter advance starter was occupied - HFSM15, Violation of rules during NI work – HFSM16, Unauthorized taking off of signal – HFSM17, Use of defective block instruments – HFSM18, Communication failure – HFSM19, Signal put back – HFSM20, Cancellation of route – HFSM21, Issuing of wrong authority – HFSM22

2.3 LC Gate Keeper

LC Gate keepers work in a very hostile working environment. They are vulnerable to commit error under pressure of work. The type of error identified are as follows.

Failed to close – HFLC1, Unauthorized opening of gate - HFLC2, Failure to lock the Gate- HFLC3, Unauthorized opening of gate- HFLC4, Gate getting closed safe- HFLC5, Failure in communication- HFLC6, Exchanging PN before gate closing- HFLC7, Violation of rules – HFLC8, Lack of knowledge of Gate keeper- HFLC9

2.4 Electrical Signal Maintainer

Electrical signal maintainers work under pressure to minimize delay to train movement. As they work under tremendous pressure against time, they are vulnerable to commit error. The main errors are due to the following reasons

Wrongfully energizing relay – HFSIG1, blanking of signal – HFSIG2, Signal lamp fuse – HFSIG3, Attending failure without traffic block. – HFSIG4, Short cut method to rectify fault – HFSIG5, Poor appreciation of risk – HFSIG6, Defective signal – HFSIG7, Interference when interlock failed – HFSIG8, Shortcut method adopted to give signal – HFSIG9, blanking off signal – HFSIG10, no light due to failure of power supply – HFSIG11, LC obtained with defective block instrument – HFSIG12.
From the above revealed that the accidents attributable to human error (Primary) are broadly as under:

i. Signal Passed at Danger – Crew Fault (HFCR1) - 37%
ii. Failure to observe speed as per signal aspect (HFCR2) – 5%
iii. Failure to observe rule (HFCR15) – 5%
iv. Reception without ensuring clearance of line (HFSM13) – 5%
v. Excess speed (HFCR6) – 6%
vi. Failure to check Auto signal (HFCR3) – 5%
vii. Poor knowledge of brake system (HFCR18) - 4%
viii. Blanking of signal (HFSIG2) – 4%
ix. Wrong operation/inattention (HFSM3) – 4%
From the above it is revealed that the accidents attributable to human error (Secondary) are broadly as under:

i. Failure to observe rule (HFCR15) - 40%
ii. Lack of alertness (HFCR29) – 9%
iii. Failure to check Auto signal (HFCR3) – 9%
iv. Signal Passed At danger (Signal was blank) – 9%
v. Failure to observe rules (HFSM6) – 6%
vi. Failure to observe speed as per signal aspect (HFCR2) – 6%
vii. Alcoholism – 6%

2.5 Error Tolerant Rail Transport System

By addressing the susceptibility of frontline staff to the identified human error as mentioned above, it may be possible to reduce accidents and also develop an error tolerant rail transport system. The above could be aimed with following strategy:

- Human error identification (HEI), Human error construction, Human Error Model, Strategies for error tolerant design
- Skill, Rule, Knowledge based human behavior, Opportunity for human malfunction, Error Antidotes, infrastructure that is adopted to the limitation of human capacity
- Pre-condition for unsafe Act: Latent, Operational factor, Environment factor, Personal factor, Unsafe Acts, Technology and Automation to monitor and control human action on the system. To bridge the gaps due to omission/commission, automation is less used to support human beings in their action/decision. Little regard has been paid to the fact that human flexibility and human capabilities can make an impact and important contribution when technology breakdown.
- Human to be kept in battle ready condition all the time for ensuring safety. Slow decay of safe working practices after long spells of safe operation being checked. The technological advancement aimed at reducing/eliminations of human error in many cases actually increase it with great risk and severe adverse consequence which needs constant evaluation.

3 CONCLUSIONS

Human error is all pervasive and ubiquitous in any human activity especially in transport sector. The percentage of accidents and incidents caused due to human error as indicated above is as high as 70% to 80%. Hence, management of ‘human error’ is the key to sustainable rail transport system. Technology how advance may be when conducted by human beings is prone to human conditions. It is not possible to design man out of the system particularly in transport system. There is clear limitation to the scope of automation in rail transport. Hence, critical study of human factors providing in sight to possible human error remains the key to develop an error tolerant rail transport system through human error identification, human error model, identification of skill/rule/knowledge/best human knowledge, best human behavior, opportunity for human mal functioning and providing error antidotes with the objective of making the infrastructure and system compatible to the limitation of human capacity.

4 Literature Review

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