AN EVALUATION OF RAIL ACCIDENTS IN INDIA

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Abstract **:** Safety has been one of the biggest concerns in the Indian Railways system. Indian Railways has suffered from the absence of a comprehensive framework for capacity expansion over last decade. Consequently, only incremental changes have taken place through gauge conversion, doubling of lines, and some modernization of signaling etc., along with continuous addition of new lines on uneconomic routes. Presently, the network is plagued by infrastructure and carrying capacity constraints and most of the routes on the high density network have already reached saturation in line capacity utilization. There has been a wave of rail accidents in India over the last few years, the major were due to derailments and level crossings further signaling towards the paucity of investments in IR infrastructure. The present study is carried out to analyze the trend in rail accidents in India and the major causes behind frequent and repeated accidents (derailments and level crossing accidents). The biggest causes of rail accidents in India include asset failures like track defects such as rail fracture and inadequate maintenance along with failure of railway staff (human factor). The pressure of passenger and freight trains does not give enough space to carry on repairs. If trains are cancelled, freight and passengers are affected. Apart from these, IR is facing a severe financial crunch due to which it has been unable to spare adequate funds for safety works especially on up gradation of rail infrastructure.

Keywords: Indian Railways, Safety, Underinvestment, Derailments, Level crossings.

I - Introduction

Railways are one of the most prominent modes of transportation in the world. Indian Railways (IR), a departmental commercial undertaking of Government of India, is the fourth largest network in the world by size, after U.S., China and Russia. It is one of the busiest railway networks in the world, handling massive number of passengers and quantities of goods daily. IR runs more than 20,000 passenger trains daily on both long-distance and suburban routes, from 7,349 stations across the country. In the freight segment, IR runs more than 9,200 trains daily (Ministry of Railways, 2017).

With huge network, heavy traffic, over-saturation of rail tracks, extreme weather conditions and many more challenges; IR is committed to safe journey to avoid loss of life and property through continuous modernization and strengthening the infrastructure, adopting latest technologies, engagement of experienced and trained manpower, periodic maintenance and checkups, safety audits etc. (Aher and Tiwari, 2018). Safety has been one of the biggest concerns in the Indian Railways system. Indian Railways has suffered from the absence of a comprehensive framework for capacity expansion over last decade. Consequently, only incremental changes have taken place through gauge conversion, doubling of lines, and some modernization of signaling etc., along with continuous addition of new lines on uneconomic routes. Presently, the network is plagued by infrastructure and carrying capacity constraints and most of the routes on the high density network have already reached saturation in line capacity utilization. Moreover, IR has been suffering from severe capacity constraints (NTDPC, 2013). As per the Standing Committee on Railways, slow expansion of rail network has put undue burden on the existing infrastructure leading to severe congestion and safety compromises. Additionof new passenger trains without providing additional resources (for operation and maintenance) and capacity augmentation, can also compromise safety in the network (Banerjee, 2011).

The rapidly growing economy of India has resulted in an exponentially increasing demand for transportation in recent years, and this has led to an enormous rise in the volume of traffic in the IR network

(Government of India, 2015). There has been a wave of rail accidents in India over the last few years, the major were due to derailments and level crossings further signaling towards the paucity of investments in IR infrastructure. There has been an unbalanced increase in traffic in somespecific zones of railways as most of the high traffic routes are concentrated in these zones. On the other hand, construction of new train-routes and tracks in IR has been nominal compared to the increase in traffic. Hence it is quite probable that the present amounts of traffic have exceeded the safe limits considering the available resources in some of the zones.

The recent rail accidents have drawn the attention as the railway is directly or indirectly connected with the life of everyone in the country. The systematic analysis of railway accidents helps to identify 'learning points', which are relevant for preventing accidents in the railway industry (Santos-Reyes et al., 2005).

On the basis of above, the present study is carried out to analyze the trend in rail accidents in India and the major causes behind frequent and repeated accidents. The paper has been organized as follows. Section I gives Introduction. Section II reviews the literature. Section III gives data base and methodology. Section IV examines the number of rail accidents in India. Section Voutlines the prime causes behind increasing derailments and level crossing accidents in Indian Railways. Section VI gives conclusions.

II- Review of Literature

Kumar (2012) described various parameters of behavioral science related tolevel crossings. The study indicated that on Indian Railways, gate closure time on most of the level crossing was unusually long and beyond the tolerance of the road users. About 30 per cent of the vehicle drivers had reaction time more than 2 seconds which resulted in delayed decisions and actions, sometimes resulting into accidents. Also the 'deliberate risk taking' behavior resulted in major risks, particularly where heavy, long or slow vehicles were involved. It was more prevalent in the people who know the site well, young people and truck drivers.

Sharma and Kumar (2014), in their paper, presented the recent developments in railways in developed countries, limitations and problems that are associated with railways. It was found that India had gained first position as far as travelled passengers per km was concerned but was far behind in the field of latest technology used by other countries. India focused only on the adoption of technology and HST as per Vision 2020 proposed by Ministry of Railways but still lack behind in the research and development in infrastructure. It was observed in the study that Vision 2020 had proposed a good methodology for implementing and expanding the railways network.

Kasinath (2016) examined the performance of Indian Railways with the objectives of analyzing the physical performance of Indian Railways, financial performance of Indian Railways, productivity in Indian Railways, human resources in Indian Railways, and security and safety of Indian Railways. The study period was from 1950-51 to 2014-15. The PKMs in IR had increased significantly by 17.24 fold while the NTKMs had increased substantially by 18.13 fold in IR during the study period indicating an increase in productivity in IR. The freight earnings were 2.44 times of passenger earnings depicting vividly the lion's share of freight earnings in the total earnings in IR. The human resource cost to the total cost was at 58.77 per cent in IR revealing a lion's share in the total cost during the year 2014-15. The train accidents per million kilometers had reduced 0.11 in 2014-15 in comparison to 0.17 during the year 2009-10. It was suggested in the study that the route kilometers in Indian Railways may be further enhanced in the potential areas to tap the commuters demand like: Pune to Aurangabad, Parliviajnath to Beed, Vizag to Simhachalam, Tirupati to Tirumala, Solapur to Tuljapur and Pandharpur, Nizamabad to Karimnagar and Kurnool to Srisailam. The number of railway stations and network electrification might further be increased and the passenger carriages should be more comfortable, safer and fire proof in the interest of the commuters.

Aher and Tiwari (2017) tried to study the causes, impacts and management of disasters in Indian Railways. It was observed that in IR, four major categories of accidents viz. derailment, level crossing accidents, collisions and fire in trains caused due to three major factors viz. human error, equipment failure and sabotage. Out of total accidents in IR derailments, level crossing accidents, collisions and fire accidents were 58%, 32%, 5% and 3% respectively. 85% accidents were caused due to human error, whereas failure of equipments and sabotage contributed to 5 % and 4% accidents respectively. The Ministry of Railways had disaster management plan for management of the railway disaster at national, zonal and divisional level. The continuous efforts of IR towards prevention, mitigation, preparedness, rescue, relief and rehabilitation

of disaster through modernization, planning, capacity building etc. reflected in terms of reduction in railway incidents over the years.

Jesuraj et al. (2017) attempted to prevent and minimize the derailment for which identification of rolling stock particulars and defects, derailment mechanism, sound theoretical understanding of the whole phenomenon of vehicle track interaction was studied that helped to analyze the evidence logically and systematically and to arrive at the probable causes of derailment. It was concluded that in order to minimize derailment, wheel-track interaction should be maintained properly which is the work of civil engineers partly.

Aher and Tiwari (2018) analyzed the accidents that occurred in Indian Railways during 2000-2016 to study the trends in causes and impacts (both casualty and economic loss). The study revealed that the dominating accidents, derailments and level crossing mishaps together constituted ninety per cent of total rail accidents in India. Out of the total accidents, eighty-five per cent accidents were caused due to human error. Among the total people affected by railway accidents, twenty-seven per cent lost their life while seventy-three per cent got injured and IR faced a total loss of 86,486 crore INR. It meant every fourth person affected by railway accidents lost his life. On an average,0.76 persons got killed and caused a loss of Rs. 31 crore per accident to IR in past 16 years. The total number of accidents and their causes in IR were found in decreasing trend over the years but the number of persons killed and economic loss associated per accident showed an increasing trend indicating an increase in severity of railway accidents.

III –Data Base and Methodology

In order to fulfill the objectives of the study, the secondary data with respect to number of railway accidents, track length, electrification, railway traffic, finances of Indian Railways etc. has been obtained from authentic databases such as Indian Railway website, Government of India websites, Indian Railway Year Books (Various issues). The collected data is compiled and subject to statistical analysis for computation of averages and standard deviations.

IV- Empirical Results

A Classification of Rail Accidents in India

Table 1 depicts the data pertaining to the year wise rail accidents in India over the period 2001-02 to 2016-17. The data revealed that a total of 3145 accidents occurred during the 16 years period (2001-02 to 2016-17) with an average of 196.6 accidents per year. Derailments (1772) were found to be the major type of accidents in Indian Railways followed by level crossing accidents (both manned and unmanned) (1051) and collisions (152). However, 104 accidents were due to fire in trains and 65 were miscellaneous accidents. The year wise analysis of accidents in Indian Railways revealed that a total of 415 accidents took place in 2001-02 thereafter the number declined steadily up to 2013-14. In 2014-15 the number grew up to 135 (an increase of 18 accidents from the previous year) while the number again declined in the following years. Though the number of accidents declined during the period under study the number is still above 100 which is a matter of great concern to the railways. The incidence of train accidents per million train kilometer (an important safety index) also declined from 0.55 in 2001-02 to 0.09 in 2016-17.

Derailments were recorded as the highest reason for railway accidents in India during the period under study as 56.3 percent of total accidents were due to derailments. The year wise derailments decreased from 2001-02 to 2013-14 (except in 2007-08) while 2013-14 onwards derailments showed an increasing trend. The data on level crossing accidents also show a worrying picture as they accounted for 33.4 percent of total accidents in IR. It was the second major accident type in IR after derailments. On an average, 111 accidents were due to derailments every year while about 66 were on account of level crossings every year. However, collisions and fire in trains accounted for 4.8 percent and 3.4 percent of total accidents in Indian Railways respectively.

Table 1 Rail Accidents in India over 2001-02 to 2016-17

(Number)

Year	Derailments	Level Crossing Accidents	Collisions	Fire in Trains	Misc.	Total Accidents	Incidence of train accidents per million train kms.
2001-02	280	88	30	9	8	415	0.55
2002-03	218	96	16	14	7	351	0.44
2003-04	202	85	9	14	5	325	0.41
2004-05	138	70	13	10	3	234	0.29
2005-06	131	75	9	15	4	234	0.28
2006-07	96	79	8	4	8	195	0.23
2007-08	100	77	8	5	4	194	0.22
2008-09	85	69	13	3	7	177	0.20
2009-10	80	70	9	2	4	165	0.17
2010-11	80	53	5	2	1	141	0.14
2011-12	55	61	9	4	2	131	0.12
2012-13	49	58	6	8	-	121	0.11
2013-14	53	59	4	7	3	117	0.10
2014-15	63	56	5	6	5	135	0.11
2015-16	65	35	3	0	4	107	0.10
2016-17	77	20	5	1	0	103	0.09
Total	1772 (56.3)	1051 (33.4)	152 (4.8)	104 (3.3)	65 (2.1)	3145	-
Mean	110.75	65.69	9.5	6.5	4.06	196.56	-
S.D.	67.5	19.4	6.5	4.8	2.4	93.9	-

Source: Year Book Indian Railways, Ministry of Railways, Government of India, Various Issues.
Note: Figures in brackets ( ) are percentage values.

Thus derailments and level crossing accidents were identified as the major types of accidents in Indian Railways together accounting for about 94 percent of rail accidents in India (see Table 2). It has also been revealed that derailments accorded highest percentage values in 2015-16 and 2016-17 (more than 60 percent) while there was corresponding decline in level crossing accidents in the same years.

Table 2Derailments and Level Crossing Accidents as percentage of total accidents in IR

Year	Derailments	Level Crossing Accidents
2010-11	56.74	34.04
2011-12	41.98	41.22
2012-13	40.16	43.44
2013-14	44.92	39.83
2014-15	46.67	37.04
2015-16	60.74	27.10
2016-17	74.76	19.42

Source: Compiled by author from Table 1.

B Causes behind Derailments and Level Crossing Rail Accidents in India

Derailments are mostly caused by 'rail fractures' during extreme summer and foggy winter conditions on account of the expansion or contraction of tracks (Jha, 2016). While technology and funding issues are there, the big problem is that adequate time to carry out routine maintenance of tracks is never available as loco pilots are under stress to run more trains in lesser time. Track failures and subsequent derailments are caused by twin factors- excessive traffic and underinvestment in rail infrastructure.

i) Traffic Congestion in Indian Railways

The demand for transportation of passenger and freight traffic has increased rapidly with the growing population leading to unbalanced rise in rail-traffic vis-à-vis growth in rail-infrastructure over last few years. On the other hand, less emphasis has been given on constructing new routes leading to tremendous pressure or over saturation of railway tracks. Slow expansion of rail networks has put undue burden on the existing infrastructure leading to severe congestion and safety compromises. It is clear from Table 3 that traffic of IR (both passenger and freight) had increased significantly during the years 2010-11 to 2016-17 subject to a slow expansion of railway track kilometers and running track kilometers. The passenger traffic had increased from 7651 million in 2010-11 to 8116 million in 2016-17 (an increase of 6.1 percent) while freight traffic had increased from 926.43 million NTKMs to 1106.15 million NTKMs (an increase of 19.4 percent) during the same period. On the other hand, there had been only 6.5 percent and 7.9 percent increase in track length and running track length respectively during the period under consideration. This suggests that the railway lines are severely congested.

The track constitutes the basic infrastructure of a railway system and bears the burden of coping with ever increasing traffic. Higher speed and heavy axle load operation of IR has necessitated up-gradation of the track structure while the data (as given in Table 3) revealed that track renewal had been kept up at a rather declining rate during seven year period (2010-11 to 2016-17). Only 2487 km of track renewal was carried out in 2016-17. It has generally been argued that,on average, about 5000 km of track should ideally be renewed annually but the data revealed that IR had been able to carry out only about 2500-3000 km track renewal each year leaving a backlog of about 2000 km each year.

The congestion on India's tracks grows with the announcement of new trains (especially passenger trains) and no parallel expansion of track length. There has been 12.7 percent increase in the daily tally of passenger trains over seven years (from 11,824 in 2010-11 to 13,329 in 2016-17) while the number of freight trains was increased by 59 percentin the same period (Ministry of Railways, 2016). But the running track length for all these trains increased by only 7.9 percent in seven years (from 87040 km to 93902 km as given in Table 3). Moreover, congestion reduces the headway (the time interval between two consecutive trains running on the same route) thus increasing the chances of collisions on very busy stretches. This also eats into the time available for maintenance.

Table 3 Traffic and Track Record of Indian Railways

Year	Passenger Traffic (in millions)	% change over previous year	Freight Traffic NTKM (in millions)	% change over previous year	Track kilometer	% change over previous year	Running Track Length	Track Renewal (in km)	% change over previous year
2010-11	7651	-	926.43	-	114037	-	87114	3465	-
2011-12	8224	+7.49	975.16	+5.26	115062	+0.90	89801	3300	-4.76
2012-13	8421	+2.40	1014.15	+4.00	115833	+0.67	89236	3296	-0.12
2013-14	8397	-0.29	1058.81	+4.40	116765	+0.80	89919	2885	-12.47
2014-15	8224	-2.06	1101.09	+3.99	117996	+1.05	90803	2424	-15.98
2015-16	8107	-1.42	1108.62	+0.68	119630	+1.38	92084	2794	+15.26
2016-17	8116	+0.11	1110.95	+0.21	121407	+1.49	93902	2487	-10.99

Source: Ministry of Railways, Government of India, 2016.

Decongestion requires doubling of lines and electrification of railway network rather than constructing new lines. In 2010-11, 709 km of new lines were constructed while the figure grew to 953 km in 2016-17 indicating an increase of 34.4 per cent over the study period. 769 km of railway track had been converted from single to double line in 2010-11 which increased to 882 km in 2016-17 (an increase of 14.7 per cent). An increase of 21.9 per cent was observed in gauge conversion from medium/narrow gauge to broad gauge during the study period (from 837 km in 2010-11 to 1020 km in 2016-17). Also electrification of railway network had been carried out at a rate of 106.5 per cent as only 975 route km of rail network was electrified in 2010-11 which increased to 2013 route km in 2016-17. It must however be noted that only per cent of railway network has been electrified till 2016-17.

Level crossing accidents (both manned and unmanned) are the second highest reason behind railway accidents in India as they accounted for 65.69 accidents per year (2001-02 to 2016-17). Of these unmanned level crossings are observed to be the predominant cause of casualties in rail accidents (see Table 3). They take place mainly due to the negligence of road vehicle users in not observing the precautions laid down in the Motor Vehicle Act while negotiating unmanned level crossings (Ministry of Railways, 2016). In 2015-16, there were 35 level crossing accidents out of which 29 (nearly 83 percent) were on account of unmanned level crossings.

Table 5Network Expansion in Indian Railways

Year	New lines constructed (kms)	Track Conversion from Single to Double Line	Gauge Conversion to BG from MG/NG	Railway Electrification (RKMs)
2010-11	709	769	837	975
2011-12	727	752	856	1,165
2012-13	501	705	605	1,317
2013-14	449	708	404	1,350
2014-15	313	705	527	1,375
2015-16	813	973	1042	1,730
2016-17	953	882	1020	2,013

Source: Year Book Indian Railways, Various Issues.
Note: BG – Broad Gauge, MG- Medium Gauge, NG- Narrow Gauge.
RKM- Route Kilometers

ii) Underinvestment in rail infrastructure

Indian Railways face several constraints while addressing safety issues, most notably the non-availability of funds to create additional capacity and modernize assets due to which the network expansion and modernization has not happened at the requisite pace. Under-investment in railways has resulted in congested routes,inability to add new trains, reduction of train speeds and more rail accidents. Significant investments are required towards capital maintenance of railways infrastructure to avoid accidents in the future. Poor finances of railways had led to low investment in infrastructure. Low investment means Railways' infrastructure and services take a hit resulting in low speed, delays, and safety issues (Ministry of Railways, 2017).

Indian railways is financed through i) budgetary support from the central government, ii) its own internal resources (freight and passenger revenue, and leasing of railway land), and iii) extra budgetary resources (primarily borrowings but also includes institutional financing, public private partnerships, and foreign direct investment). Railways' working expenses (salaries, staff amenities, pension, asset maintenance) are met through its internal resources. Capital expenditure (procurement of wagons, station redevelopment) is financed through extra budgetary resources, the budgetary support from central government, and Railway' own internal resources. Table 5 reveals that the share of gross budgetary support (GBS) to total plan expenditure increased from 51 per cent in 2012-13 to 55 per cent in 2014-15 and then declined sharply to 40 per cent in 2015-16. It, however, revived slightly thereafter to 42 per cent in 2016-17. The share of internal resources to total plan expenditure decreased from 26 per cent in 2014-15 to 18 per cent in 2015-16 and then to 10 per cent in 2016-17. A decline in the growth of internal revenue generation has meant that railways have been funding its capital expenditure through budgetary support from the central government and borrowings. The central government supports railways in order to expand its network and invest in capital expenditure. This budgetary support used to be the primary source of funds for capital expenditure for railways. IR got a budgetary support of 18385 crore in 2010-11 which was increased to 45232 crore in 2016-17 (an increase of 146 per cent). Decline in generation of internal resources resulted in greater dependence on GBS and Extra budgetary resources (EBR). Extra budgetary resources include market borrowings such as financing from banks, institutional financing, and external investments. External investments in IRB could be in the form of public private partnerships (PPPs), joint ventures, or market financing by attracting private investors to potentially buy bonds or equity shares in railways. Railways mostly borrow funds through the Indian Railways Finance Corporation (IRFC). In the past few years,

borrowings have increased sharply to bridge the gap between the available resources and expenditure. In 2016-17, 52,579 crore capital expenditure was raised through extra budgetary resources.

Due to under-investment, there has been severe congestion on the network and has resulted in the ability of the system to accommodate more trains and increase the speed of trains. Therefore, the need of the hour is to undertake a massive infrastructure expansion and decongestion program coupled with up gradation of technology and judicious electrification of tracks along with enhancement of terminal capacity. It is evident that the real issue today is the lack of physical capacity over IR on key routes due to severe congestion and incremental traffic is being offered on the saturated routes only.

Table 5 Sources of Plan Expenditure (Rs.in Cr)

Sources of Plan Expenditure	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Budgetary Support	18385 (45)	20013 (44)	25710 (51)	29055 (54)	32328 (55)	37608 (40)	45,232 (42)
Internal Resources	11528 (28)	8935 (20)	9532 (19)	9709 (18)	15347 (26)	16845 (18)	10480 (10)
Extra-budgetary Resources	9780 (24)	14790 (33)	15142 (30)	15224 (28)	11044 (19)	39,066 (42)	52,579 (49)
Total	40793	45061	50384	53988	58719	93519	108291

Source: Railway Budget Documents, PRS.
Note: Figures in brackets are percentage values.

V - Conclusions

The present environment on IR reveals a grim picture of growing rail accidents largely due to congestion of traffic (both passenger and freight) and no parallel expansion of rail infrastructure in terms of track length, electrification of rail network and doubling of route kilometers. It also includes paucity of resources and funds to upgrade the rail infrastructure along with lack of empowerment at the functional level. With more than 90 percent of train accidents in India are of type derailments and level crossing accidents, IR must invest in newer technologies, mechanization of maintenance, up gradation of track structure, including higher capacity long welded rails, their ultrasonic testing and electronic monitoring of track geometry.

The biggest causes of railaccidents in India include asset failures like track defects such as rail fracture and inadequate maintenance along with failure of railway staff (human factor). The pressure of passenger and freight trains does not give enough space to carry on repairs. Iftrains are cancelled, freight and passengers are affected. Apart from these, IR is facing a severe financial crunch due to which it has been unable to spare adequate funds for safety works especially on up gradation ofrail infrastructure.

The problem of railway accidents is not of safety standards but the execution of standards. The marked rise in the number of train accidents in India is a matter of great concern and yet the concerned authorities have not done much to make the travelling by train's safe and secure, it has become a routine to order an enquiry after an accident, pay compensation under the rules and then everything is forgotten till another tragedy strikes and passengers die while travelling.

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