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ECONOMICS OF SAFETY ON RAILWAY SAFETY

Brijesh Dixit*

It has been increasingly recognized that safety related aspects of operations on the Indian Railways have not been given the priority and critical attention that is required for a huge organization of its type which handles a huge network in terms of passenger and freight movements. Despite recommendations of High-level Committees on Safety appointed by the Government from time to time, inadequate provisions to the Depreciation Reserve Fund for renewals and replacement has been a persistent and disturbing feature. While such inadequate allocations can endanger safety considerations, what is not easy to understand is the continued absence of safety related investments required for operations especially given the significant returns that can result from the resulting improvements in railway operations and thereby revenue generation. Our case studies in this context, as reported in the present paper, reveal this feature clearly. Further, in an indirect way, the absence of inadequate and timely investments for expansion, for example, on the railways to take care of huge emerging requirements can lead to misallocation of resources which results in losses to the organization due to loss of traffic to the highways.

SECTION 1

1.1 Background

Safety is a central issue that challenges decision-makers during the planning, implementation and operation of any transportation network and it is well recognised that appropriate systems need to be in place to ensure effective, efficient and, above all, safe performance during operations. A most striking feature of the railways as compared to other modes is that it is rigidly bound. The direction of traffic is either permanently decided as in the case of double line provision or determined every time in the case of single line. Also, a space interval (also known as the headway) is maintained between following trains with a safety zone by way of an overlap kept to take care of the contingency of overrunning a signal over a short distance. Railway Transport has also two other features in the matter of operation as distinct from other methods of transport like the road. The first is that the train is "track bound", i.e., a train can move only along the fixed path made for it; and a train has the "right of way" which means other transport like road vehicles cannot come in its path, except at certain places known as "level crossings". Both these features have an important bearing on the safety rules regarding operation of Railways. Historically, it may be mentioned that when the train first started a man had to go ahead of it with a bell to "make way" but that is a matter of the past. [IRT notes, 2011] If the rules prescribed are observed by all concerned, there is no danger of any accident occurring. It is for this reason that railways are considered as the safest mode of transportation. And with technological developments it has been possible to progressively reduce the human element (or error) to a great extent. This briefly summarises the overall philosophy of railway safety.

The Indian Railways (IR) operates on a continental scale. It is one of the largest networks in the world. Presently [as on March 31, 2018], it has a route kilometrage of 68442, 7318 railway stations, 11764 locomotives, 71825 passenger

* Brijesh Dixit is Managing Director, Maharashtra Metro Rail Corporation Limited, Nagpur. Views are purely personal. Brief version of Ph.D. thesis approved by the University of Mumbai, 2017. For more details, see Dixit [2017]. The thesis was submitted in 2016. Some updating has been attempted.

coaches, 2,79,308 freight wagons and 1,31,205 railway bridges across the network. Today, IR operates nearly 13500 passenger trains and 900 freight trains each day while transporting nearly 23 million passengers and over 3 million tonnes of freight traffic every day. It has currently 1.271 million employees on its rolls and had an annual revenue base of Rs. 1,78,725 crores for the year 2017-18 [GOI, IRYB, 2018]. It is the lifeline of the country being the backbone of its economy's transportation network.

However, its track record in terms of safety has been the subject matter of many a debate over decades since each year a number of persons continue to be affected (deaths and injuries) by accidents. Though in recent years, there has been considerable improvement by way reduction in the number of casualties, what is disconcerting is that the total number of casualties per million passengers carried on the system has shown only marginal improvement. These figures are shown in Table 1 below for the period 2000-2001 to 2017-18.

Table 1. Number of Casualties

Year	Number of Passengers		Total Casualties per Million Passengers Carried
	Killed	Injured	
(1)	(2)	(3)	(4)
2000-2001	055	286	0.01
2001-2002	144	595	0.02
2002-2003	157	658	0.03
2003-2004	135	302	0.03
2004-2005	050	191	0.04
2005-2006	315	627	0.17
2006-2007	208	402	0.10
2007-2008	191	412	0.09
2008-2009	209	444	0.09
2009-2010	238	397	0.09
2010-2011	235	358	0.08
2011-2012	100	586	0.08
2012-2013	060	270	0.04
2013-2014	042	094	0.02
2014-2015	118	340	0.05
2015-2016	040	126	0.02
2016-2017	195	346	0.07
2017-2018	028	184	0.05

Source: GOI IRYB, (Several Years).

But it must be noted that as a result of safety initiatives taken by the organization especially in the past two decades or so, the number of train accidents on IR has come down as given in Table 2 below:

From Table 2, for example, in 2017-18, derailments (about 75 percent of the total- 66% out of which related to freight trains and the rest to passenger trains) accounted for the largest number of accidents, followed by accidents caused on unmanned level crossings (12 percent), collision (7 percent), accidents on manned level crossings (4 percent) and fire (2 percent). However, the majority of deaths (38 percent) have been caused by collisions, followed by deaths in accidents on unmanned level crossings (37 percent), derailments (14 percent), accidents on manned level crossings (9 percent), and fire (2 percent). It may also be noticed that we could view the situation in a somewhat different maybe better perspective, by trying understand the occurrence of accidents in relation to the quantum of traffic handled, which can be indicated in terms of accidents per million train kilometres on the Indian Railways, an important index of safety used by most railway systems in the world, which has come down from 1.80 accidents per million train kilometres in 1960-61 to 0.55 accidents per million train kilometres by 2001-02, to 0.15 by 2010-11 and to 0.06 in 2017-18.

Table 2. Train Accidents on Indian Railways Since 1970-71

Year	Collisions	Derailments	Level Crossing Accidents	Fire in Trains	Misc.	Total	Movement of Traffic, i.e., Train Kms. Run (in Million)	Incidence of Train Accidents per Million Train Kms.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
2000-2001	20	350	84	17	02	473	723.80	0.65
2001-2002	30	280	88	09	08	415	756.40	0.55
2002-2003	16	218	96	14	07	351	786.20	0.45
2003-2004	09	202	95	14	05	325	790.80	0.41
2004-2005	13	138	70	10	03	234	810.14	0.29
2005-2006	09	131	75	15	04	234	825.40	0.28
2006-2007	08	096	79	04	08	195	847.80	0.23
2007-2008	08	100	77	05	04	194	890.50	0.22
2008-2009	13	085	69	03	07	177	905.20	0.20
2009-2010	09	080	70	02	04	165	997.20	0.17
2010-2011	05	080	53	02	01	141	1005.20	0.14
2011-2012	09	055	61	04	02	131	1077.00	0.12
2012-2013	06	049	58	08	--	121	1109.70	0.11
2013-2014	04	053	59	07	03	126	1096.00	0.11
2014-2015	05	063	56	06	05	135	1166.70	0.12
2015-2016	03	065	35	00	04	107	1144.19	0.09
2016-2017	05	078	20	01	00	104	1173.50	0.09
2017-2018	03	054	03	13	00	073	1170.74	0.06

Source: GOI IRYB, (Several Years).

In an Appendix to this Section, figures relating to broad causes of Accidents, Collisions and Derailments, Derailments, Damage to Railway Property, Budgetary Allocations for Railway Safety Related Activities, Year-Wise Allocation of Funds under 'Railway Safety' (RSF), Accidents at Unmanned Level Crossings, Number of Manned and Unmanned Level Crossings (LC), Compensation paid for deaths and injuries, are given in Tables A1 to A9, respectively.

Safety issues mostly concern train accidents which have severe repercussions in terms of loss of life, injury, damage to railway property or interruption to rail traffic. According to GOI, [2003a], an accident is an occurrence in the course of working of railways which does or may affect the safety of trains or which does or may cause delay or loss to the railway. The term 'accident' envelopes a wide spectrum of occurrences of consequences not necessarily leading to a mishap. 'Failures of railway equipment' are also treated as technical and potential 'accidents' for the purpose of managing assets safely [IR, 2003b]. Accordingly, railway safety involves basically the end-product of a cohesive fusion of myriad parts which include railways staff, track, rolling stock, signals, electrical equipment, suppliers/vendors of different equipment and of course 'the general public'. Since the 1960s, safety on the Indian Railways has been subject matter of a number of high- powered Committees which have examined the various issues and recommended remedial measures. Though all aspects of railway working affecting railway safety have been examined in detail and remedial measures identified but their implementation has been tardy with the result that safety issues on IR have continued to be a matter of great concern to all the concerned stakeholders.

One major area of concern has been in regard to the extent of over aged assets and its implications for safe railway operations. According to GOI [2001b], the figures given in the following Table 3 were the arrears of asset renewals as on 1st April, 1999.

Table 3. Arrears of Asset Renewals

Arrears of Track Renewals - (BG)*	12,260 Kms.
Distressed Bridges	262 Nos.
Over aged Signaling Gears	1,560 Stations
Over aged Coaches (BG)*	1,322 Vehicle units
Over aged wagons (BG)*	34,000 (in terms of 4-wheeler units)

*BG refers to Broad Gauge
Source: GOI, [2001b]

In the late eighties and nineties, the Railways were not able to provide fully for their depreciation needs due to severe financial constraints. The position worsened further being aggravated by the implementation of the recommendation of the Vth and VIth Central Pay Commissions. The steep increase in the working expenses of the Railways resulted in an erosion of the Railways' capacity to generate investible surpluses. The railways had to resort to drawing down the balances of the Depreciation Reserve Fund (DRF) (see Table No. 4) to enable fund minimal plan outlays.

Table No 4. Contributions to Depreciation Reserve Fund (DRF)

(Rs. in crores)

Year	Opening Balance	Appropriation	Withdrawal	Interest on Fund Balance	Closing Balance
(1)	(2)	(3)	(4)	(5)	(6)
2006-07	4141	4298	4957	247	3729
2007-08	3729	5550	5774	253	3757
2008-09	4347	7100	8371	259	3335
2009-10	3336.19	2287	5731.19	112.99	4.99
2010-11	4.99	5615	5598.91	-16.33	4.69
2011-12	4.69	7100	7100	0.28	4.97
2012-13	4.98	7050	7045.47	0.29	9.80
2013-14	9.80	8100	7119	25.30	1021.38
2014-15	1021	8043	7286	69	1772
2015-16	1786	5800	7688	9	32
2016-17	32	5400	4982	-	450
2017-18	465	1740	1525	40	712
2018-19	712	500	534	37	718

Source: GOI IRARA, (Several Years).

The closing balance was more or less nil during 2009-10, 2010-11, 2011-12 as observed by GOI [2012a] but found hardly any improvement in 2012-13 as revealed in the above Table. The situation improved to some extent in 2013-2014 and 2014-2015 worsened in 2015-16 but again showed improvement in 2016-17, 2017-18 and 2018-19.

Given the precarious situation in the late nineties, GOI [2001a] had recommended a grant of Rs. 17000 crores to the Railways for wiping out the accumulated arrears of the replacement and renewals. Accordingly, a onetime grant for renewal of these over aged assets was sought by the Ministry of Railways. A non-lapsable Special Railway Safety Fund (SRSF) of Rs. 17000 crores were set up in 2001 to expedite the works of renewal/replacement of over aged safety related assets within a time frame of the next six financial years. It was decided that this fund would be funded through two sources viz., (I) railways' contribution through the levy of a 'safety surcharge' on passenger traffic and (ii) through additional financial assistance to be given by the Ministry of Finance. The amount to be so provided would be Rs. 5000 crores and Rs. 12000 crores, respectively. The surcharge was in place since October 1, 2001but was subsequently merged into fare structure.

Around the same time, the Corporate Safety Plan of the Indian Railways for 2003-2013 [GOI, 2003b] was formulated whose broad objectives included reduction in the rate of accidents and passenger fatalities, development of manpower, safety on all fronts of train operations and maintenance and adoption of fail-proof environment, etc.

Since the time the SRSF was set up, the situation changed vastly. Provisions from the SRSF succeeded in wiping out the backlog of renewal of assets of IR, whether track, signaling, and rolling stock or any other category. The

so-called golden turn around of IR, which followed during the period 2004-2008 leading to adequate fund surpluses, ensured adequate provision in DRF which took care of the replacement requirements. The targets set in the Corporate Safety Plan for reduction in derailment and accidents at unmanned level crossings have since been achieved. By the end of the Corporate Safety Plan in 2012-13, accidents per million train kilometres reduced to 0.11 from 0.17 in 2002-03.

The High- Level Safety Review Committee headed by Dr. Anil Kakodkar [GOI, 2012a] identified a number of such frontline areas of working and suggested options before the IR and the road ahead in terms of technology and financial challenges. It came to be once again recognized that overused assets are to be renewed and replaced regularly while ensuring that their maintenance and technological up gradation is also taken care of in the interest of safety and to avoid equipment failures, which not only affect safety but interrupt operations, thereby, reducing line capacity, haulage and revenue potential.

The pace of technological up gradation on IR to reduce dependence on human judgment has also been slow. All this has meant that, in the absence of overall and adequate safety related investments, not only related to arrears, but also due to new requirements, the full potential of the system is not and has not been bee exploited. Such a situation has implications in terms of inefficiencies, diversion of traffic to the roads, etc., which when corrected would serve the basis for greater revenue generation. In other words, there are a lot of gains financial as well as economic-that can be derived by a greater focus on safety related but timely investments on the railways. But the potential gains from safety related investments need to be quantified, if that is to serve the immediate purpose of drawing greater attention of policy makers to safety issues on the IR. It is against this background that we attempted a comprehensive study on the subject which is presented in this paper in a somewhat brief form.

1.2 Structure of the Paper

The following Section provides a brief on some theoretical considerations examined in the literature on the economics of railway safety and also a critical review of policy based literature based on the observations and recommendations contained in the reports of the various high- level Safety Committees appointed by IR since 1962 from time to time while Section 3 attempts a critical review of the implementation of the policy recommendations of these Safety Committees. Further, in Section 4, an attempt has been made in to identify the critical safety issues still outstanding and those that need to be addressed at this juncture based on an analysis of the reviews of the Committees. Section 5 reports some case studies in the diverse area of IR's working, related to safety, made to evaluate financial gains which can be expected to flow soon from the investments in safety and related matters some of which have not been evaluated even on an elementary basis let alone systematically evaluated in the past so as to provide a stronger basis for understanding the need for such crucial investments on the part of policy makers. Finally, a brief description of the present safety framework on the IR as prescribed in the Railways Act, 1989 [GOI, 1989] is given in Section 6. Based on this framework, the relevant practices in regard to rail safety on the IR have been based on Codes, Manual and Procedural Orders issued by Ministry of Railways (Railway Board) to the Zonal Railways. In the same Section, an attempt is made to present a proposal for the Adoption of a New Safety Management System on IR which could possibly eliminate the feeling that the emphasis on safety will hamper operations of IR and lead to realization that safe working of the railways is definitely more orderly, efficient as well as more productive.

APPENDIX

Table A1. Broad Causes of Train Accidents

Years	Failure of Railway Staff	Failure of Persons other than Railway Staff	Failure of Equipment's			Sabotage	Combi-nation of Factors	Inci-dental	Causes could not be Establ-ished	Under Investi-gation	Grand Total
			Rolling Stock	Track	Electr-ical/ S&T						
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
2000-2001	293 (62)	109	16	17	-	19	04	11	04	-	473
2001-2002	248 (67)	103	11	13	-	14	-	20	05	01	415
2002-2003	186 (53)	118	06	11	01	10	02	15	02	-	351
2003-2004	161 (50)	107	06	09	03	18	02	17	02	-	325
2004-2005	119 (51)	078	05	07	02	04	01	16	02	-	234
2005-2006	120 (51)	086	01	06	01	05	-	11	03	01	234
2006-2007	85 (44)	084	004	05	-	08	01	07	-	01	195
2007-2008	85 (43.81)	071	04	03	02	07	-	08	01	03	184
2008-2009	075 (42.37)	075	-	-	-	13	04	04	04	02	177
2009-2010	063 (38.18)	075 (45.45)	03	03	-	14	01	04	02	02	167
2010-2011	056 (39.72)	057 (40.43)	-	05	-	16 (11.35)	03 (2.12)	04 (2.83)	-	-	141
2011-2012	052 (39.69)	063 (48.10)	-	05	-	06 (4.58)	01 (0.76)	03 (2.29)	01 (0.76)	-	131
2012-2013	045 (37.18)	059 (48.76)	-	06	-	03 (2.48)	-	07 (5.79)	01 (0.83)	-	121
2013-2014	050 (42.73)	055 (47.00)	-	03	-	04 (3.42)	-	04 (3.42)	-	01 (0.85)	117
2014-2015	060 (44.44)	058 (42.96)	-	04 (2.96)	-	03 (2.2)	-	08 (5.92)	02 (1.48)	-	135
2015-2016	055 (51.40)	038 (35.51)	-	02 (1.86)	-	01 (0.09)	01 (0.09)	09 (8.41)	01 (0.09)	-	107
2016-2017	064 (61.54)	022 (2.15)	-	02 (1.92)	-	02 (1.92)	03 (2.88)	07 (6.73)	-	04 (3.85)	104
2017-2018	044 (60.30)	018 (24.70)	-	02 (2.74)	-	02 (2.74)	02 (2.74)	05 (6.85)	-	-	073

Source: *Lok Sabha Secretariat* [2018]

Table A2. Collisions and Derailments

Year	Number of Collisions and Derailments	No. of Collisions and Derailments Attributed to Failure of Railway Staff	Percentage
(1)	(2)	(3)	(4)
2000-2001	370	280	75.68
2001-2002	310	-	-
2002-2003	232	182	78.45
2003-2004	211	143	67.77
2004-2005	151	110	72.85
2005-2006	140	106	75.71
2006-2007	104	075	72.12
2007-2008	108	075	69.44
2008-2009	098	064	65.31
2009-2010	089	057	64.04
2010-2011	085	051	60.00
2011-2012	064	048	75.00
2012-2013	055	037	67.27
2013-2014	057	044	77.19
2014-2015	068	052	76.47
2015-2016	068	053	77.94
2016-2017	083	063	75.90
2017-2018	063	040	63.49

Source: Same as Table A1

Table A3. Derailments

Year	Total Accidents	Derailments	Percentage
(1)	(2)	(3)	(4)
2000-2001	473	350	74.00
2001-2002	414	280	67.63
2002-2003	351	216	61.54
2003-2004	325	202	62.15
2004-2005	234	138	58.97
2005-2006	234	131	55.98
2006-2007	195	096	49.23
2007-2008	194	100	51.55
2008-2009	177	085	48.02
2009-2010	165	080	48.48
2010-2011	141	080	56.74
2011-2012	131	055	41.98
2012-2013	122	049	40.16
2013-2014	118	053	44.92
2014-2015	135	063	46.67
2015-2016	107	065	60.75
2016-2017	104	078	75.00
2017-2018	073	054	73.97

Source: Same as Table A1

Table A4. Damage to Railway Property and Interruption to Communications

Year	Cost of Damage (Rs. in lakhs)		Interruption to through Communication (in Hours)
	Rolling Stock	Permanent Way	
(1)	(2)	(3)	(4)
2000-2001	3693.00	1831.00	4045.00
2001-2002	3234.60	1647.00	3224.00
2002-2003	3158.40	0617.30	2388.00
2003-2004	4348.60	0826.00	2806.00
2004-2005	2225.00	0497.10	1691.00
2005-2006	2443.40	0941.50	1904.00
2006-2007	2321.70	0871.30	1148.00
2007-2008	2970.00	1085.40	4380.52
2008-2009	5011.90	1052.90	1420.08
2009-2010	4216.48	1244.99	1105.01
2010-2011	4584.52	1311.37	1455.05
2011-2012	8210.49	0771.99	1041.16
2012-2013	4142.21	1281.78	1131.41
2013-2014	2003.29	1798.61	0745.38
2014-2015	6313.06	0894.45	0946.27
2015-2016	5089.42	0834.33	0923.05
2016-2017	3554.24	2674.09	0902.77

Source: Same as Table A1

Table A5. Budgetary Allocations for Railway Safety Related Activities

Year	Amount	
	Budget Estimate	Revised Estimate
(1)	(2)	(3)
2016-2017	59970	63062
2017-2018	68797	68724
2018-2019	73065	----

Source: Same as Table A1.

Table A6. Year-Wise Allocation of Funds under 'Railway Safety Fund (RSF)'

Year	Amount (Rs. in Crore) (RE)
(1)	(2)
2013-2014	02000.00
2014-2015	02200.00
2015-2016	02661.40
2016-2017	10780.00
2017-2018	11375.00*

** In the Budget 2017-18, an exclusive fund called "Rastriya Rail Sanraksha Kosh" (RRSK) has been made with a corpus of Rs. 1 lakh crore over a period of 5 years for giving a major boost to safety related works.*
Source: Same as Table A1

Table A7. Accidents at Unmanned Level Crossings

Year	Number of Accidents at Unmanned Level Crossings	As Percentage of Total Number of Consequential Train Accidents
(1)	(2)	(3)
2010-2011	48	34.04
2011-2012	54	41.22
2012-2013	53	43.44
2013-2014	47	39.83
2014-2015	50	37.04
2015-2016	29	27.10
2016-2017	20	19.23
2017-2018	10	13.70

Source: Same as Table A1

Table A8. Number of Manned and Unmanned Level Crossings (LC)

Sl. No.	State	As on 1.4.2015		As on 1.4.2016		As on 1.4.2017		As on 1.4.2018	
		No of Manned LC	No of Un-manned LC	No of Manned LC	No of Un-manned LC	No of Manned LC	No of Un-manned LC	No of Manned LC	No of Un-manned LC
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
01	Andhra Pradesh	1071	0453	1096	0361	1140	0272	1133	0171
02	Assam	0609	0202	0708	0225	0771	0141	0821	0072
03	Bihar	1263	0938	1293	0898	1339	0809	1380	0742
04	Chandigarh	0004	0000	0004	0000	0004	0000	0004	0000
05	Chhattisgarh	0280	0088	0286	0061	0285	0040	0265	0025
06	Delhi	0032	0001	0032	0001	0031	0001	0028	0001
07	Goa	0010	0000	0010	0000	0010	0000	0010	0000
08	Gujarat	1555	2052	1534	1985	1543	1895	1564	1700
09	Haryana	0603	0182	0590	0159	0602	0092	0579	0048
10	Himachal Pradesh	0050	0006	0049	0006	0049	0006	0050	0004
11	Jammu & Kashmir	0034	0001	0034	0001	0034	0001	0034	0001
12	Jharkhand	0471	0221	0486	0172	0511	0113	0525	0034
13	Karnataka	0704	0382	0727	0300	0702	0253	0711	0179
14	Kerala	0451	0009	0440	0007	0431	0007	0425	0000
15	Madhya Pradesh	1179	0518	1104	0452	1019	0382	0982	0255
16	Maharashtra	1244	0413	1249	0335	1236	0268	1169	0214
17	Manipur	0001	0000	0000	0000	0000	0000	0000	0000
18	Mizoram	0001	0000	0001	0000	0001	0000	0001	0000
19	Nagaland	0001	0000	0001	0000	0001	0000	0001	0000
20	Odisha	0539	0497	0601	0370	0687	0223	0723	0125
21	Puducherry	0019	0004	0020	0003	0021	0002	0021	0002
22	Punjab	1037	0436	1026	0395	1024	0334	0998	0228
23	Rajasthan	1323	1022	1292	0940	1263	0805	1194	0464
24	Tamil Nadu	1336	0702	1374	0611	1390	0444	1429	0269
25	Telangana	0413	0086	0423	0072	0421	0037	0420	0009
26	Tripura	0011	0007	0015	0000	0015	0000	0015	0000
27	Uttar Pradesh	3219	1466	3226	1357	3180	1112	3165	0912
28	Uttarakhand	0144	0056	0145	0047	0147	0035	0153	0023
29	West Bengal	1443	0698	1501	0582	1623	0429	1707	0314
	Total	**19047**	**10440**	**19267**	**9340**	**19480**	**7701**	**19507**	**5792**
		29487		**28607**		**27181**		**25299**	

Source: Same as Table A1

Table A9. Compensation Paid by Railways@

Year	Compensation Paid
(1)	(2)
2000-2001	886.12
2001-2002	482.46
2002-2003	489.19
2003-2004	757.07
2004-2005	513.16
2005-2006	221.63
2006-2007	500.89
2007-2008	121.37
2008-2009	218.94
2009-2010	265.81
2010-2011	585.79
2011-2012	510.77
2012-2013	319.63
2013-2014	149.22
2014-2015	127.48
2015-2016	262.96
2016-2017	303.17
2017-2018	188.52

Source: Same as Table A1

SECTION 2

Before we review the work of High-level Committees on safety related issues on Indian Railways, we provide, to begin with, some insights from the very limited available literature relating to the economics of railway safety relevant for the purpose of this paper.

2.1 Economics of Railway Safety- a brief note

Railway operations involves movement of heavy vehicles on the surface and on tracks at high speeds with long stopping distances which means the distance travelled between the time when someone decides to stop a vehicle moving, and the time when the vehicle completely stops: The stopping distance depends on several factors, including the road surface and the driver's reflexes). The safety risks of such operations have long been recognised, and elaborate control systems and technical standards have been developed to mitigate these risks. These risk controls are complex and had become deeply embedded in the structure of the railway organisations especially related to safety. Therefore, safety and safety regulation have been a major concern throughout the railway development process. Accordingly, it is widely recognised that, the principal responsibility for rail safety lies with the infrastructure providers (who for decades have been train operators themselves, because they can best control their risks. It is for the organisations to determine their safety systems and comply with them. The function of the safety regulator is to oversee this process: to be satisfied that a railway organisation's safety systems are suitable and sufficient for their purpose, and that they are being complied with while specifying certain broad standards [OECD, 2010]. The generic label for the operators' safety arrangements is their "Safety Management System" (SMS). This phrase covers both the safety systems themselves and the documentation of those systems. The development of rail Safety Management Systems has another important and more generic origin. Over the last decades it has become accepted that many kinds of accidents or incidents in tightly controlled safety-critical systems such as railways are not simply the result of an immediate technical failure or human error, but may have their origins in the safety arrangements and culture of the organisation in which they occur. Accidents may stem from decisions and actions taken at times and places quite distant from the final accident. Therefore, an effective safety management system must be embedded in the whole organisation and not just cover the arrangements for the immediate control of well-recognised hazards.

According to Savage [2013], the field of transportation safety has been dominated by engineers, psychologists, medical doctors and those who study organisational behavior. "A relatively small band of economists have contributed to the debate" (p. 1). And the issues raised by these relate to:

1. How safe is safe enough?
2. Can safety provisions be left to the market place?
3. What is the role of public regulation in the provision of safety?

In an earlier work, Savage [1998], it is argued that from an economist's point of view the issue is to determine whether there is any failure in the market mechanisms that determine safety. The theory can be divided into two distinct types. The first is in terms of the economics of bilateral accidents. These are accidents where the probability of an accident is influenced by the level of preventive effort undertaken by both the railroad and the other party involved in the accident. The

prime examples of bilateral accidents are grade-crossing collisions, trespasser fatalities, and occupational injuries. Because the highway user, trespasser, or employee can affect the probability and severity of an accident by the level of care that they take, economic and legal theory has been developed to provide all parties the appropriate incentives so as to minimise the societal cost of accidents. Further, a different theory of safety is used when we look at operational safety. Here, safety is one of the attributes of the service offered by the railroad to its passenger and freight customers. It is an attribute of service that is desired by customers but costly to provide. There will be some economic equilibrium where desire and costs are matched. Thus, Savage [2013] says that in terms of traditional economic models, safety is most likely an important part of both the demand and supply functions. The possibility of loss, injury and even death enters mode choice decision making in some way that is yet to be quantify in any reasonable way. This is because trip makers, for example, are normally supposed to have imperfect knowledge of the risks that they face. In other words, asymmetric information is a major problem. On the supply side, the costs are ill defined since besides costs being imposed on the parties involved, there are also externalities which the underlying legal regime is supposed to determine by way of internalising the party that was responsible. Savage also points out to an unusual feature in the context of users and firms that they need to consider both ex-ante costs that lessen the probability and severity of an incident but also ex-post costs that are incurred only if incidents really happens. Thus, there are trade-offs of certain costs in the present against averting or lessening uncertain cost consequences in the future. Savage warns that a myopic view on decision taking in these circumstances could lead to regret in the long run.

Safety, thus, being so deeply embedded in the design and day-to-day operation of railways, it is, thus, impossible to separate the costs of safety from other costs of the provision of rail services. However, it is possible to consider the costs and the benefits of specific safety measures. The railways are subject to many different kinds of hazards, and risks are mitigated by a wide variety of safety measures, ranging from minor local improvements such as lighting or fencing at specific places, to major system safety measures such as train protection. And railway operators and regulators have long recognised that some safety measures represent better value for money than others, and that some safety measures may not be worthwhile, even though they would reduce accidents. However, the criteria for deciding what measures are worthwhile have not generally been very clear.

2.2 A brief outline of Social Cost Benefit Analysis (SCBA) relating to Safety with some examples at the International level

The systematic process of identifying, quantifying, and comparing expected benefits and costs helps decision-makers organise information about, and evaluate trade-offs among, alternative transportation investments. A SCBA compares the anticipated benefits that accrue from a project to the anticipated costs of the project over a specified period of time. A SCBA looks at project benefits that accrue to both direct users, (e.g., rail passengers or freight rail shippers) and non-users, (e.g., society at large), as well as the costs required to achieve a project's expected outcomes. Benefits could include such factors as improved safety, air quality, mobility, or transportation system

connectivity, while costs should include the capital, operating, and maintenance expenses necessary to deliver the project benefits.

In addition to serving as a valuable tool for defining and narrowing investment alternatives, Social CBAs are also increasingly a prerequisite to receive financial assistance from Governments. SCBAs can vary greatly in complexity and workload from one project to the next. The minimum requirements for a SCBA will be dependent upon multiple factors, including the type of project proposed, the development stage of the project, and the cost of the project.

A recent study [FRA, 2016] spells out the safety benefits for rail projects occur when a project reduces the likelihood of a derailment or any other type of railroad crash. Benefits can also occur if a project minimises the severity of any railroad crash, because reducing crash risk or severity will result in fewer injuries and fatalities, as well as less property damage. To claim safety benefits for a project, there is a need to clearly demonstrate how a proposed project targets and improves safety. The project sponsor should include a discussion about various crash causation factors addressed by the project, and establish a clear link to how the proposed project mitigates these risk factors. Some examples of rail projects that are likely to generate safety benefits include: improvements to grade crossings (highway-rail, pedestrian-rail, rail-rail and rail-water grade crossings); shifts from alternative modes that involve higher safety risks to their users; and improvements in rail infrastructure or technology that reduce crash risk. Rail crash for these purposes include, but are not limited to, derailments, head-on collisions, raking collisions, and at-grade crossing collisions.

Safety benefits can result when a project improves a grade crossing; for example, by removing the grade crossing altogether or increasing the signage, warnings, or other protection measures at the crossing. A project that removes the grade crossing will increase safety at the intersection by eliminating the likelihood of an auto and train crash at that intersection. Similarly, a project that installs flashing lights and gates at a previously unprotected crossing will enhance safety by reducing the likelihood of an auto and train crash at the intersection. Depending on the type of updates, grade crossing projects may also eliminate or reduce pedestrian access to the site, removing or lowering the likelihood of a pedestrian being hit by a train. For example, better signage or increased fencing might deter or prevent pedestrian access. Technological advancements can also enhance the safety of rail corridors. The study also attempts to outline some of the major components to estimating the safety benefits in, for example, a project on grade crossing (level crossing) as: baseline risk; the reduction in risk expected to result from a project that improves a grade crossing; and the expected consequences posed by those risks.

Ben Aoun, E.-M. et.al., [2010] presented the results of the SCBA for Level Crossings (LCs) within the framework of the rail optimisation safety analysis project process. To that purpose, they analysed the railway systems in France and in Germany in order to identify the possible safety options to implement for enhancing safety at LCs. As more than 98% of accidents at LCs were due the non-respect of the rules of the road, they found it not surprising to notice that the best safety measures are without any doubt those which directly act on road users' behavior, such as radar installations on roads and on rail or safety campaigns. Nevertheless, it was important, they noted to recall that the aim of the SCBA is to determine

the best actions to be taken from a railway point of view. On the basis of a detailed analysis, it was found useful to have radar installations which could result in benefits to the railways. However, given that it is very difficult to include all the effects of a safety option in a SCBA (as spelt out in Andrieu, L. et.al., [2006], the results have to be used with caution.

A cost benefit criterion for safety measures, like any other investment, would typically suggest that safety measures are worthwhile if their benefits exceed their costs, but not otherwise. But it must be understood that the benefits of safety measures normally include the prevention of casualties which means the valuation of the benefits of safety measures requires also the valuation of prevention of fatalities and injuries.

OECD [2010] reported a review of European valuations that was provided by the European Union (EU) HEATCO project [Universitdt Stuttgart, 2006]. The study took for granted that the same valuations for the prevention of casualties should be applied to rail as to road safety, and indeed to other transport modes. In Britain the Rail Safety and Standards Board (RSSB) has commissioned research [Oxford Risk Research and Analysis, 2006] on the rail Value of Preventing a Fatality (VPF), and RSSB presents its own advice in "Taking safe decisions" [RSSB, 2008]. The researchers' and RSSB's conclusion are broadly that the rail VPF should be the same as the road VPF. That is in line with HEATCO's implicit view. The European Railway Agency held a conference on the "Economic Appraisal of Rail Safety related Interventions" in April 2009 [ERA, 2009], which presented an up-to-date snapshot of the use of Cost Benefit Analysis (CBA) in railway safety.

Generally, there is agreement among the professionals that SCBA is a sensible form of analysis, but there are only very limited examples of the use of CBA in railway safety in practice. The most specific, albeit small, example presented at the ERA conference was by Hallden [2009] of Banverket, Sweden. This was of track surveillance cameras as a protection against suicides, trespassers and vandalism. Hallden's conclusion was that the benefits of suitably located cameras exceed the costs. On a larger scale, but dating back to the 1990s, British Rail carried out a major cost benefit appraisal of Automatic Train Protection (ATP) in Britain [see Evans, 1996 for a succinct account]. This came to the conclusion that the costs of ATP far outweighed its benefits, and this then contributed to the decision by the government not to pursue network-wide ATP. Two common requirements in organisational safety are that risks should be reduced to a level "as low as reasonably practicable" (ALARP), or that systems should be safe "so far as is reasonably practicable" (SFAIRP). These phrases neatly capture the idea that there are trade-offs in safety. While it is desirable to improve safety, but there are limits beyond which safety measures may not be practicable and feasible. The problem with ALARP and SFAIRP is that they do not themselves indicate what safety measures should be regarded as practicable and what not. For many safety measures, ALARP and SFAIRP are interpreted as requiring the adoption of best practice, on the argument that good-practice safety measures must be reasonably practicable. For large or less tested safety measures, it is possible to interpret ALARP and SFAIR through the cost benefit criterion, and define a safety measure to be practicable if its benefits exceed its costs, and not otherwise. Some railway organisations promote the interpretation of the ALARP or SFAIRP requirement in this way, notably [2008] in "Taking safety decisions". In practice,

there is a strong tendency in railways to adopt safety measures at the margin whose costs of preventing casualties exceed the roads values, especially for preventing passenger and staff fatalities [Oxford Risk Research, 2008].

Backman [2002], in his work, attempted to describe and develop methods for analysing railway safety based on the explicit weighing of safety against other costs and benefits. Safety analysis is described as a procedure that moves from the identification of problems to the evaluation of decisions and implementation while including analyses of different alternatives. The procedure proposed was a combination of traditional socio-economic cost-benefit analysis and setting up of limits in the form of criteria for the absolute level and the distribution of risks in which the risk criteria set the level above which risks from an activity are not permitted. Risks below this level should be weighed against other costs and benefits. The approach was claimed to be quite simple in theory, but the information and conditions needed for the safety analysis considerable. An economic analysis of a train traffic control system was described in some detail. The railway is a technical system for which there are various methods for analysing risks. It was pointed out that the problem with using traditional statistical methods for estimating accident probabilities, and so on, was the lack of data, the main problem being data for estimating accident risks. Even if risk analysis methods were to be used, it was often necessary to have some information on the incident rates or reliability in different parts of the system. Developing a system for detailed incident reporting could be one possible way of increasing the information available on system disruptions and may lead to a better knowledge of the risks in the railway system. One common way of presenting criteria for collective risk has been in the form of Frequency - Number lines (FN lines). But Evans [2003] showed that using FN criterion lines for judging risks could lead to inconsistent decisions. It offers the opportunity of giving higher weightings to multiple-fatality accidents than to "smaller", single-fatality accidents. The calculated level of the disutility is then compared with a threshold value for an unacceptable level of disutility. Backman concluded that it was not only conceivable but also probable that we currently have safety rules that have major socio-economic effects, with the aim of reducing risks that are already so low that they can be classified as negligible.

This brief on the literature indicates the need for a more comprehensive analysis of Costs and Benefits even on safety related investments to do that a much better and relevant data base is required (and accordingly generated) to look at issues of safety and derive lessons for a better and a safer railway system. Till such time, it would be the necessary to, at least, focus on a specific subsystem(s) that could in betterment of safety practices. It is within this limited framework a simple cost benefit analysis can be undertaken to provide useful directions. This paper provides some preliminary attempts in a later Section to undertake this form of limited empirical analysis relating to specific improvements undertaken/ attempted on Indian Railways with a view to provide some guidelines on safety related investments which along with basic provisions of safety could make the system more safe and reliable.

2.3 A Concise review of work of High-level Committees

To review the state of safety on the Indian Railways, the Ministry of Railways has, from time to time, appointed Committees headed by

eminent persons from outside the Indian Railways. The Reports of these Committees give us good insights into the major issues relating to safety that the IR has faced over decades since the sixties and the remedial measures suggested by them. An initial reading of all these reports revealed that all of them were set up following some accident(s) on the railway system which raised an outcry in Parliament as well amongst the travelling public. We now look at the reports of the different Committees and review them in some detail sequentially.

a. The Railway Accidents Committee Report, 1963

Among the earliest of the Committees to be constituted was the one under the chairmanship of the distinguished Parliamentarian and Social worker, Shri Hriday Nath Kunzru, in the early sixties. The appointment of this committee was the outcome of discussions in Parliament and then in the Government on the three serious accidents that took place within a period of 20 days in October and November, 1961 at Ghatsila on the South Eastern Railway Zone, at Mainpuri on the Northern Railway Zone, and at Kosgi on the Southern Railway Zone, respectively, resulting in 76 deaths and injuries to 266 persons. These accidents aroused considerable public concern, which was expressed in Parliament and was voiced in the press all over the country. In the course of the discussions on these accidents in Parliament, it was suggested that besides the statutory enquiries which are normally conducted by the additional Commissioners of Railway Safety functioning under the Ministry of Transport and Communication at that time to determine the cause of each accident, a more detailed and comprehensive enquiry by an expert Committee into the issue of accidents on Indian Railways should be conducted with a view to suggesting ways and means for further minimising their occurrences. The report, in two parts [GOI, 1963], was submitted to the Ministry of Railways in December 1962 and in November 1963 respectively.

To understand the nature of accidents, the Committee defined a train accident on Indian Railways for its consideration as a mishap to a train, or a part of it, which may or may not result in loss of life or limb, or damage to property. Within the ambit of such a comprehensive definition, the Committee observed that about 9000 accidents were taking place per year on IR and went on to further classify train accidents on IR into the following two categories:

(i) Consequential accidents: those accidents which normally result in loss of life, limb or damage to property. In this category, they included collisions, derailments, sabotage cases, fires in trains and trains running into road traffic at Level Crossings.
(ii) Indicative accidents: Mishaps generally not resulting in casualties, but which are indicative of unsafe acts or unsafe conditions of work or defective railway equipment like averted collisions, trains bye-passing signals, breach of basic rules, etc.

On the basis of this defined framework, the Committee pointed out that during the five years (1957-1962), there were 74 such serious accidents on Government Railways on which statutory enquiries were held by the Railway Inspectorate. A careful study of these serious accidents revealed that the human factor involving station staff, drivers & gatemen was responsible for lapses leading to about 73% of serious accidents.

The Committee emphasised the point that in the case of running staff, their running duty at a stretch should not ordinarily exceed ten hours and they should be entitled to claim relief after twelve hours provided, they had given a two -hour notice to the controller. For the purpose of computing duty at a stretch, time should be calculated from the actual departure of the train. It was also found that a number of collisions were caused by the reception of a train on a blocked line or by dispatch of a train into a blocked section or incorrect setting of points. Therefore, it was felt that many accidents could be avoided by providing Track Circuiting of reception lines at stations. In short, track circuiting indicates the actual presence of a train on a line and gives continuous indication of this fact and makes it impossible to admit a second train into it until it is clear throughout its entire length. Track circuiting was then being widely used in all modern signaling schemes on busy sections of many railways systems. In India, its use had been extremely limited and was confined to a few big stations. Though the railways had planned to provide track circuiting at 70 stations during the Second Plan period but could implement it at nine stations, i.e., to the extent of 13% only. During the first two years of Third Plan, this programme had progressed by another 33%. The failure of the Railways to execute, during the noted seven years, even half of the works programme target seemed very apparent. It was also pointed out that the lack of wooden or concrete sleepers was a serious obstacle in extending track circuiting on a large scale.

Another issue related to Automatic Block Signaling which were required in order to have an enhanced standard of safety on those double line sections where speed and density of traffic are high and constantly on the increase. Under this system, the lines are track circuited throughout and the signals are operated automatically by the passage of trains. This signaling, apart from increasing capacity of lines, establishes greater harmony between the train and the track by eliminating station masters as agents for signaling the trains and thus the element of safety got considerably enhanced. At that time, it was observed by the Committee that the automatic block signaling scheme covered hardly 2% of the total double line route network on the railways. Further, it was necessary to ensure power signaling such as Route Relay Interlocking (RRI) which is electrically operated and controlled from a central cabin by means of push buttons, at times mounted on illuminated track diagram, which normally guaranteed the highest safety factor, while reducing time of operations, make the working more efficient, economical while, at same time, increase the track capacity. And it was necessary to keep in mind that track circuiting was an essential feature of RRI. With speeding up of trains on trunk routes of the railways to meet emerging requirements, there also arose a pressing need to make sure the engine crew followed the respective indications exhibited by the signals *en route.* And this process was typically provided for by Automatic Train Control (ATC) which consists of an apparatus on the engine and on the track to function firstly as a location warning, then, secondly as an audible alarm to the engine crew and, lastly, as an automatic control on the train through application of brakes, in case, the engine crew failed to exercise control. It was as valuable an aid to the driver as track circuiting was for the station master. Since railways in most of the advanced countries had successfully adopted this system, it was felt that this should be used on suburban sections and selected trunk routes on Indian Railways. Further, over aged Rolling Stock, both coaching and goods, ought to receive special attention both in passing through shops as well as on the sick line. For this purpose,

such stock should be distinctly marked so that the staff dealing with repairs bestowed additional attention in their examination and repairs. It was also emphasised that the period of overhaul of such over aged stock should be suitably reduced and their utilisation should be as far as possible limited to specified areas.

It was pointed out that about 13% of the derailments on Broad Gauge and Metre Gauge were caused by Permanent Way Failures. In this connection, it was recommended that in view of the regular shortage of wooden, steel & cast iron sleepers, IR should go in for an extensive use of pre-stressed concrete sleepers and the program of welding of rails should be extended to all sections on the Indian Railways. Finally, the Committee suggested the setting up of a suitable organisation at the various levels of the Railway administration to exclusively deal with problems of accidents and safety and to undertake the tasks enumerated and assigned to them.

b. The Railways Accidents Inquiry Committee, 1968

The appointment of this Committee was the outcome of two accidents in the latter half of March 1968 - one at Yalvigi on the Southern Railway on 19th March, 1968 and the second at Bharwari on the Northern Railway on 30th March, 1968 - involving heavy causalities and damage to Railway property in quick succession. The close sequence in which they followed each other greatly agitated the public mind, press and the Parliament. In response to such an upsurge, the then Minister of Railways announced the setting up of the Railway Accidents Inquiry Committee in 1968 with Shri. K. N. Wanchoo, retired Chief Justice of India as its Chairman.

The following were the terms of reference:

(i) To review the position of accidents on IR since the appointment of Railway Accidents Committee, 1962 in the light of recommendations made by it and the implementation thereof.
(ii) To suggest measures for further minimising accidents.

The report [GOI, 1968], in two volumes, which provided a detailed review of accidents during the period 1963 to 1968 and of the implementation of recommendations of GOI [1963], went on to make recommendations to further improve upon the several areas of railways working, improved signaling system, rail testing, coach maintenance, duty hours of train crew, etc.

During the five years, 1963-64 to 1967-68, 79 serious accidents occurred on Indian Railways. It is significant that the number of serious accidents due to failure of drivers and station staff decreased from 40 to 34 and those caused by defects in track, rolling stock, engines and fires in trains from 11 to 9, thereby registering a reduction of 15% and 18% respectively. Putting these together, the number of cases in which the responsibility can be laid on the railway administration or its staff came down from 52 in the years 1957-1962 to 43 in the years 1963-64 to 1967-68. Though the number of accidents due to human failure came down from 40 to 34, it was observed that the consequences of such accidents in the latter period were more serious both in the matter of loss of limb and in the matter of damage to property.

After the initial review, the Committee assessed in some detail the follow up on the earlier Committee's recommendations and then went on to state theirs. On staff matters, the railways' remarks on training facilities and their utilisation for the various categories of staff during the years

1966-67 and 1967-68 in response to the Kunzru committee's recommendations were found to be too general and vague to be considered for any reasonable appraisal by the Committee which observed that in many of the training schools, many instructors were those who had been selected on an ad hoc basis, many of them being rejects from line operations. Some of the instructors in the school were reported to have been there for more than a decade. Such practices were termed 'unhealthy' and it was suggested that only persons with outstanding record of work to their credit on open line should be assigned to training schools as instructors. Further, it was observed that in the case of running staff, every railway zone had instances of trips exceeding even 20 hours of running duty when the limit should be 12 hours in line with Indian Railways (Amendment) Act 1956, and not 14 hours as recommended by GOI [1963].

On tracks, the Committee found the progress of welding of rails commendable while hoping that the pace of welding of rails would be maintained and even further accelerated. On the introduction of pre stressed concrete sleepers, the Committee was unable to appreciate the reasons given for the administration's inability to develop concrete sleepers to suit the railways special requirements. It emphasised the need to make special efforts for introducing the pre- stressed concrete sleepers on an extensive scale in view of the unfavourable and inadequate supply position of wooden sleepers and the increasing demand for modern signalling. While on track renewals, though the position was found to be comfortable, the Committee expressed its disappointment on the rate of progress of track circuiting which had been slow, while, at the same time, noting emphatically that progress in terms of introduction of modern signaling techniques was grossly inadequate and which felt was essential with increasing use of diesel and electric traction and running of heavier trains at higher speeds. On issue of the slow progress of introduction of Automatic Traffic Control, it was observed that a part of the equipment in the installation of ATC had to be imported. However, given that certain signaling firms in India were then keen on setting up indigenous capacity for manufacture of the equipment in collaboration with their principals abroad, once the system gets into operation, the Committee was of the strong the view that had the trials and installation of ATC been initiated earlier, these firms would have become interested in this field of manufacture by then.

c. Accidents Inquiry Committee, 1978

The latter part of the second half of 1977 saw two serious railway accidents in quick succession, involving heavy casualties and damage to Railway property. The first was collision between Howrah-Amristar Deluxe Express and a goods train at Naini station on Mugal Sarai-Allahabad Broad Gauge section of Northern Railway on October 1977 and the second was the derailment of Ahmedabad-Delhi Mail between Ajarka and Bawal stations on Bandikui-Rewari Metre Guage section of the Western Railway on November 11, 1977. Against this background then Minister of Railways, Prof. Madhu Dandavate, while making a statement in Rajya Sabha on December 19, 1977 announced the Government's decision to constitute a High-Power Accidents Inquiry Committee with Shri. S.M. Sikri, former Chief Justice of Supreme Court of India, as Chairman to look carefully into the whole issue of accidents.

The terms of reference of the Committee were as under:

(i) To review the position of accidents on the Indian Railways since the appointment of the Railway Accidents Inquiry Committee, 1968 and to review the implementation of their recommendations: and

(ii) To examine the adequacy of the existing organisation, equipment and practices for ensuring safe running of trains on the Indian Railways, and to suggest measures for prevention of accidents.

The Committee submitted its report in 1978 [GOI, 1978]. After a detailed review of serious accidents and their causes, the Committee began its work by looking at the term 'accident' and the manner in which the accident statistic should be compiled on IR. And rightly speaking, law and order related incidents like murder, theft in the train were removed from the scope of railway accidents. Accordingly, accidents were classified under five categories, viz. -

(i) Consequential train accident. These will include collision, derailments, accidents at Level Crossings and fire in trains as the present. These may have serious repercussions in terms of casualties and damage to property.

(ii) Miscellaneous accidents: These accidents include certain types of train accidents not covered under category (i) above (for example Train Running over Cattle, where derailment is not caused) as also yard shunting/siding accidents.

(iii) Breach of Rules (indicative): These are at present termed as Indicative Accidents. These are serious potential hazards ad include cases of Trains Passing Signal at Danger, Breach of Block Rules and Averted Collisions.

(iv) "Equipment Failure": These included cases like engine failure, rail fracture, signal failure, OHE failure, etc., not resulting in a mishap.

(v) 'Unusual Incidents' like murder, suicide within railway premises, thefts, attempted thefts, etc.

While attempting to understand the extent to which the recommendations of the earlier Committee were implemented, GOI [1978] took some of this forward in terms of their own recommendations relating to different aspects of railway operations.

It was observed once again that every railway zone had numerous incidences of trips involving running staff exceeding 20 hours of duty. They urged that vigorous steps should be taken to ensure that 12 hours running duty is ordinarily the limit. The earlier Committees had envisaged the use of concrete sleepers as an alternative to wooden sleepers for track circuiting. There had, however, been very little progress in the use of concrete sleepers in track-circuiting. The Committee found that the number of accidents attributed to rail breakages has increased substantially in recent years. And rail fractures on running lines had also gone up and the delays in track renewals would have contributed to this some measure. They viewed this matter with grave concern and strongly recommended that no efforts should be spared in solving this problem in all its aspects.

The Committee noted with some concern that though GOI [1968] had recommended the provision of Automatic Warning System (AWS) on lines with speeds of 100 Kmph or over, covering all trains including goods trains, and GOI [1963] had also stated that all signals *en route* should be brought under a similar scheme- ATC (AWS), the

Railway Board had proposed to provide AWS only on trunk routes with speeds of 120 Kmph or above covering only mail and express trains. Further, only the first stop signal was proposed to be covered under the present scheme. It was found that very little progress has been made even under such a restricted programme. The poor progress in the last fifteen years has been due to the reluctance to import the equipment and to excessive time that is taken for its indigenous development and manufacture. The Committee advised that the Railway Board should take steps to fulfill at least their diluted commitment of providing AWS on trunk routes and suburban sections at the earliest, In doing so, it would no doubt take full advantage of the available sources of supply in the country and undertake imports if necessary, so as to complete this important safety measure speedily.

d. High Power Railway Safety Review Committee, 2001

This Committee headed by Justice H.R. Khanna, a retired Judge of the Supreme Court of India as its Chairman was set up in 1998, following a spate of serious train accidents.

The terms of reference of the Committee were as under: -

(i) To review the position of accidents on the Indian Railways since the appointment of the Railway Accidents Inquiry Committee, 1968 and to review the implementation of the recommendations of all previous accident Inquiry committees:

(ii) To examine the adequacy of the existing organisation, equipment and practices for ensuring the safe running of trains on Indian Railways and to suggest measures for prevention of accidents.

(iii) Implications of financial investment planning of Railway projects on safety; and

(iv) To examine safety measures/equipment/technology as adopted by Railways of some advanced countries which would have relevance for Indian Railways and could be adopted for use on Indian Railways.

The Committee which submitted its report [GOI, 2001a] in two parts contained a total of 278 recommendations. Beginning with a statistical review of accidents in the past ten years, the Committee went on to spell out its recommendations on various dimensions relating to safety on the railway system.

During the period 1988-89 to 1997-98, there had been 5671 consequential train accidents on the Indian Railways, out of which 368 accidents fell under the category of "Collisions". Accidents in this category constitute 6.5% of the total consequential train accidents. An analysis of the causes of collisions revealed that collisions on account of "drivers disregarding signal or failing to control train" were a preponderant factor both on the Broad Gauge and the Meter Gauge. During the period under review, this group accounted for 197 collisions or 58.11 per cent on BG and 20 collisions or 69 per cent on MG. In the two gauges taken together, the percentage of such collisions, ‘i.e., due to the drivers’ errors were around 59 per cent. Derailments constituted, by far, the highest proportion of the total consequential train accidents on Indian Railways, despite the fact that the non -reported accidents generally fall under this category. The percentage of derailments to total accidents in the 10-year period under review ranged between a high of 88.27% of the total accidents in 1991-92 to a low of 75% in 1997-98.

After a comprehensive review of the action taken on implementation of earlier recommendations, it was concluded that much more needs to be done regarding the recommendations of all Safety Committees than has been achieved so far. The slow implementation of the safety measures was a matter of great concern with factors such as the tight financial situations, politically motivated decisions and the general lax environment in the country identified for the slow implementation. The Committee observed that time and again it was stated that there is nothing really that the railway men did not know about safety and that IR had all the answers to the problems of safety, but the missing element was the proper implementation and execution of that knowledge. The most serious deficiency in safety matters was that there were inordinately delays in implementation or there may have been insufficient funds.

It was emphasised once again that if the Railways were to survive as a viable, healthy and vibrant organisation, it was imperative that appropriate institutional structures are put in place to ensure that the individual capabilities of railway staff are enhanced through proper training. With increasing sophistication of equipment that was being inducted into the Railways, it was crucial that the staff assigned to operate and maintain such equipment have the necessary skills. The success of a training programme depended not only on the aptitude and keenness of trainees but was also largely determined by the knowledge and teaching skills of the trainers. As the most vital element in the entire scheme of training, the instructors needed to be professionally competent with adequate field experience and a flair for teaching. They felt attractive opportunities should be provided to the staff to enhance their professional skills during the course of their service.

The Committee, after an in-depth study of the situation, concluded that technology progression on IR had lately not kept pace with time with even basic features that had been accepted as necessary across railway systems such as track circuiting of stations had made slow progress which with increasing traffic and greater work pressure increased the potential for human error. It was strongly felt that induction of appropriate safety related technology should be the most crucial plank in any safety strategy of the Railways as it could substantially reduce the risks associated with human error and negligence. Since such technology was costly, there had to be careful prioritisation among the essentials required for safety especially in the context of the huge financial resource crunch being faced by IR. Also, it was felt that acquisition of the appropriate technological systems would not only enhance safety but will also increase productivity thereby eventually improving financial viability. These included adoption of effective Train Radio Communication, Train Protection and Warning System (TPWS), Track Circuiting of Stations, etc. Further, given that one of the most vital elements to be factored into any safety strategy of the is the loco driver, it was important for the health and safety of the system that this category of staff be provided with the very best in terms of emoluments, training, working conditions, etc. It was very obvious to the Committee that the railway management had so far done very little besides attending to the monetary emolument's aspect of the drivers. The committee strongly recommended to the Central Government to provide a one- time grant to the railways to wipe out the huge arrears in assets renewal observed then within a timeframe of the next six years. Finally, the committee following the recommendation of GOI [1963] reiterated the need to set up a Safety Organisation within the Railways whose personnel should be drawn from amongst

officers of the five departments directly associated with train operations namely Traffic, Civil Engg., Mechanical Engg, Signal and Telecommunication Engg. and Electrical Engg and not just from the traffic department, as was the practice then. This would indeed constitute a truly multi-disciplinary team to handle safety issues on the railways which are genuinely multidimensional in nature.

e. High Level Safety Review Committee (Kakodkar Committee) [2012a]

A serious rail accident on 10/7/2011, near Fatehpur in UP involving derailment of Kalka Mail, resulting in the death of 71 persons set the stage for the appointment of yet another safety review committee on IR headed by the eminent nuclear scientist and former Chairman, Atomic Energy Commission, Dr. Anil Kakodkar, in September 2011.

The terms of reference of the Committee were far more detailed and specific and were as under:

(i) Whereas safety is an ongoing multi-disciplinary exercise well entrenched into railway working that is subject to independent verification, the Committee was asked to suggest ways and means for reinforcing the mechanism for improvements that are timely, enduring, cost effective and aimed a further enhancement of safety margins wherever warranted.

(ii) Based upon trends of accidents and their consequences witnessed in the recent past, the committee was expected to lay down a road map for improving safety in respect of the following:
   a. Signalling systems
   b. Rolling stock (of all types)
   c. Fixed Structures (Tracks, bridges and OHE)
   d. Human Resource development with emphasis on training, education and research
   e. Need for a third party audit, organisational and structural changes in RDSO and in any other department, improvement in procedures and systems
   f. Any other item/modification which the group company may desire to identify.

The Committee submitted its report in February 2012 [GOI, 2012a]. It went into all technical and technology related aspects in connection with safe running of train services in the country. The initial observation made it clear that the present environment on IR revealed a grim picture on the poor safety adequate performance, largely due to poor infrastructure and resources, and lack of empowerment at different functional levels of the railway administration, though it was observed that the data of consequential train accidents over the years had been showing a declining trend despite the phenomenal growth of traffic. According to the Committee, the safety of traffic on IR remained a matter of serious concern.

While the Committee undertook a fairly comprehensive review of the recommendations of the earlier Committees and their implementation, the focus turned out to be issues that were critical for the purpose of implementation which had been lacking in a significant way. It was made very clear in the report that the IR suffers from what is familiarly known as the 'implementation bug'. In other words, it was again emphasised that the severe lack of implementation of accepted recommendations of the previous safety Committees was a major issue, with the most serious deficiency in safety matters being the inordinate delays in implementation and /or insufficiency of funds to implement measures.

To begin with, a major issue that was identified related to data on accidents which was found to be inadequate to help take decisions on the issues more comprehensively. For example, details of asset failure which could possibly translate into train accidents and which were collected by the Committee indicated very high absolute figures (though it was observed that there had been some improvement over the years). It was apparent that this data reflected only a fraction of the actual position on the field as was understood during discussions that the Committee has during its interaction at the field level. The recommendation in this context pointed to an urgent need for setting of an Information Technology (IT) based system which could help in collection and collation of all train accidents- whether consequential or of little significance, near misses, safety related asset failures, etc., in order that a correct picture emerges and was available at the highest level to enable proper decision making.

Renewal of over-aged assets is of paramount importance for safety of Railway infrastructure. Most important is to have realistic estimation of the assets requiring replacements for making necessary provision of funds under Depreciation Reserve Fund (DRF). The Committee noted that there was no system on Indian Railways to undertake any realistic estimation relating renewal of assets to be programmed on a year to year basis based on the availability of funds under DRF. Looking at the fund position of DRF, it was seen that appropriations to DRF has been constrained specially during 2009-2010 and the closing balance had been more or less 'nil' during 2009-10, 2010-11 and 2011-12 (BE). The position was not any different in the case of the Development Fund.

During one of the interactions, the Committee was informed that the net social service obligation borne by Indian Railways was quite substantial. Indian Railways incurred losses every year by performing a variety of un-remunerative services especially passenger services. These losses were incurred due to low ordinary class fare, suburban and non-sub-urban season fare, a variety of concessions granted on passenger tickets, transportation of certain commodities below cost and working of un-economic branch lines imposing burden on Indian Railway finances. A gap thus results between the revenue income generated through these services and their running cost. Net social service obligation borne by Indian Railways in 2009-10 was assessed at about Rs. 15000 crores which was more than 17 % of the total revenue earnings and 18 % of the total expenditure.

While commenting on the then existing Safety Architecture on IR, based on their analysis of the existing safety related operational practices and procedures, the Committee made a strong case for immediate steps to bolster the safety orientation of Indian Railways along with inculcation of a culture of zero tolerance of accidents. Accordingly, they strongly recommended the setting up of a statutory Railway Safety Authority which could act as an independent Authority under the Government and would responsible for all aspects pertaining to safety regulation and enforcement while the prime responsibility for safety would continue to be that of the Railway Board. It was suggested that the Institution of Commissioner of Railway Safety should be merged with this Authority. Also, a new post of Member (Safety and Research) in Railway Board ought to be created to provide the link between the Railway Board, the Railway Safety Authority and the Railway Research and Development Council, a

new organisation recommended by the Committee to be created. It was further recommended that a review of implementation of recommendations of earlier safety committees by the above proposed statutory outfit of Railway Safety Authority be undertaken.

Though earlier Committees had made several useful recommendations, they had not gone into the issue of the funding requirements (except perhaps for the Khanna Committee which had recommended the setting up of a Railway Safety Fund). However, the Kakodkar Committee not only made an attempt to have more precise estimate of the requirement of funds to implement their recommendations over a period of five years but also outlined the methodology for raising of such funds. According to their estimates, the total investment requirement would be of the order of Rs. 1,03,110 crores, in addition to the capacity enhancement works that would be required to decongest existing networks and facilitate corridor maintenance blocks. For financing the above, the Committee suggested the creation of non-fungible, non-lapsable safety fund generated with a safety cess of Rs. 5000 crores per annum. In addition to this, there would have to be matching grants from the Central Government, deferring of dividend liability, a road cess, etc., all totaling to Rs. 20000 crores per annum.

In addition to the reports reviewed above, two other expert groups, one GOI [2011] and the other GOI [2014] also had some important observations on issues related to railway safety. But a reading of these reveal that these emphasised the implementation of recommendations of the earlier Committees along with some specific issues related to the greater use of information technology for help in better operational practices as well as in the role of better data for quicker and appropriate action. We now turn to Section 3 to find out to what extent implementation of these recommendations were out carried out and the implications thereof.

SECTION 3
IMPLEMENTATION OF POLICY RECOMMENDATIONS ON SAFETY

The Expert Group on Railways (Chairman: Rakesh Mohan) had very succinctly observed in its report [GOI, 2001b] that the Indian Railways could be considered to be one of the most studied organisations on the planet. It was, thus, well recognised that the railways had all the answers to the problems of safety but the real issue was in their implementation. Due to technological obsolescence and consequent up gradation, as also continuous changes in traffic requirement conditions, safety issues themselves undergo several changes. Yet, from our review of reports of the various safety Committees, it is observed that a number of relevant issues remained unsolved over many decades. We now make an attempt to review the implementation of the recommendations of the successive Committees in order to understand the extent to which safety issues have been resolved from time to time and also to provide a perspective on the implications of the inadequacy of implementation measures.

3.1 Inadequate Provisioning for the Depreciation Reserve Fund (DRF) for Renewal and Replacement of Over-Aged Assets:

One persistent observation of all the high-level safety Committees appointed on IR has been the emphasis on proper and adequate provisioning of funds to DRF the appropriation to this fund being met out of the revenues earned by IR so as to take care of renewal and replacement of over aged assets. It was pointed out that renewal of over-aged assets was of paramount importance for

safety of railway infrastructure and thereby movement of passengers and freight. At the same time, it was pertinently noted there was no proper system on Indian Railways for any realistic estimation of depreciation requirements. The programme for renewal of assets had been and is even now being continually programmed on a year-to-year basis based on the provision and appropriation and, thus, the availability of funds under DRF.

It is interesting to note what GOI [2001a] had observed in this regard that a crucial aspect of the functioning of the railways that should have determined the thinking on railway safety was the general state of disrepair of the essential infrastructure and assets of the railways. A fundamental dictum of safety is thorough and timely maintenance and renewal of key railway equipment and infrastructure The railways were saddled with a huge inventory of over aged and decaying assets {(recall Table 3 which listed the arrears of asset renewals (overaged assets), as on 1st April, 1999, of track, rolling stock and signaling gear translated into money terms amounted to a staggering Rs. 15,054 cores at the then prevailing costs as pointed out by GOI [2001a]}, a problem that had become almost intractable when linked with the unhealthy state of railway finances. Also, a matter of great concern was the dwindling allocations to Depreciation Reserve Fund (DRF) over the years, which had contributed largely to the then unhappy state of railway infrastructure and assets. Non-availability and provision of sufficient funds in Depreciation Reserve Fund to replace the over aged assets was indicative of weak financial health of Indian Railways. The huge backlog of renewal and replacement of over aged assets in the railway system needed to be addressed for safe running of trains as often pointed out by the reports of the CAG (2016-17).

In 2017-18, as against the budgeted amount of Rs. 5000 crores, only Rs. 1540 cores were appropriated to the DRF of which Rs. 1100 crores were transferred to the Rashtriya Rail Sanraksha Kosh (RRSK) for undertaking critical safety works. compared to the 'throw forward' for works to be done under DRF but in Revised Estimate 2017-18, the entire amount of Rs. 5000 crore contribution to RRSK has been advanced from DRF. The total outlay for capital expenditure from RRSK for the year 2018-19 was Rs. 20,000 crore. In 2018-19, appropriation to the DRF was Rs 500 crore, 90% lower than the revised estimates of 2017-18 (Rs 5,000 crore). Provisioning Rs 500 crore towards depreciation is truly an extremely small amount (almost nothing) considering the scale of infrastructure managed by the Indian Railways, a good part of which needed to be replaced.

The Standing Committee on Railways [Lok Sabha Secretariat, 2018] had observed that appropriation to the DRF is obtained as a residual after payment of the dividend and appropriation to the Pension Fund, instead of the actual requirement for the replacement of assets. It noted that transferring funds from DRF to the RRSK does not allow for replacement and repair of depreciating assets. In other words, it provides only for (maybe) new safety provisions and commented that this showed a lack of vision and poor way of utilising and appropriating valuable resources. The funds from DRF should have been utilized for replacement of assets, tracks etc. Transferring the funds, by not allowing replacement repair etc. of assets to RRSK funds and not utilizing it for safety purposes explains the lack of vision and shoddy way of utilizing and appropriating the valuable resources.

In their 17th Report, the Standing Committee on Railways [Lok Sabha Secretariat, 2017] had expressed their apprehensions about the financing of RRSK and had recommended dedicated financing for it. The Committee recommended to the Ministry to ensure the non-fungible financing to RRSK and stressed upon the Ministry to ensure prudent deployment of the fund strictly on the works it has been assigned with regular scrutiny of the progress. The Committee feel that RRSK was created with a vision to have a single head in order to cater all safety related needs of the Railways by dissolving various safety related funds and if the Ministry is not been able to utilize the funds judiciously and fully from RRSK, the sole purpose of having a dedicated fund becomes futile. Here, it is to be noted that expenditure out of RRSK by the end of January 2018 was only Rs. 10709 crores, which was just about 50% of the allocation. The Committee further recommended that at the time when there is tepid growth in Net Revenue of Railways and a lot of funds are needed for capital asset creation, funding to and expenditure from RRSK for safety purposes should be ensured at highest level in order to accord paramountcy to the safety.

The CAG Report on Railways (2017-18) had also noted that the appropriation to the DRF was very insignificant compared to the 'throw forward' for works to be done under DRF. The 'throw forward' value of assets to be replaced from DRF (up to 2017-18) was estimated at 1,01,194 crore. This mainly included 32,975 crore on rolling stock, 61,551 crore on track renewals, 1,288 crore on bridge works, 1,758 crore on signaling and telecommunication works and 659 crore on machinery and plant. Thus, there was a huge backlog of renewal and replacement of over aged assets, which needs to be replaced timely, for safe running of trains.

3.2 Reordering of Priorities not Undertaken

While the aspect of renewal of overaged assets which directly affected safety, suffered on account of inadequate financial allocations, it is well known that the railways have been frittering away scarce resources on massive, but unessential and financially unremunerative projects. In a situation of inadequate financial resources, it has always been emphasized that the prime focus of Railways should be on consolidation and up gradation of the essential infrastructure and assets rather than on populist but financially ruinous projects. Reorientation of priorities was the need of the hour in the interests of the safety of the travelling public. There was no doubt on the thinking that rehabilitation of the existing system must get overriding priority - even priority over viable projects. Only then could safety be ensured.

At the same time, it is useful to note the persistent claim of successive railway administration, when discussing their achievements, regarding the spectacular increase in the tonnage of traffic lifted and passengers carried without commensurate growth in the infrastructure. It was true that this productivity has been achieved in large measure through sheer hard work, technological and operating innovations for which the railways had good reason to be proud of and be satisfied. "But without commensurate emphasis in terms of investment and managerial focus on core areas, invariably associated with safety, such as maintenance and replacement of worn out assets, human resource development and modernization and undue emphasis on operational performance essentially freight loading and movement, at any cost, has encouraged adoption of an approach which has resulted in conditions less safe than desirable" GOI [2001a, p. 12].

Though previous safety Committees had also made strong recommendations regarding wiping out of arrears of replacement of over aged assets on IR in view of their implications for safety, yet it has remained one of the most persistent and sticky issues related to safety on IR which is yet to be addressed effectively even today. According to GOI [2015], recent as as 01.07.2014, 5300 km track length was due for renewal. However, due to financial constraints, the progress in track renewals has constantly coming down over the last six years. As on 1st April 2014, 11,563 unmanned Level Crossings were still required to be eliminated. It was estimated then that the IR needed Rs 39,001 crore to complete all the ongoing works of constructing Road Over Bridges, Low Height Subways and elimination of all the remaining unmanned Level Crossings. It has been claimed by the IR that initiatives have been undertaken to streamline clearances and procedures to expedite the works which were being funded almost entirely out of the proceeds of the share of IR from the collections of the Diesel Cess authorised by the Central Road Fund Act. IR got only 12.5% of the total amount annually credited to the Fund, whereas Roads got 50% of the share, the balance being shared by the States. It was, therefore, a limited amount.

3.3 Absence of Seriousness in Implementation of Recommendations

The most severe criticism of the railway administration in terms of its implementation record has come from GOI [2001a], which found the IR's track record of implementation of recommendations of various safety committees as very unsatisfactory. It was observed that in its pursuit of showing improvement in the implementation process, recommendations were treated as implemented purely on the grounds that necessary instructions had been issued by the Railway Ministry of Zonal Railways. For instance, the GOI [1978] had enjoined upon the railways the need to improve the overall conditions in the running rooms. This recommendation was treated as implemented as 'necessary instructions had been issued to Zonal Railway.' Similarly, issue of instructions was given as evidence of implementation of recommendations such as: the need to address shortage of staff in Safety categories; provision of proper equipment and training to gateman; the importance of ensuring that wagons with 'reject able' defects are not turned out of shops; curb on the practice of examining goods loads on the sorting lines, Divisional Safety Officers to be relieved of miscellaneous functions; safety counselors to be given appropriate training in counseling techniques, etc.

Some recommendations were treated as implemented with the commissioning of trials, even when it was apparent that actual implementation was still many years down the road. An example of the same was the railway's response to GOI [1978] recommendation urging the railways to ensure that no locomotive, which is to work a train, leaves the shed or yard without speedometer/speed recorder in working order. This recommendation, which has remained only partially implemented, was treated as implemented 'in view of the policy decision of the Board to fit all new main line locos with Hasler speed recorder'. GOI [1978] recommendations regarding electric lighting of semaphore signals, communication between Driver, Guard and SM were also disposed of in a similar manner. In similar vein, the recommendation that development and manufacture of thick-web switches should be undertaken, on a priority basis, was treated as implemented on the basis of trials being

conducted in 1986. Even to this day [2016], the adoption of thick web switches on regular basis on IR seems to be some years away.

But what was most reprehensible was that some recommendations were treated as implemented even when there was no attempt at implementation at all, in any possible sense. Among the recommendations that fall in this category is the recommendation of GOI [1978] that the railways should make the AWS system operative. This recommendation was shown as 'implemented being long-term process', though almost four decades after this issue was first raised, AWS was installed only on the suburban systems of Central & Western Railways. Here too, the AWS system only covers the EMU services but not the other services, not even Mail/Express trains. On a similar note, GOI [1978] recommendation that BOX wagons should not be loaded beyond their carrying capacity had been treated as implemented, although there are instructions to the effect that BOX wagons can be loaded up to 2 tonnes above their carrying capacity. Now, however, carrying capacity of these wagons have further been enhanced by 8 tonnes, effectively increasing the designed axle load by 2 tonnes each, since 2006, as a policy measure, with suitable precautionary measures for rolling stock, track, bridges, locomotives, operational practices, etc. The situation is still evolving as all the precautionary measures prescribed are yet to be put in place fully again causing the alarm, as the increase of axle load has already been allowed.

3.4 Persistence of Crucial Inadequacies on the Safety front such as:

a. Continued Over Dependence of IR on Human Judgment of Loco Crew

GOI [1963] had first suggested that automatic train control systems (ATC) should be introduced on some suburban sections and some selected trunk routes. The need was emphasized for the Railways to undertake research for adapting the ATC in use in advanced Railway Systems to Indian conditions. As an additional safety feature, it suggested the introduction of cab-signaling to be tried on an experimental basis. The non-adoption of ATC drew severe criticism from GOI [1978] which opined that ATC is only second, if even second, in importance to track circuiting and observed that if the trial and installation of ATC been initiated earlier, certain signaling firms in India would have become interested in this field of manufacture already. The Committee made a specific and strong recommendation that on sections with provision for speeds of 100 Kmph or over, ATC should be provided. This was important as a prevention measure.

Auxiliary Warning System (AWS) or its advanced versions known as Train Protection & Warning System (TPWS) and Automatic Train Protection (ATP) is a system of providing advanced notification of upcoming signal aspects to the Loco Pilot or Loco Driver or Motorman, as the case may be, via a display panel in the driving cab of the Loco or EMU. The advanced notification is done through track side equipment including electro magnets that trigger relays in the passing Loco/EMU cabs. If a train approaches a stop signal at danger, at too high a speed, application of brake will be initiated by the system automatically, to control the speed so as to enable it to stop in time. TPWS has certain features which allow it to provide an additional level of safety over the AWS, but it has certain limitations *vis-a-vis* a full ATP system.

But the poor progress in the installation of AWS came in for criticism from GOI [1978] which attributed to it to the reluctance to import the equipment and to the excessive time taken for its indigenous development and manufacture. The clarion call to the Railway Board was to take steps to fulfill at least their diluted commitment of providing AWS on trunk routes and suburban sections at the earliest. The railways accepted this recommendation without any reservations, and on the basis of work in progress on Howrah-Burdwan section of Eastern Railway and Churchgate-Virar section of Western Railway, the recommendation was treated as implemented.

The railways' response to all these recommendations could be termed positive in terms of the stand that besides the Howrah-Burdwan and Mughalsarai-Gaya sections of Eastern Railways, provision of AWS has been sanctioned for suburban sections of Central and Western Railways also. It was further stated that for providing AWS equipment, priority would be given to suburban sections and trunk routes on which trains run at speeds of 120 Kmph and more, with AWS being provided on locomotives of Mail/Express trains and EMUs.

Almost four decades after this issue was first raised, AWS was installed only on the suburban systems of Central & Western Railways. Here too, the AWS system only covers the EMU services but not the other services, not even Mail/Express trains.

Another type of in-cab signaling system known as Train Protection and Warning System (TPWS) was deployed and put on trial on the Chennai sub-urban sections in 2009, and also for about 160 Kms. of Delhi-Agra section and then adopted. TPWS is based on European Train Control System (ETCS) Level 1. In this system, driver gets audiovisual indication of the signal aspect and in case he fails to acknowledge yellow/red signals within a stipulated period, brakes are applied automatically. In addition to this, on-board controllers can compute the permissible train speed (based on braking distance and distance to the signal) and apply brakes if this speed is exceeded. Even though TPWS provides the safety in fixed block mode, its protection integrity rating is very high since the signaling loop is mostly in a hardwired mode. However, this system, based on proven European design, was reportedly not working well under IR conditions. Motormen, especially operating on the Chennai suburban system reported false braking and system problems.

After a serious accident at Gaisal in August 1999, Konkan Railway Corporation Limited demonstrated a proto type of an indigenous Anti-Collision Device (ACD) with the intent to prevent train collisions by actuation of automatic application of train brakes in collision like situations. ACD is a GPS (Global Positioning System) based device to prevent train collisions. The system comprises of on-board device designed to determine the location of train through GPS and communicate this information through radio communication in 3 km zone with other trains. The on-board ACD equipment actuate train brakes in case a collision like situation is encountered.

The introduction of Automatic Collision Device (ACD), as one of the main features of the Corporate Safety Plan of Indian Railways (2003-13) [GOI, 2003b] was slated to bring down collisions to 'zero'. ACD, designed and manufactured by Konkan Railway Corporation Limited (KRCL) through outsourcing with functional inputs from IR, began to be deployed on KRCL and NF Railway on about 1800 route

kilometres. During trials, mostly on Diesel loco routes, its functioning was periodically reviewed by North Frontier Railway, Research Development and Scientific Organisation of the IR and Railway Board. Railway officials, in its review, reported some uncertainties on its intended operation which were then rectified by KRCL. Version II of ACD for multiple line electrified sections were then put on trial on Southern Railway with the discrepancies observed and addressed by KRCL. ACD projects were then extended some of the other zonal railways.

IR experimented with technical solutions, such as Anti-Collision Device (ACD) since 2000 and Train Protection & Warning System (TPWS) since 2009 without reaching final conclusions on their large-scale adoption. In the absence of the same, human over-dependence on train running is leading to collisions and increased Signal Passing as Danger (SPAD) cases on IR. GOI [2012a] observed that this situation presented a bleak picture of implementation strategy of critical safety items on IR, and IR has to consider a paradigm shift in implementation strategy for deploying modern and effective signaling systems to ensure proper customization and tropicalisation of the same to suit Indian conditions.

As may be seen above even after some decades of trials and experiments with various anti-collision and train protection measures, IR came nowhere close to finalization of a suitable device to reduce over dependence of human judgment of the loco crew to prevent collisions and SPADs. Poor functioning of TPWS, which was based on proven European technology, also indicated lack of its tropicalisation and customization to Indian conditions. "IR may like to consider a paradigm shift in implementation strategy for deploying modern and effective signaling systems" [GOI, 2001a, p. 40]. This Committee recommended adoption of state of the art signaling and protection system - at least equivalent to the functionality of ETCS Level 2, throughout IR, starting with the busy routes (19000 Kms) immediately. Diverse and redundant means of satellite-based train position sensing (as used in ACD) should be incorporated and merged in ATP functions.

b. Failure on Track Renewals

The basic infrastructure for a railway line is the track. Its components, viz., rails, sleepers, fastenings which hold rails and sleeper together, ballast, etc., suffer wear, tear, fatigue in service and are, therefore, required to be renewed/replaced to avoid service failures which may cause accidents and affect safety. Each of these components has a stipulated life laid down in the codes and manuals on IR but very seldom renewals/replacements get done in time most often due to resource constraints. Renewal of track on a fast track basis has been a major recommendation of all the safety/accident Committees on IR as well as other Parliamentary Committees.

GOI [1963] noted that the Estimates Committee of Parliament had observed that they are definitely of the opinion that topmost priority should be given to wipe out arrears of track renewals. Endorsing this view, GOI [1963] felt that non-fulfillment of the track renewal targets on certain railway zones was responsible for a large number of derailments due to track defects. Apart from their implications on safety, track renewals would also decrease the length of track under speed restriction on the railways, thereby enabling faster movement.

The railways responded positively to this recommendation by making efforts to reduce the arrears in track renewals, a fact that was noted with appreciation by the GOI [1968] which commended the progress made on track renewals and expressed the hope that the pace of renewals would be maintained. But according to GOI [1978] not only were such hopes belied but the position had deteriorated considerably and its ill effects becoming more apparent from the rising incidence of rail breakages and imposition of speed restrictions on increasing length of rail sections. There was serious concern that the actual allocation of funds for track renewals was much less than the requirement, and emphasized the need to provide the full requirement so that the arrears are wiped out early. On account of the inadequate outlays, the backlog of primary renewals which was about 2400 Kms in 1974, had increased to about 6000 Kms in 1978. The emphasis was that the requirement of funds for track renewals should be viewed by Government as an essential input for safety and should get commensurate priority. In what can be termed a very casual remark, the Ministry of Railways maintained *that every possible effort was being made to allot maximum possible funds for track renewals and hence treated as implemented (our italics).*

The fears expressed that unless larger financial allocations for track renewals are made, the backlog would get totally out of hand, became a grim reality. We have already referred to the huge arrears in track renewal of more than 12,000 Kms. (in 1999) and which excluded loop lines and yard lines which grew since then. But under the provisions made from the SRSF over a period of 7 years, the backlog of arrears in terms of track renewals were wiped out. This was commendable. But since then, with very little to provide from the DRF, it became very clear that the railways have not been in any position to bridge the gap from its own financial resources. Committees set up later have been emphatic in saying that that the Central Government would need to continue to lend a helping hand and that too in a significant way.

c. Virtual absence of Corridor Maintenance Blocks for Track/ Signaling Gears/ OHE

The growth of passenger and goods traffic on IR has been over 4 times and 6 times respectively in over 4 decades since Independence up to mid-1990s, without commensurate increase in route Kms. and track Kms. This increase in the productivity in the asset has put considerable pressure on the line capacity utilization of the sections, particularly on 'Golden Quadrilateral' Routes where bulk of the traffic is moving. In many sections, line capacity utilization is over 150 %.

GOI [2012a] observed that during their discussion with all concerned in Zonal Railways the need for corridor maintenance block was strongly felt as it was very difficult to carry out planned and systematic maintenance on trunk route since very little time was available due to excess traffic. They felt that IR was clearly violating the prescribed norms in this regard eventually leading to unsafe working. Preventive maintenance norms, in addition to emergency and breakdown maintenance needed to be taken into account and accordingly corridor planning should be such that adequate time in a day is reserved for planned periodic maintenance.

This situation has been prevailing for a long time without being redressed, and has been going from bad to worse, with regular introduction of new express trains without commensurate increase in the line capacity.

d. Shortfalls in Track Circuiting

Track circuits are provided at railway stations normally by creating electrical circuits using DC or AC current and involving rails of the track and the rolling stock standing on the same. When no train is present, the relay is energized by the current flowing from the power source through the rails. When the train is present, its axles short the rails together, the current to the track relay coil drops and it is de-energized. Track Circuits through the relay contacts, therefore, report whether or not the track is occupied. They help in detection of the rolling stock occupying different lines at the station and accordingly allow or not allow taking off the signals of the station. They, therefore, prevent collision of trains and other unsafe signaling actions at the station.

It is, therefore, well recognized that, track circuiting is an important requirement in every station as this device would almost completely eliminate collisions due to a second train being received on an occupied line. Equally important is the provision of the route relay interlocking which should be considered as an essential provision in large stations and yards. Once again, it has been noted that in the face of such recommendations, the railway administration has typically responded with a general statement of intent that track circuiting would be provided to the maximum extent possible and that zonal railways would be directed to follow these recommendation regarding route relay interlocking in view while making proposals for signaling works. To the observation of GOI [1968] expressing doubts on whether the Railways were addressing themselves to the task of providing track-circuiting with the necessary sense of urgency, the Railway Board responded that a target of track circuiting 200 stations every year had been fixed. But it was well known that the actual execution fell far short of this target. Though GOI [1978], the Railway Reforms Committee GOI [1983] and the Parliament's Standing Committee on Railways GOI [1996] also strongly emphasized the need for track circuiting between block section limits on all trunk routes and main lines, the reality was that the execution of track circuiting work was slow, though after the Ferozabad rail accident in August 1995involving collision of Kalindi & Purushotam Express, resulting in 358 deaths due to fault in the signaling system and lapses of the station staff, there was been good progress.

e. Non-replacement of Over-aged Signaling Gears

Signaling systems at stations whether they are mechanical, electro-mechanical, electrical, electronic or digital, have their own service life and they need to be replaced after completing the same. However, there have always been backlogs in their replacements. Excessive delays in replacement may lead to their malfunctioning and thus jeopardizing the safety of train operation through the station.

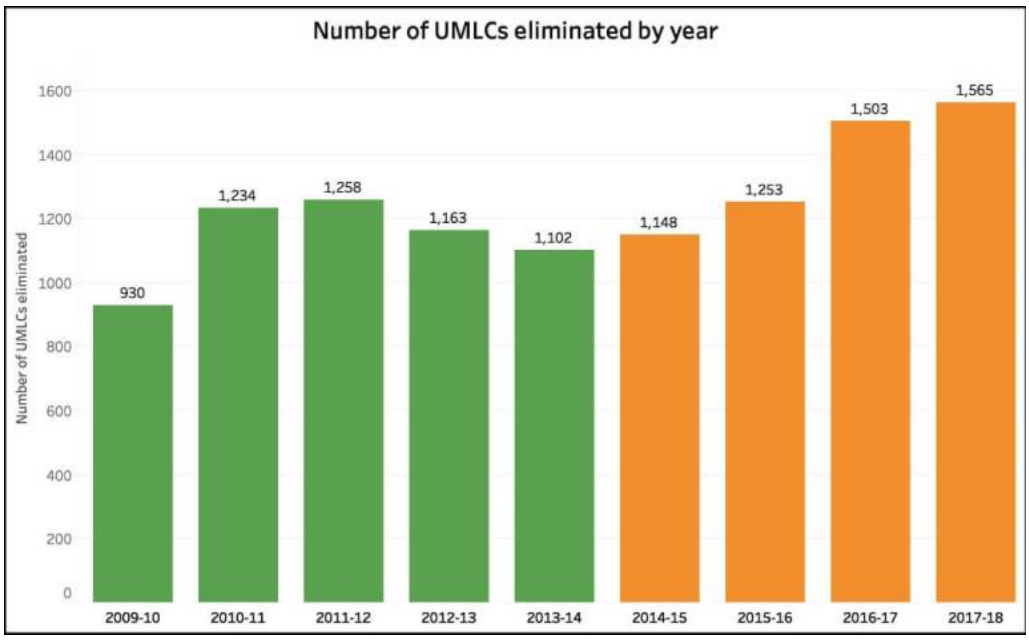
It is widely recognized that that there is need to overhaul and provide replacement of lever frames and worn out signaling gear from time to time as per prescribed schedules in the absence of which signaling failures could continue to increase considerably thereby reducing the factor of safety in rail operation. Following recommendations of GOI [1962] and GOI [1968], in July 1969, the Railway Board advised the Zonal Railways that whenever signaling equipment needed replacement on age-cum-condition basis, replacement should be carried out early so that safety was not compromised. However, notwithstanding the guidelines issued by the Railway Board, there was further increase in the arrears of

signaling gear due replacement, which prompted GOI [1978] to point out a distinct deterioration in the situation. Once again in a very casual manner, the Railways considering the fact that implementation was also of a continuous nature, advised the zonal railways accordingly and treated this recommendation as being implemented. But from the information furnished to GOI (2001a) by the Ministry of Railways, there were 1560 stations where signaling gear replacement was overdue. When one considers the fact that Railways were not able to ensure replacement of signaling gear despite warnings from earlier High-powered Committees, the existing status of signaling gear overdue replacement has been viewed as a matter of grave concern by Committees set up in the last decade.

f. Train Actuated Device/Automatic Lifting Barriers

Level crossing gates, particularly unmanned gates on IR are involved in a large number of accidents. These accidents have involved a large number of casualties also. To control the same, it was proposed that Audio Visual Warning Devices and/or Automatic Lifting Barriers be provided at the gates and which should be actuated by the oncoming trains while the train is still some distance away to ensure the safety of road users moving across the level crossings.

Figure 1



Source: Based on GOI IRYB (several years)

Going by the methods of provision of Level Crossing Gate Protection that were in use in Europe and America, it was always felt that the Indian Railways should make determined efforts to install fail-safe automatic barriers to suit Indian conditions, which would close automatically when a train is at a pre-determined distance from level crossing gate. This was to be reinforced by the provision of bells and flasher signals at the gates and the adoption of Train Actuated Warning Devices (TAWD). The provision of TAWD was recommended in the first stage at all manned LCs in mid-sections. Neither of these two recommendations was accepted by the Ministry of Railways initially on the ground that these devices were unworkable under Indian conditions. There was then a change in the Railways' thinking on the TAWD, quite obviously because of the increase in number of level crossing accidents, particularly at unmanned gates. TAWD with audio-visual indication was sanctioned at 10 level crossing gates each on Eastern and Western Railways on trial basis. During the trial, it was found that the equipment could not be maintained in working condition at isolated locations of unmanned LC gates and the trials were not carried out further. The Railway Board, however, in February 2012, decided to provide the same at manned LC gates in a phased manner. However, there was no timeframe for overall completion of the work. Figure given below gives the number of Unmanned Level Crossings (ULMCs) eliminated during the past decade.

According to GOI ARA [2019] as on 1st April, 2019, of a total of 22,388 level crossings, 21340 (95%) are manned while the rest 5% are still unmanned. The document also stated that IR has decided to eliminate level crossings by 2020 considering the safety of train passengers and road users.

g. Inadequate attempts on Proper Running Rooms

Recognizing the critical role of the driver in ensuring safety, GOI [1963] had stressed the importance of setting up suitable running rooms and "early completion of standard facilities in all of them. This recommendation was treated as implemented on the grounds that the railways have generally provided essential facilities. The railway administration avoided commenting upon provision of "standard" facilities in the running rooms.

GOI [1968] was also of the view that much needed to be done to make the running rooms adequately comfortable, the committee felt that the prescribed yardsticks for provision of amenities in running rooms should be rigidly applied in order to ensure that adequate facilities are available for the comfort of the running staff.

The need to provide the right kind of environment for the running staff to take rest at outstations also engaged the attention of the GOI [1978] which was very specific about the facilities to be provided in the running rooms. Apart from recommending individual cubicles, the Committee called upon the railway administration to provide basic necessities like clean linen, mosquito nets, adequate water supply, improved sanitary conditions. This recommendation was treated as implemented on the basis of various instructions issued by the Railway Board on the subject.

Khanna Committee also urged the Railway administration to make the improvement of running rooms a corporate mission. Still, even today 100% running rooms have not been brought up to the level as desired by these Committees.

h. Persistence of Long Duty Hours of Loco Crew

In order to appreciate the issues involved, it would only be appropriate to have a look at the brief history of the Hours of Employment Regulations and the evolving pattern of concept of the hours of work and periods of rest of the railway staff governed under it. Following the ratifications by Government of India in 1923 of Washington Convention No. 1 of 1919 and Geneva Convention No. 14 of 1921, the Hours of Employment Regulations (HOER) came into existence in 1931 under the Railways Amendment Act 1931.Detailed rules were made accordingly and necessary instructions in this respect were issued in 1931. The Hours of Employment Regulations (HOER) emanating from the 1931 Act did not apply to running staff at that time, as they were kept under the "Excluded" category. However, the ceiling on employment of the Continuous and Essentially Intermittent staff was fixed at 60 hours and 84 hours a week respectively. Since the running staff were classified as "Excluded" category no limit of maximum hours on duty was laid down for them and obviously their weekly duty hours were beyond 60 hours. Thus, the provisions of HOER under 1931 Act occasioned further dispute between the labour federations and the then existing Railway Administrations.

In 1946 the Government of India appointed Mr. Justice Rajadhyaksha, ICS of Bombay High Court to adjudicate upon the disputes among the workmen and the Railway Administrations. Justice Rajadhyaksha submitted his report in 1947. Together with making several recommendations Justice Rajadhyaksha also suggested amendment to the Railway Act of 1931. One landmark decision of the adjudication of Justice Rajadhyaksha was to bring the erstwhile excluded category of running staff under the purview of HOER classifying them as Continuous Workers. Hence the Weekly employment hours of Continuous Workers i.e. Weekly rostered hours of 52 and statutory hours of 54 became applicable to them. Considering that the hours of daily duty vary due to various factors i.e. length of the runs, locations of engine sheds and running rooms, irregular timings of goods trains, availability of trains and crossings and precedence involved, the Adjudicator deemed it feasible to make a case for framing rosters for normal hours of daily duty in respect of the running staff. However, having regard to humanitarian considerations as well as public safety and confidence demand he recommended that a maximum limit of hours of duty at a stretch should be laid down through subsidiary instructions. He pointed out that the running duty at a stretch should not ordinarily exceed 10 hours and that the Running Staff should be entitled to claim relief after 12 hours of duty provided, they have given 2 hours' prior notice for relief to the controller. He further recommended that for the purpose of computing duty at a stretch, time of duty should be reckoned from the actual departure of the train.

Thus, the concept of 10 hours running duty ordinarily at a stretch from the departure of a train to its arrival which could even extend up to 12 hours of duty came into being with the submission of Justice Rajadhyaksha's Report in 1947. Justice Rajadhyaksha also held that in case of continuous workers employed in a non-continuous process, the hours of work may be "a little more than eight". As in his opinion the railway work was not as arduous as factory work, therefore, a railway worker could work for sometime more than 48 weekly hours fixed for a factory worker. He also

accepted the principle of averaging for determining the total number of Weekly hours. Thus, it can safely be asserted that the adjudication award of Justice Rajadhyaksha constitutes a landmark in the history of the Hours of Employment Regulations on the railways. In 1951 Ministry of Railways (Railway Board) laid down the Railway Servants Hours of Employment Rules, 1951 incorporating therein the adjudication award of Justice Rajadhyaksha. Again in 1956 the Ministry of Railways amended the Railway Act and introduced Chapter VI-A.

This adjudication had the consequence of putting the HOER on firmer ground. By all reckoning it was a classic award not only in tone and tenor but also in scope. It was to cast its shadow on the subsequent developments in connection with Hours of Employment Regulations embarked upon by Ministry of Railways because then, these have been a constant and persistent source of friction between railway management and labour leading to disagreement on duty hours for the running staff [GOI, 2013, Chapter 2, Pp. 4-6].

Thereafter, the railway management progressively reduced the rostered duty hours of running staff.

GOI [1963] had expressed the serious concern that in many cases the actual duty hours of goods train drivers exceeded the rostered hours and desired that the Railways take steps to improve the situation. GOI [1968] was also critical of the railways' failure to make sufficient headway in keeping the duty hours of running staff within the prescribed limit. Although this recommendation on duty hours of running staff was treated as implemented, the actual situation on the ground provoked GOI [1978] to state that the recommendation still remained to be implemented and that it was unfortunate that in a matter that has a direct bearing on safety the action taken so far has been tardy.

According to the extant instructions, the overall duty at a stretch of running staff from 'signing on' should not ordinarily exceed 12 hours. Indicating the present status of implementation of the recommendation on duty hours of running staff, the Railway Board advised the Khanna Committee [GOI, 2001a] that, in the period January to June 1998, the overall duty is being completed within 12 hours from 'signing on' on all the Railways except Southern and South Eastern Railways who have been advised to improve the position. GOI [2001a] found from the data of Incidence of longer hours of duty of Goods Driver, for the year 1997-98 that No. of trips over 16 hours overall duty was still - 1.95% and that of between 14-16 hours and 12-14 hours were 7.73 % and 8.18% respectively, which showed the problem still persisting without being effectively redressed. GOI [2012] hardly had anything to say except that there was need for Human Resource development with emphasis on training, education and research.

3.5 The silver lining in the Cloud finally - The success of SRSF

However, a noteworthy example of what can be considered an earnest implementation of an expert committees' recommendations of GOI [2001a] by IR is that of creation of Special Railway Safety Fund (SRSF) by IR in the year 2001 in pursuit of the specific recommendation GOI [2001a] which took a very serious note of the very grim situation of heavy backlog of asset

renewals on IR in 1999. The Committee had recommended the creation of a non-lapsable Special Railway Safety Fund (SRSF) of Rs. 17000 crores to be financed partially through railway revenue by levy of a safety surcharge with effect from October 1.2001 which was expected to garner Rs. 5000 crores over a period of five years and the balance (Rs. 12000 crores) through additional financial assistance (Dividend free capital at charge from the general budget). The SRSF resulted in eliminating the backlog of Renewals/Rebuilding of track renewal, bridges, signaling & telecom, rolling stock and other safety enhancement measures by the year 2007-08 to a large extent. This in fact was responsible for the so called 'Golden Turn around of Indian Railways' during the period from 2004 to 2008. During this period, IR's freight & passenger traffic saw a compound annual growth rate of (CAGR) of over 8% leading to increase of revenue from Rs. 47000 crores to Rs. 71000 crores, registering a CAGR of over 14%, which was unprecedented in the history of the IR since independence. It was claimed by IR that this resulted in cumulative cash surplus close to Rs. 88000 crores during this period, which was also unprecedented on IR.

Other notable examples of positive and effective action taken by IR to implement recommendations of various safety committees, to improve safety, are withdrawal of 4-wheeler tank wagons & CRT wagons which were found derailment prone, creation of adequate indigenous production capacity of Pre-Stressed Concrete Sleepers to replace wooden sleepers, introduction of LHB coaches with better safety performance particularly their anti-climbing and anti-telescopic features during accidents, track circuiting of all planned stations etc. However, constantly evolving and dynamic situations in which IR is finding itself as a vehicle of economic growth for a continental sized Indian economy, the above successes remain as a footnote to the otherwise overwhelmingly inadequate response of IR as found by the successive safety committees and as brought out above.

As suggested earlier, GOI [2012a] had made some scathing comments on the way IR had gone about implementation of safety measures suggested by earlier committees. It held that the Indian Railways severely suffers from 'implementation bug' with the most serious deficiency in safety matters being the inordinate delays and insufficiency of funds. To help bringing about more focus on safety issues, it recommended the formation of an empowered group of officers (including an officer from finance) in the Railway Board to pilot the implementation of safety enhancement recommendations and projects as accepted by the Ministry of Railways in a time bound manner with full funding and also recommended the formation of a 'Railway Safety Authority' as a statutory institution independent of Indian Railways, on the lines of similar institutions in other advanced countries, and wanted this authority to review the implementation of accepted recommendations of safety committees, from time to time for the next three to five years.

We have made a detailed review of the implementation process of policy recommendations of the various Committees appointed to look at major safety issues on IR with a view to identifying the major issues that remain to be tackled in order that safety considerations could be handled better on the system today. We turn to this subject matter in the next Section.

SECTION 4

Critical Safety Issues to attend to

A fairly extensive reading of the relevant policy literature reveals critical issues relating to railway safety many of which have been stressed upon by High level Committees set up for the purpose but which need to be addressed urgently even today within a time framework too in a realistic way. These relate to asset related failures Some of the significant ones being are as follows:

1. Asset/ Equipment Failures

Data on consequential train accidents does not capture the entire picture reflecting vulnerability of the system and safety risks as it does not include other categories of accidents. As mentioned above, there are safety related incidents also that are not reported. In addition, there are innumerable asset/ equipment failures taking place on a day-to-day basis on the Indian Railways (see Table 5 below) which could translate into train accidents. According to the General Rules on IR [GOI, 1976, Chapter 6], these failures are also to be treated as accidents and acted upon accordingly.

Table 5. Asset/Equipment Failures on Indian Railways

Year	Signal	Rail	Diesel Loco	Electric Loco	Coach	Detach-ment	Poor BP	Train Parting	Spring BR.	Hot Axle	Jl. Brea-kage	OHE
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
2002-03	-	-	-	-	149	5796	164	826	2472	1092	5	651
2003-04	117240	8613	4301	2928	156	4586	60	688	1722	776	2	475
2004-05	123752	7162	4410	2639	142	3598	56	668	1188	591	7	541
2005-06	114587	6807	4432	2902	125	2909	30	926	716	527	7	495
2006-07	147966	5953	4181	2653	85	2454	15	996	483	509	2	353
2007-08	167831	5761	3967	2198	72	1936	17	877	300	567	0	332
2008-09	140852	5752	3545	1659	87	1551	6	793	159	599	1	295
2009-10	123502	6734	3505	1668	94	1470	12	778	129	684	0	390
2010-11	118758	6693	3818	1574	66	1350	8	717	104	779	2	379
2011-12	2260	3780	6040	3439	1463	1237	6	611	18	775	3	
2012-13	2054	3727	5781	3479	1556	1335	1	562	7	955	0	
2013-14	150040	5068	3165	1509	73	1185	4	403	3	851	0	294
2014 15	138197	3219	3255	1558	129	1139	2	445	2	862	0	363
2015-16	138985	3237	3048	1590	81	916	1	365	1	726	2	378
2016-17	130952	3546	2906	1546	91	814	8	366	1	521	0	447
2017-18	127704	4369	2653	1476	97	703	-	328	-	453	-	281
2018-19	114368	6265	10664	13483	1755	2377	-	753	-	572	-	2759

Source: GOI EF (Several Years)

The above failures data indicates very high absolute figures of failures though there has been a gradual improvement over the years. But it must be kept in mind that the figures reported here appear to be only a fraction of actual position in the field as was recognised by the various Committees and revealed in our conversations during interactions at the ground level. Asset failures could normally strain the capacity of the system which is already very limited. Though very reliable data of the loss of line capacity due to asset failures is not available (since they are not properly collected and evaluated except to fix departmental individual responsibilities), it has been estimated that the down time of the system due to failure of assets of all departments (signaling, track, rolling stock, etc.), is about 3 to 4 hours on an average over 24 hours on busy sections. It has been well recognized that human intervention is normally made to run trains during this transient period of uncertainty, and presumably more accidents happen during such periods though the same could not be corroborated by statistics of consequential train accidents. It may perhaps be the case that accidents of a minor nature or near misses do happen during such transient period. However, no details of such incidents are maintained in any of the railway offices. Thus, there is a strong case to take steps to improve reliability of assets and measures to have redundancies in the systems so that normal operations are least hampered. Intensity of asset utilization on the IR has increased to such an extent that there is no slack available now. Certain amount of slacks needs to be provided in the system to take care of in-service failures, so that operations are not severely affected leading to safety and punctuality issues. Slacks are provided in the system by way of redundancies and standbyes. Some of the redundancies could be track circuiting by two diverse different means at vulnerable locations such as bridges.

2. Signaling

Though most of the routes of IR are covered with Track circuiting and Multi Aspect Colour Light Signals (MACLS) in an interlocked manner, loco pilots have not been provided with communication based on-board system to help them in train running. Continued occurrence of collision & SPADs need to be addressed by providing the same. Track circuiting and MACLS signaling works wherever not yet completed have to be completed at the earliest as per the commitment already given by IR. As on March 31, 2017, 534 stations on Broad Guage routes having either Semaphore Signalling or multi cable lever frame MACLS are to be liquidated in the next five years.

Introduction of Anti-Collision Device (ACD) which was one of the main features of corporate safety plan of the Indian Railways 2003-13 [GOI, 2003b] was meant to eliminate the collisions from Indian Railways. However, it has still remained at the trial stage in North Frontier & Southern Railways. A variant of the same named Train Collision Avoidance System (TCAS) has been developed by the Research Development Standards Organisation to address the discrepancies noted with respect to ACD developed by Konkan Railway Corporation Limited (KRCL). This system is still under trial on 250 route kilometres as a pilot project.

While the ACD was at the trial stage, another type of in cap signaling system known as Train Protection and Warning System (TPWS) which was deployed on trials on the Chennai suburban sections since 2009 has been implemented on 342 RKMs (200 RKMs Delhi-Agra Section, 117 RKMs Chennai Suburban section and 25 RKMs of Metro Railway, Kolkata. The same is based on the European Train Control System Level-1 (ETCS L-1) in which the driver gets audio visual indication of the signal aspect and in case he fails to acknowledge the yellow/red signal, brakes are applied automatically. This system senses the speed on approach to signals and activates braking accordingly if needed. Even this system, though functional in a limited way, is reportedly facing implementation issues on IR for its expansion.

3. Rolling Stock

Though IR introduced Link Haufmann Bush (LHB) coaches in 2003 and the first indigenous coach was operated in the country in 2003, for quite some time, the manufacture of such coaches (incorporating both anti-climbing & anti telescopic features which are critical for speeds of 110 Kmph and above and 24 coach rakes) was limited and it was only after 2015 manufacture of such coaches picked up with production rising to 1,469 LHB coaches in 2016-17, 2,480 LBH coaches in 2017-18 and 4,429 LHB coaches 2018-19. Obviously, the remaining coaching stock needs to be replaced as soon as possible to make travel safer and faster.

Also, the need of the hour is to have track side sensors to detect Hot Axles, Flat tyres of wheels. Radio tags on all types of rolling stock and a communication backbone are required to be provided along the railway network to ensure better last mile connectivity for transfer of condition data from track side to the control centre as well as maintenance depots. The network could be used to carry commercial data in addition to ID and maintenance related data.

Toilets with no discharge or with harmless discharge need to be introduced in all the 43000 coaches within next five years. Flame detection system are required in coaches which should sound hooter at many places in the coach to warn the passengers. Its interface with Alarm Chain Pulling system should be soon considered for use after relevant and extensive field trials. A uniform operating protocol in terms of norms to deal with overloaded wagon ought to be prescribed by Railway Board. There are also some areas which have not been covered in the safety regulations though they affect the safety very significantly and have been commented upon by the safety committees. For example, when the carrying capacity of the freight stock was enhanced by the IR from 'CC+2 to CC+8' with attendant increase in the axle loads, in the year 2006, it was done with conditions as a provisional measure. These measures continue to be provisional without full implementation despite adoption of CC+8 as a universal regular practice on IR.

4. Track

Replacement and renewal of over-aged track should not be allowed to accumulate over years, which result in backlogs, due to paucity of funding to DRF. Such replacements and renewals

should be addressed on a top priority and regular basis by adequately providing for appropriations to DRF.

For planned and systematic preventive maintenance of track without any compromise, corridor blocks should be in place by augmenting the line capacity on the busy routes. Operation of line capacity far beyond 100% on busy corridors every day compromises the safety maintenance of the track as well as other infrastructure like Signals, Over Head Electric equipment etc. There are also issues relating to rail failures which call forth the need to establish the root cause of rail failures and identify the metallurgical and chemical solutions including enhanced quality assurance and control protocols from steel melting to laying of rail on a war footing within the next three months. Modern and, technologically driven vehicle borne ultrasonic testing machine should be introduced for faster and reliable detection of rail and weld flaws and the present manual track patrolling system should be replaced with Technologically Aided System to detect Rail and Weld failures, buckling of track, daily visual examination of track by key men, etc. Rail grinding at required intervals should be mandatory to increase the life of rails and wheels of the rolling stock.

In addition, there are also some emergent safety risks which also need to be covered. As is well known, IR bulk passenger and freight traffic moves in its high-density routes mostly falling in what is known as Golden Quadrilateral which is connecting the four metros. Line capacity on this route today is fully saturated with utilization crossing even 150% leaving little scope of grant of Corridor Blocks for maintenance of infrastructure including track, OHE, signaling, etc., GOI [2012a] considered this to be a grave safety risk and observed that, "there is no policy guidelines laid down by IR in terms of maintenance protocol or if it exists then IR is clearly violating the prescribed norms eventually leading to unsafe working" [GOI, 2012a, p. 67]. They further observed and recommended that", under such a scenario, maintenance in a hurry shall not yield quality compromising safety and may also lead to loss of life of Railway men on duty. IR needs to fix this at the earliest by taking measures to improve line capacity" [GOI, 2012a, p. 68]. To ensure safety in such a scenario, there is need for laying down speed slowing down mechanisms wherever maintenance has not been done as per laid down requirements due to non- availability of blocks. An outline of such a mechanism for track is suggested as under:

Schedule 'A'- Track activities having frequency of 10 years or more (Table 6)

Schedule 'B'- Track activities having frequency from 3-8 years (Table 7)

Schedule 'C'- Day to day activities (Table 8)

Table 6. Schedule 'A' - Track activities having frequency of 10 years or more

Sr. No.	Activity	Frequency	Condonation		Speed limit
			Period	Authority	
(1)	(2)	(3)	(4)	(5)	(6)
1.	Renewal of rails (TRR)	As per provision of P-way Manual	6 months	CTE	Normal
			6 to 12 months	PCE	Pass. trains 100 Kmph Freight 60 Kmph
			Beyond 12 months		Pass. trains 75 Kmph Freight 40 Kmph
2.	Renewal of Concrete sleeper	Condition basis	6 months	CTE	Normal
			6 to 12 months	CTE	Pass. trains 100 Kmph Freight 60 Kmph
			Beyond 12 months	PCE	Pass. trains 75 Kmph Freight 40 Kmph
3.	Deep screening of plain track and Turnouts having MSS of 100 Kmph and GMT more than 30kmph	As per provision of P-way Manual	Up to 12 Months	Sr. DEN-Co.	Normal
			12 to 18 months	CTE	10 % reduction
			18 to 24 months	CTE	20% reduction
			Beyond 24months	PCE	30% reduction.
4.	Renewal of channel sleepers	Condition basis	Up to 12 Months	CTE	Normal
			12 to 24 months	PCE	Normal
			Beyond 24months		10% reduction.
5.	Renewal of AT welds	50% of stipulated life of rails or condition basis	Up to 12 Months	CTE	20% reduction in speed beyond stipulated life of weld.
			Beyond 24months	PCE	

Source: Author's Own Research

Abbreviation: TRR-Through Rail Renewal
P-Way- Permanent Way
CTE- Chief Track Engineer
PCE Principal Chief Engineer Coordination
MSS- Maximum Safe Speed

Table 7. Schedule 'B' - Track Activities Having Frequency From 3-8 Years

Sr. No.	Activity	Frequency	Period	Authority	Speed limit
(1)	(2)	(3)	(4)	(5)	(6)
			2 months	Sr.DEN	Normal
			2 to 4 months	CTE	Normal
			4 to 6 months	PCE	Normal
			6- 8 months		10 % reduction
1.	Tamping of track as per laid down frequency	1-2 years.	8 to 12 months		20% reduction
			Beyond 12 months		30% reduction
			If relaxation not given Sr will be imposed.		
2.	Destressing of LWR	As per LWR manual	Nil		Suitable Sr to be Imposed
3.	TFR (renewal of fittings) of PRC sleepers, plain track/Turnout	GRSP plain track-4 years, GRSP of T/outs-2 years, Liner- 6 years, ERC -8 years	Up to 12 Months	CTE	Normal
			Beyond 12 Months	PCE	10% reduction
			Beyond 18 months		20% reduction
4.	LC overhauling	2 Years (PRC sleepers)	Up to 3 Months	Sr. DEN/Co	Normal
			3 to 6 months	CTE	Normal
			6 to 12 months	PCE	Normal.
			Beyond 12 months		10% reduction
5.	TTR (Switch & CMS X-ing sleepers.	OR Switch 60 kg-200 GMT, 52 Kg-250 GMT, Conventional 60 Kg-200 GMT, 52 KG 150 GMT or condition basis.	Up to 3 Months	Sr. DEN/Co	Normal
			3 to 6 months	CTE	Normal.
			6 to 12 months	PCE	Normal
			Beyond 12 months		10% reduction
			Beyond 24 months		20% reduction

(Contd.)

Table 7. Schedule 'B' - Track Activities Having Frequency From 3-8 Years (Concld.)

Sr. No.	Activity	Frequency	Period	Authority	Speed limit
(1)	(2)	(3)	(4)	(5)	(6)
6.	Renewal of SEJ along with sleepers	Improved 60 KG -400 GMT, 52 Kg 250 GMT, Conventional 60 KG-200 GMT, 52 KG-150 GMT or condition basis	Up to 3 Months	Sr. DEN/Co	Normal
			3 to 6 months	CTE	
			6 to 12 months		Normal.
			Beyond 12 months	PCE	Normal
			Beyond 24 months		10% reduction
					20% reduction
7.	Replacement of fluid joints	200 GMT or condition basis.	Up to 6 Months	Sr. DEN/Co	Normal
			6 to 12 months	CTE	
			12 to 18 months		Normal.
			Beyond 12 months	PCE	Normal
			Beyond 24 months		10% reduction
					20% reduction

Source: Author's Own Research

Abbreviations: TFR- Through Fastening Renewal
GRSP- Global Road Safety Partnership
LC- Level Crossing
PRC- Pre- Rest Concrete
TTR-Toronto Railways
CMS- X- Crew Management system crossing
GMT- Gross Million Tonnes
SEJ- Switch Expansion Joint

Table 8. Schedule 'C' - Day-to-Day Activities

Sr. No.	Activity	Frequency	Period	Authority	Speed limit
(1)	(2)	(3)	(4)	(5)	(6)
1.	USFD testing	1 month to 2 Years as per USFD manual.	Nil		As decided by PCE
2.	Rail Painting	One/Two years			SR as per need
3.	Oiling and Greasing of fish plated joints and JFP	Before onset of winter.			10 % reduction in speed if not done by onset of winter
4.	Scattered renewal of scabbed/ Cupped AT welds	As and when required			SR as per need
5.	Casual renewal of Rail and sleepers	As and when required			SR as per need
6.	Track recording/OMS on A & B routes	As per the provision of the manual			10% reduction beyond one month.
7.	Removal of USFD defects and Track defect	As per the provision of the manual	As per provision of manual		

Source: Author's Own Research
Abbreviations: USFD- Ultrasonic Flaw Detection
JFP Jogged Fish Plate-
AT- Auto Transformer
SR- Speed Restriction

5. Bridges

Distressed and vulnerable bridges should be instrumented in terms of deflections/displacements, water level and flow velocity on a continuous basis and data should be communicated to the office of the concerned Chief Bridge Engineer for monitoring. Advanced scientific measurement and inspection for the condition assessment of the under-side of the bridges using mobile and articulating platform is essential. All the distressed bridges should be rebuilt on a priority basis.

6. Training

Continuing education of railway staff is very crucial to increase the awareness of new technology and safety considerations. In an on organization like the IR having a huge manpower presence, the importance of the same cannot be over emphasized. However, this aspect has not at all received the attention that it deserves. As mentioned earlier, more than half of accidents on IR are attributed to human failures. Many of these failures are basically the failure of equipment. A substantial number of such failures are also on

account of inadequate training and skill of concerned staff who have not kept pace with the upgradation of technology at various levels in different departments. All these shortcomings get camouflaged as human failures which have been very commonly occurring without any attempt to effectively addressing them. Therefore, the quality of training needs to be enhanced significantly. This would require infrastructure facilities and syllabus up gradation for all levels and categories of staff and officers on IR while at the same time there is need to leverage information and communication technology and simulation possibilities that are being introduced in a big way, both within and outside the organization.

7. Financial Appraisal of Railway Projects

It is well known that the GOI (1981) referred to as the Indian Railway Finance Code provides the framework of Financial Management on IR. For investments in safety related work it provides as under two Sections:

> 201 General Principle. - Investment decisions are among the most interesting and difficult decisions to be made by the Managements. It is fundamental to railway system as a commercial undertaking that expenditure other than that wholly chargeable to Ordinary Revenue **incurred on new assets or for improvement** of existing assets should be financially justified and sanctioned before it is actually **incurred.**
>
> **202:- As an exception to Para 201, while no financial j**ustification as such need be given in the following cases, it should be seen that the scale of expenditure incurred is as economical as possible consistent with the extant orders, if any, on the subject:- -when the expenditure is unavoidable on considerations of safety;

Thus, no financial appraisal of investments/expenditure on safety works is done on IR, as is the case of investments on other projects of New Lines, Doubling, and Gauge Conversions, etc. Underlying principle for the above might have been that the consideration that since investments in safety works are unavoidable, as mentioned in the para itself, there is no need of the financial appraisal. However, what happened actually over years is that, as sources of Railway's internal finances dwindled, IR started relying more and more upon external sources, General Budgetary Support as also borrowings from the market and multilateral agencies. Not carrying out financial appraisal for investments in Safety Works was construed as the same being financially unviable and hence they did not receive investments from external sources. Over the years, due to tight financial position of the railways, progressively less funds were earmarked for DRF resulting in a huge backlog of asset renewals. It is a contention that had investments on safety related works of renewal of assets been assessed properly, i.e., on the basis of the viable financial returns, and benefits from these, it would have been easier not only to justify but also allocate more funds for the same. Accordingly, it needs to be recognized that suitable changes are required to be made in the financial code to make it mandatory to properly appraise investments in the context of preparations of IRs Annual Works Programme including those related to safety.

Having identified critical issues of safety that are required to be tackled within a specified period of time on IR, we now move on to examine some cases related to the above issues that have already been taken up on a pilot basis with a view to

understanding the nature of investments involved and the returns that can be expected even when attempted on a very limited scale. This exercise has been attempted to emphasis the need to undertake significant efforts to examine the viability of investments on safety related equipment and facilities at least, in a simple way, to begin with, which has not been traditionally undertaken since safety of any system was assumed to be always taken care of. However, given the resource crunch faced by the IR and the need to expand the network and its throughput, the returns on investments especially in regard to safety related works have hardly received the attention that is required from policy and decision makers for a long time.

SECTION 5
CASE STUDIES

5.1 Case Study No. 1
Conversion of Mechanical Signaling & Interlocking into Electrical/Electronic Signaling & Interlocking
Background:

An interlocking device is a basic safety device at a railway station. Interlocking means an arrangement of signals, points and other appliances, operated from a panel or lever frame, so inter-connected by Mechanical locking or Electrical locking or both that their operation must take place in proper sequence to ensure safety. In order to ensure that the signaling system never provides unsafe or conflicting signals and the points are not set for more than one train that might end up proceeding on to the same track and hence giving rise to the possibility of a collision, interlocking is provided between the points and the signals. (In North America, the official railroad definition of interlocking is: *"An arrangement of signals and signal appliances so interconnected that their movements must succeed each other in proper sequence* (Wikepedia). Before the advent of electrical or electronic devices, interlocking was done by way of a Mechanical Interlocking System wherein the levers controlling the points and the signals were coordinated with the help of mechanical devices. With the introduction of modern electrical or electronic interlocking systems in the 1960s), interlocking has been accomplished by electrical circuitry comprising of relays and switches, to begin with and then computerised circuits.

A case study was undertaken on the Amla-Parasia section (113 Kms.) of the Central Railway which serves as an artery of movement for one of the oldest high- quality coal mines in India. The objective was to work out the investment required to replace the old, over-aged and obsolete mechanical interlocking systems (semaphore signals with lever frame cabins) with an Electrical/ Electronic Interlocking system and also to measure the expected gains from investment.

Introduction to the Case study

The Amla - Parasia section is located on 'E route of Nagpur Division Central Railway. The length of the section is 113 kilometres. There are 8 block stations in the section. A block station is a station at which the driver has to obtain an 'authority to proceed' in order to enter the next block section. In a railway system that is inclusive of block stations, the entire railway line is divided into convenient block sections of 5 to 10 km and a block station is provided at the end of each block. This system ensures that a suitable 'space interval' is provided between running trains so that there are no collisions and accidents. There are three types of block stations. A class stations are normally provided on double-line sections. At such stations a 'line clear' signal cannot be

granted at the rear of a station unless the line on which a train is to be received is clear and the facing points set and locked. No shunting can be done after line clear has been granted. stations in this section. A class station is the most common type of station and is provided on single-line as well as double-line sections. At a B class station, the line has to be clear up to an adequate distance beyond the outer signal before 'permission to approach' can be given to a train. A C class station is only a block hut where no booking of passengers is done. It is basically provided to split a long block section so that the interval between successive trains is reduced. No train normally stops at these stations.

All the 8 block stations in the Section under consideration were provided mechanical signaling/interlocking gears having semaphore signals with 12 of lever frame cabins at different stations. They have been in operation for a period of 45 years. These signaling gears were obsolete and their spare parts for maintenance not readily available in the market. Thus, the maintenance of these worn out assets became difficult due to the scarcity of spares. This was the only section of Central Railway having this type of mechanical signaling and point operation by double wire rope drum. As per [GOI, 2001c] and [GOI, 1981], the laid down code life of Mechanical Interlocking Gears is 30 years for 'E' routes. Any signaling system if not replaced after completion of code life is susceptible to failures creating unsafe conditions for train running at those stations, which may result even in accident, like collisions, etc. Frequent signal failures of the overaged signaling system hamper the day-to-day operations and this adversely affects the line capacity. Cost of operation & maintenance of mechanical type signaling and interlocking system is also high due to larger man power requirement which further increases with their age. It is also important to note that the permissible speed at the stations with this type of signaling/ interlocking is lower which also reduces the line capacity of the section.

Sanction of Work of Replacement of Mechanical Signaling/ Interlocking with Electrical / Electronic Signaling and Interlocking -

A work was, therefore, sanctioned for replacement of signaling gears in Amla - Parasia section at a cost of Rs. 23.125 Crores. The sanction work included replacement of mechanical signaling/ interlocking gears, with electrical / electronic gears (Panel Interlocking - PI) and providing Color Light Signaling (CLS) in place of semaphore signals.

Benefits of electrical / electronic signaling and interlocking system:

i) **Increase of speeds at the stations** - with mechanical signaling / interlocking having Semaphore signals, standard of interlocking was I-R with maximum permissible speed of 50 Kmph. After completion electrical / electronic interlocking (PI), standard of interlocking would be II-R, with a maximum permissible speed of 110 Kmph.

ii) **Enhanced line capacity creating extra paths for train movement:** Faster movement of traffic will lead to enhanced line capacity thereby creating 12 additional paths for train movements.

iii) **Expected Increase in freight traffic:** Amla - Chhindwara section serves the Pench and Kanhan area of Western Coal Field (a subsidiary of Coal India Ltd.), for loading coal to core and non-core sectors,

viz., thermal power plants, cement plants, etc. Apart from coal, the goods sheds at Chhindawara and Parashia are functional for Outward traffic of De-Oilcake which is a by-product from the Soya Oil Plant and is exported to foreign countries as poultry feed, corn and other agricultural products. The then coal loading in this area was 1.5 rakes per day. Agriculture product loading is of a seasonal nature.

- A New goods shed being planned at Parasia (Kirsadoh) station was expected to fetch 12 rakes outward traffic of coal to thermal power plants in Wardha and Warora areas. Some other sidings were also at the planning stage to serve the new coal mines coming up in this section. With the completion of the work of panel interlocking along with Color Light Signaling (CLS) work of the section, the growth in this area was expected to bring additional goods traffic.

iv) **Expected Increase in Coaching Traffic** - At that time, one express train and four passenger trains ran in this section. The average coaching earnings for the year 2012-13 was Rs. 2.66 crores.

There was expected to be an increase in coaching earnings due to introduction of new trains in future due to generation of additional train paths.

v) **Saving in terms of Manpower** - With the commissioning of panel interlocking work at all the stations, a total of 25 posts of lever man was expected to be surrendered. Saving in terms of money value due to surrender of above posts is as given in Table 9 given below.

Table 9. Saving in terms of money value due to surrender of posts

SN	Station	No. of Cabins	Total Posts Surplus	Saving per Month Rs.	Saving per Annum Rs.
(1)	(2)	(3)	(4)	(5)	(6)
1.	Jambhara	1	2	52560	630720
2.	Bordhai	1	2	52560	630720
3.	Navegain	1	2	52560	630720
4.	Hirdagarh	2	5	131400	1576800
5.	Junnardeo	2	4	105120	1261440
6.	Palachori	1	2	52560	630720
7.	Iklehara	2	4	105120	1261440
8.	Parasia	2	4	105120	1261440
	Total	12	25	657000	7884000

Source: *Central Railway Statistics*, 2012-13.

vi) **Additional Earning - from additional Goods Trains from the section due to extra paths generated.**

Locos and Rolling stocks on IR were being operated from the common pool. Consignees and consignors of goods were spread across the national network. In such a situation, calculation of the earnings and the cost of the operations on a place to place basis was unrealistic. Given that the Indian railways published Annual Statistical Statements containing the data of earnings and costs giving net earnings per train Km of goods trains, the average net earnings (including interest) was a good yard stick to indicate the earning potential for additional traffic generated from the investments in any particular section. Accordingly, this was worked out as follows:

Net Earnings on working a Goods Train per kilometre - As per statement no -15 Sr. No.13 (ii) at page 227 of IR Annual Statistical Statements Year 2011-12 [GOI, IRASS, 2012]. Net earnings (including cost of interest) on working a goods train for one Km is Rs. 630.21, as given below:

Table 10. Net Earnings on working a Goods Train per kilometre

Results of Working of Coaching and Goods Services Statement 15 - Goods Traffic						
	1990-91	1995-96	2000-01	2005-06	2010-11	2011-12
(1)	(2)	(3)	(4)	(5)	(6)	(7)
13. Net Earnings on working a Goods Train one kilometre (Rs.)						
i) Excluding Interest	94.98	222.77	213.71	505.06	666.57	692.22
ii) Including Interest	74.76	194.18	177.34	450.72	599.91	630.21

Source: GOI IRASS, 2011-12, p. 227

Net additional Earnings per year in Parasia - Amla section due to increased traffic-

As per item 1 above, net earnings per train Km of goods train working = Rs. 630.21.

No of additional paths to be created after completion of work of PI - 12 nos.

Average Lead of the goods loading of coal from Parsia goods train to Wardha / Warora area - 360 Kms

Net additional goods earnings per year on creation of 12 additional paths in Amla - Parasia section on completion of PI work and materialisation of loading from Parasia (Khirsadoh) goods shed and other sidings in this section could be worked as

= Rs. 630.21 per train Km. x 12 trains/day x 360 Kms. lead x 365 days

= Rs. 9.934 Crores, as given in Table below:

Table 11. Net Earnings of Goods Train per Year in Parasia - Wardha Section

Section	Distance	Increase in Trains	Net Earnings of goods train one Km.(item 13(ii) Annual Statement 15)	Net Earnings per day	Net Earnings per year (Rs.)
(1)	(2)	(3)	(4)	(5)	(6)
Parasia - Wardha	360 Kms.	12	630.21	2722507.20	993715128.00

Expected gains and financial returns from the proposed investments.

Total Investment - Rs. 23.124 Cr.

Total Gains

i) Net Manpower Cost saving per annum -	Rs. 0.788 Cr.
ii) Net Addl. Earning per annum -	Rs. 9.937 Cr.
Total -	Rs. 10.725 Cr.

Conclusion

The cost of the above- mentioned work was Rs. 23.124 Cr. With the Mechanical Signaling /Interlocking (semaphore signals with lever frame cabins), this section was expected to handle to handle on an average $1\frac{1}{2}$ no. outward Goods trains and 4 pairs of Passenger and one Pair of Mail/Express trains. Thus, a total of 11 to 12 Paths were available per day. After conversion of Mechanical Interlocking to Electrical/Electronic Interlocking Panel Interlocking - (PI), the same section will provide for have 22 to 23 Paths and thus could handle 12 no. additional Goods/Passenger trains. Both freight and Passenger traffic on the section have been on the rise due to increased coal mine activities of Western Coal Fields, as a result, new sidings are coming up. Economic development of this agriculturally fertile area has also picked up speed. This can be expected to increase traffic flows too.

In addition to handling increased traffic, the new system has resulted into savings of 25 posts of lever men and other staff required in the operation and maintenance of the Mechanical Levers of the Signaling Cabin, as the new system needs less manpower for operation and maintenance. The total annual gains from increased traffic and savings of manpower worked out to Rs. 10.725 Cr.

The Pay Back Period of the above -mentioned investment has been found to be = 23.124/ 10.725 = 2 years and 2 months.

The pay Back period is short especially on an investment by a public entity on a public facility.

5.2 Case Study No. 2

Installation of Loco Training Simulator for improving the driving skills of the Loco Pilots.

Background:

A 'Loco Pilot' (LP) is part of a frontline safety

category staff on IR and is directly responsible for working of the train by operating all types of locomotives. Safety of train operations is, therefore, dependent on the driving skills, fitness and alertness of the LP, to a large extent. In case of equipment trouble, the LP is also required to undertake trouble-shooting so that the train does not get detained in the mid-section. Out of course, detention of a train leads to blockage of path for the trains in the rear and causes a net loss of earning to the Railways.

IR has followed an extensive charter for continuously up grading the skills of loco pilots so that they are synchronised with the latest technology and trouble-shooting requirements. They are also required to be fully conversant with the changes in the driving environment, if any. Loco Pilots are regularly deputed for pre-promotional training and refresher courses at Zonal Training Institutes. As a part of this training module, they are given exposure on locomotive simulators.

A locomotive simulator is a man-machine interface facility which looks like a sophisticated electric locomotive and is equipped with a host of computers and a video camera to capture the movements of the LP. The LP is made to sit in the driving seat and operate the controls. Compute generated images create an audio-visual effect to simulate actual locomotive working and the LP feels as if he is actually driving a train on a selected route. Motion pictures on the monitor in front of driving wheel change every second and the loco pilot experiences all activities as if he is driving a train, e.g., passing of trains on adjacent track, appearance of signals at specified intervals, appearance of stations, etc. In a room next to the simulator, trainers monitor the performance of the loco pilot through man-machine inter-face and judge his abilities.

The advantages of simulator training are as under:

* Improvement in overall driving performance & confidence of loco pilots.
* Imparts correct driving technique without having to go on line.
* Saves training time and reduces training cost.
* Reflexes of various actions of the loco pilot can be judge.
* Response to change in measured parameters (coupler force, etc.,) can be judged.
* Provides a safe environment for training.
* Reflexes of Loco Pilot during abnormal situations can be tested.
* It is a consistent method of providing uniform training.
* Wear and tear of moving parts, coupler damages, energy consumption, etc., is avoided.
* Complete road map with gradients, curvatures, etc., of particular section can be taken for simulation which enables loco

pilots to have better road learning repeatedly before actually driving the train in the section. This was not possible before simulator training.

Introduction to the Case Study

A Zonal Railway Training Institute (ZRTI) is located at Bhusaval where all the Loco Pilots and Assistant Loco Pilots of entire Central Railway as also other Zonal railways undergo initial, pre-promotional and periodical refresher courses of electric locos. 3-phase electric locomotives, viz., WAG-7 / WAG-9/ WAP-7 were introduced on IR over the past two decades in different parts of the system. Operations of these locos are different from conventional electric locos.

Traditionally, Loco Pilots on Indian Railways were given hands-on training on the locomotive itself by the trainers by closely supervising the actual operations of the Locos by the trainees. On recommendations of various Safety Committees on Indian Railways, IR have now initiated a programme of installing loco training simulators.

Sanction of Work of Motion Based Simulator for WAG-9 / WAP-7 Locomotives at Bhusawal, CR:

Installation of Motion based simulator for WAG-9 / WAG-7 loco at Zonal Training Centre, Bhusaval was sanctioned at a cost of Rs. 1827.07 Lakhs. (Machine cost- 1723.00 lakhs + D&G charges - 85.97 lakhs + contingency of 1% -18.09 lakh)

(Source: COFMOW compendium no. COF-MOW / IR / M-003/2 issued on 12/07/2012, Sr no. 155)

Loco Running Staff of Nagpur Division:

The Nagpur division of Central Railway has been regularly deputing its Loco Pilots (LP)/ Asstt. Loco Pilots (ALPs) who work goods trains as well as Mail/Express trains for Initial, Pre-promotional and Periodical Refresher training to ZRTI, Bhusaval.

During the period 01.01.2013 to 22.05.2013 a total of 91 Loco Pilots of Nagpur division underwent simulator training. Percentage improvement in the work efficiency of each Loco Pilot is computed by the trainers at ZRTI after every training programme, based on tests given to the Loco Pilot on the first day of training and last day of training. The results of training in terms of percentage improvement in work efficiency of a sample of 10 Loco Pilots are shown in Table 12 below, where a substantial improvement in skills is observed, which directly results in enhanced safety performance of the Loco Pilots when they work train on line.

Table 12. Improvement in work efficiency of a sample of 10 Loco Pilots after Simulator Training

Sr. No.	Name of Loco Pilot	Date of Stalling	Date of training	Entry Performance	Exit Performance
(1)	(2)	(3)	(4)	(5)	(6)
1.	Kamble	08.03.10	14.09.2012	80%	97%
		11.07.10			
2.	Rajesh	25.06.01			
		17.06.10	18.11.2011	80%	98%
		03.07.10			
3.	Joshi	18.11.10			
		23.11.10	25.03.2013	99%	99%
		07.08.12			
4.	Sanjay	30.06.10	25.03.2013	75%	98%
		07.07.10			
5.	Venugopal	08.11.11	26.04.2012	100%	97%
		01.03.12			
6.	Ajay	19.07.11	24.01.2013	74%	96%
		25.11.11			
7.	Bhagwat	09.07.11	18.11.2011	76%	96%
		19.10.11			
8.	Khorgade	15.06.12	24.01.2013	99%	92%
		01.08.12			
9.	Shaikh	17.06.12			
		01.07.12 29.07.12	24.01.2013	80%	84%
		02.04.12			
10.	Akela	22.05.12	30.04.2012	98%	100%

Source: Author's Own Research based on Central Railway Statistics.

From column no 3 above, it is seen that out of these 10 LPs who were involved in several stalling cases due to poor road knowledge and poor driving technique before this training, 9 did not have any case after the simulator training. Since stalling of a goods train is a very unsafe condition, any improvement on this aspect leads to greater safety in train operation.

Apart from the above, the division continuously monitored the performance of LPs after their simulator training. As a result, a substantial decrease in number of stalling cases, loco failures/accidents and loss of punctuality due to inefficiency/ignorance of these Loco Pilots have been observed after their training on simulator. The results of such improvement in performance are shown in Table 13 below;

Table 13. Improvement in Performance of LPs / ALPs after Simulator Training

a) Stalling on Crew Account

Year	2009-10	2010-11	2011-12	2012-13
(1)	(2)	(3)	(4)	(5)
No. of Cases	144	121	125	79

Source: *Central Railway Statistics,* (Several Years).

b) Punctuality Loss Cases on Crew Account

Year	2010-11	2011-12	2012-13
(1)	(2)	(3)	(4)
No. of Cases	78	76	60

Source: *Central Railway Statistics,* (Several Years).

c) Loco Failures on Crew Account

Year	2010-11	2011-12	2012-13
(1)	(2)	(3)	(4)
No. of Cases	4	4	2

Source: *Central Railway Statistics,* (Several Years).

d) Accidents on Crew Account

Year	2009-10	2010-11	2011-12	2012-13
(1)	(2)	(3)	(4)	(5)
No. of Cases	3	1	1	0

Source: *Central Railway Statistics,* (Several Years).

It may be observed from the above that the performance of these Loco Pilots over the last 3 years showed significant improvement after their training on simulator in 2012-13. Improved performance of LPs and ALPs improves safety as well operations. Thus, in addition to improvement in safety performance, the division got the benefit of the same in terms of punctuality of Mail/ Express trains, reduced locomotive failures on account of mismanagement of LPs and reduced stalling of freight trains on account of poor driving techniques of LPs. Thus, investment in training of LPs through simulator not only improved the safety standards of train working but has also resulted in improvement in the operational efficiency by way of better train movement.

Expected gains and financial returns from the proposed investments.

Net Earnings on working a Goods Train per kilometer -

As per statement no -15 Sr. No. 13 (ii) at page

227 of IR Annual Statistical Statement Year 2011-12. Net earnings (including cost of interest) on working a goods train for one Km is Rs. 630.21, as shown under:

Table 14. Showing Net Earnings on working a Goods Train per kilometre

Results of Working of Coaching and Goods Services Statement 15 - Goods Traffic						
	1990-91	1995-96	2000-01	2005-06	2010-11	2011-12
(1)	(2)	(3)	(4)	(5)	(6)	(7)
13. Net Earnings on working a Goods Train one kilometre (Rs.)						
i) Excluding Interest	94.98	222.77	213.71	505.06	666.57	692.22
ii) Including Interest	74.76	194.18	177.34	450.72	599.91	630.21

Source: - GOI - IR ASS, (Several Years) Statement - 15. p. 227

Table 15. Operational Improvement as a Result of Simulator Training

Sr.	Parameters where gain achieved	Saving
(1)	(2)	(3)
1.	Reduction in AC loco holding by 0.3% despite increase in loco usage by 9.5% (566 to 620)	Saving in term of reduction in loco holding AC = 0.3 locos
2.	Reduction in DSL loco holding by 9.9% despite increase in loco usage by 4.2% (405 to 422)	Saving in term of reduction in loco holding DSL = 1.7 locos
3.	Improvement in punctuality by 1.3% (96.0 to 97.27)	Conventionally accommodated the new trains. Saving in terms of earning of passenger trains = 6 new trains introduced and frequency of 2 trains increased.
4.	Improvement in speed by 1.5% (29.93 to 30.37)	Better planning in terms of train movement, resulted in increase in speed and subsequently rise in loco usage with reduced loco holding
5.	Improvement in WTR by 8.9% (1.23 to 1.12)	Better availability of rakes for loading and unloading. Saving in terms of increased originating freight loading by 8.7% (26.220 to 28.492 MT
6.	Increase in NTKM by 6.7%	

Source: *Central Railway Statistics*, (Several Years).

Table 16. Financial Return as A Result of Simulator Training

Section	Distance	Increase in Trains	Net Earnings (Profit) on working of goods train one KM	Net Earnings per day	Net Earnings per year
(1)	(2)	(3)	(4)	(5)	(6)
NGP-WR	79	1.6	630.21	79658.544	29075369
WR-NGP	79	1.8	630.21	89615.862	32709790
AMF-ET	130	0.5	630.21	40963.650	14951732
ET-AMF	130	1.0	630.21	81927.300	29903465
AMF-NGP	167	1.0	630.21	105245.070	38414451
WR-BD	95	2.3	630.21	137700.885	50260823
BD-WR	95	2.4	630.21	143687.880	52446076
	775	10.6	630.21	5177175.150	247761705

Source: *Central Railway Statistics*, (Several Years).

Payback period for the investment in the installation of simulator.

Total Investment = Rs. 18.27 Cr.
Net Earnings = Rs. 24.78 Cr. per year
Payback Period = Total investment ÷ Net earnings per year
= 18.27 ÷ 24.78
= 9 months

CONCLUSION

The cost of the simulator installed at the Central Railway Zonal Training Institute at Bhusaval was Rs. 18,27,00,000/-. During the period from 01.01.2013 to 22.05.2013, a total of 91 Loco Pilots of Nagpur division of Central railway underwent training on this simulator. Improvement of work efficiency of these Loco Pilots was worked out meticulously and found that in addition to improvement in their safety performance, their loco handling and trouble shooting skills also substantially improved resulting in lesser detentions and failures of the locos. The annual net gains to the Railways from such improvements worked out to Rs. 24.78 Cr. per year.

The payback period of the investment was, therefore, found to be only 9 months.

5.3 Case Study No. 3

Track Renewal in Virar- Surat section of Western Railway.

Background

Track is the primary infrastructure of Railway on which trains run. The entire load of the running trains is borne by the track. Track is made of rails, sleepers and fastenings holding them together. Rails are made of high-quality steel. During their service, rails undergo fatigue, wear, corrosion, etc. Sleepers and fastenings also undergo wear & tear. As a result, they need to be replaced after the passage of a stipulated level of traffic in terms of millions tons or after reaching a stipulated level of wear and corrosion Track renewal works are undertaken as and when stretch of track becomes due for renewal on the basis of

criteria laid down in Indian Railway Permanent Way Manual on age/condition basis [GOI, 2004].

Factors Governing Permanent Way Renewal [GOI, 2004]

Criteria for Rail Renewal - The following are to be considered in connection with the criteria of rail renewals:

* Incidence of rail fractures/failures.
* Wear on rails.
* Maintainability of track to prescribed standards.
* Expected service life in terms of Gross million tonnes carried.
* Plan based renewals.

The delay in replacement of such rails results in rail fractures which affects safety as the same may lead to derailments and accidents.

Introduction to the Case Study

The Virar-Surat section falls in Mumbai Central Division of Western Railway and is located along the Western coast on Mumbai Central-New Delhi Rajdhani route, which is categorised as 'A class' on Indian Railways (Lines in this class are BG sections rated for speeds up to 160 km/h.) where the future maximum speed of trains is up to 160Kmph. This route is part of, what is known as Golden quadrilateral route of Indian Railways connecting the four metropolitan cities namely, Mumbai, New Delhi, Kolkata & Chennai which carries bulk of the traffic of IR. The maximum permissible speed on the section at present is 120 Kmph.

Virar-Surat section is a double line section with 208 route Kms. and annual traffic of up to 60 GMT (Gross Million Tonnes) on each line. There are 34 stations on this route. As this section falls in an industrial belt and in the coastal area, there has been severe problem of corrosion due to chemical effluents & the saline atmosphere. Being close to the approach to the metropolitan city of Mumbai with large number of originating & terminating mail express and passenger trains, this section is also burdened with the problem of night soil droppings from the toilets leading to severe corrosion of rails. This corrosion predominantly occurs at the rail foot where rails are in contact with the liners and therefore is known as liner biting. The track structure during 2003-04, was predominantly with 52kg rails on 52 kg Pre-stressed Concrete sleepers with sleeper density of 1660 Nos/Km.

As per the provisions in GOI [2004], the code life of 52kg rails is 525GMT after which they have to be renewed. The criteria laid down for renewal on condition basis are either of the following: (i) 8mm vertical wear, (ii) 6mm lateral wear, (iii) corrosion up to 1.5mm, (iv) spate of fractures, i.e., 5 rail withdrawals per 10 Track Kms. Rail with drawls may either be in form of fractures or a flaw detected in USFD necessitating removal of the rail.

Sanction of Track Renewal work in Virar - Surat section

During period from 1999-2000 to 2003-04, about 130 Kms of track became due for renewal due to corrosion at rail foot measuring up to 5mm. The following Track Renewal works were sanctioned in this Section with 60kg rails as given in the following Table (Table 17):

Table 17. Renewal of Track on Virar- Surat Section (WR)

No	Name of work	Cost in Rs.
(1)	(2)	(3)
1.	Virar-Surat Complete Track renewal for 18.99 Kms (sanctioned in 2001-02)	6.31 Cr.
2.	Virar-Surat Complete Track renewal for 20.10 Kms (sanctioned in 2001-02)	7.85 Cr.
3.	Virar-Surat :- Through Rail Renewal for 4.96 Kms (sanctioned in 2002-03)	2.13 Cr.
4.	Virar-Surat:- Through Rail Renewal for 28.20 Kms (sanctioned in 2002-03)	14.43 Cr.
5.	Virar-Surat:- Complete Track Renewal for 9.46 Kms ad Through Rail Renewal for 1.17 Kms (sanctioned in 2002-03)	5.35 Cr.
6.	Virar-Surat: Complete Track Renewal for 22.09 Kms and Through Sleeper Renewal for 9.70 Kms (sanctioned in 2003-04)	19.09 Cr.
7.	Virar-Surat: Complete Track Renewal for 25.90 Kms and Through Sleeper Renewal for 1.13 Kms (sanctioned in 2001-02)	20.51 Cr.
	Total	75.67 Cr.

Source: *Western Railway Statistics,* (Several Years).

Thus, out of 416 Track Km (2 lines x 208 Km each) on the section, around 130Kms of track became due for renewal due to corrosion of rails.

Delay in the execution of the above work and repercussions thereof

Due to various reasons, the works got delayed from 1999-2000 resulting into steep increase in number of rail fractures from 1999-2000 to 2001-02 as can be seen from the figures given below:-

1999-2000:- 7 fractures,
2000-2001:- 14 fractures,
2001-2002:- 33 fractures

Safety risk in the section, as a result, increased so much, that the Commissioner of Railway Safety had imposed a speed restriction of 75 Kmph in the section from Virar to Surat (130 Km) during 2003, considerably affecting the Line Capacity of this important section.

Assessment of the losses sustained by IR due to detentions caused by equipment failures like rail fracture on account of delay in track renewals.

*** Net Earnings on working a Goods Train per kilometer -**

As per statement no -15 Sr. No. column no. 27 at page 142 of IR Annual Statistical Statement

Year 2003-4 (for the year 2002-03). Net earnings (including cost of interest) on working a goods train for one Km is 2003-04 Rs. 456.21, as under:

Table 18. Showing Net Earnings on working a Goods Train per kilometer

	Net Earnings on working a Goods Train one kilometre (Rs.) (Western Rly.)
(1)	(2)
	ii) Including Interest
	27
2002-03	456.21

Source: GOI ASS (Several Years), Statement - 15.

Calculation of Losses Due to Resultant Detention to Goods Trains

* Average no. of goods train per day = 20 in each direction
* Average no. of goods trains in both = 40 directions
* Average no. of passenger trains in = 42 each direction
* Average no. of passenger trains in = 84 both direction
* Time lost by a passenger train in restricted speed of 75 Kmph instead of 100 Kmph = (200 Km/ 75 Kmph) - (200km/100Kmph) = (2’40" - 2’0") = 0’40"
* Time lost by a goods train: - Since speed of goods train is 75 Kmph, there was no loss to goods train earnings due to this speed restriction. However, detention occurred to the goods trains due to bunching of passenger trains on account of speed restrictions on passenger trains. Since percentage utlisation of line capacity of the section was around 140%, the goods trains got detained on the loops of stations to give preference to passenger trains so that they got clear headway (green instead of yellow or double yellow or danger signals so that they may not have to slow down due to yellow, double yellow or danger signal). Therefore, the time loss to goods trains was more than the time loss to passenger trains. On a conservative estimate, the loss of time to a goods train could be considered as equal to the loss of passenger train, i.e., 0’40" in a section of 200 Km length.
* Average speed of goods train on WR as per statement No. 20 of Annual Statistical statement of Indian Railway* = 28.1 Kmph
* Therefore loss of time of 40 goods trains per day = 40 trains x 0’40" = 20.66 train hours per day
* Loss of time of 40 goods train per year = 365 x 20.66 = 7540.90 train hours per year
* Earnings of goods train as per para a above = Rs. 456.21/- per Km
* Loss of earning due to time lost by goods trains = 7740.90 x 456.21 x 28.1 = Rs. 99234475.29

Calculation of losses due loss of line capacity resulting in reduction in no. of goods trains running on the section

* Loss of traffic: - Traffic of two goods trains were lost per day due to loss of line capacity. 2 trains x 40 wagons/train x Rs. 799/wagon km per day** x 200km x 365 days
  = Rs. 466.62 Cr/year

Calculation of losses due detentions of trains on account of equipment failures like rail fractures, etc.,

99 fractures took place between 2000-01 to 2003-04 on an average of 25 fractures per year against 6 to 7 fractures per year in the previous period as well as in the period after 2003-04.

Loss of time due to 72 fractures = 72 fractures x 20 minutes detention/fracture x 2 trains

= 2880 Hours

Loss of earning due to the 72 fractures = 2880 Hours x 456.21 x 28.1 = Rs. 36920162.88

Total annual losses due to imposition of speed restrictions & fractures due to delay in execution of track renewal work:

b+c+d= Rs, 99234475.29+ Rs. 466,61,60,000+ Rs. 36920162.88 /- = 4802314638.17 = say 480.23Cr.per year

Payback Period of Investment

Total cost of track renewals carried out	= Rs. 69.64 Cr, (Para No 6.3.3)
Loss of earning due to the 72 fractures	= Rs. 480.23 Cr. Per year
Therefore payback period of investment	= Total cost of track renewals carried out
÷ Loss of earning	= (Rs, 69.64 Cr ÷ 480.23 Cr) x 12 months
	= 1.74 months.

Table 19. Calculation of Loss of Earnings per Goods Train in Virar Surat Section of Western Railway

	CALCULATION LOSS OF EARNING PER GOODS TRAIN RUN LESS IN VIRAR-SURAT SECTION OF WR				
	1	**Saving in Wagons**			
		i	Average no of goods trains run daily in each way (As per the Annex A)	33	
		ii	Average no of goods trains run daily in both way (i*2)	66	
		iii	Average no of light engines + Deptt trains run daily (As per the Annex A)	10	
38		iv	Average load per train in terms of wagons (Source W. Rly financial results &		26.4
35			important statistical highlights 1998-99 (As per the Annex B)	104	121.9246
35		v	Average detention in train likely to be saved after MSDSE bet VR-ST		
36			(item 5 - item 6)	0.40 HRS	41756
28		vi	Saving in detetion in train hours likely to be saved daily (Excluding LE's		152.4094
33			Deptt trains)	66*0.40=26.40 hours	
32					
31		ix	Saving in detention in terms of wagon per day (item viii* item No iv)	26.40*104/2 0.41756	Wagons

(Contd.)

Table 190. Calculation of Loss of Earnings per Goods Train in Virar Surat Section of Western Railway

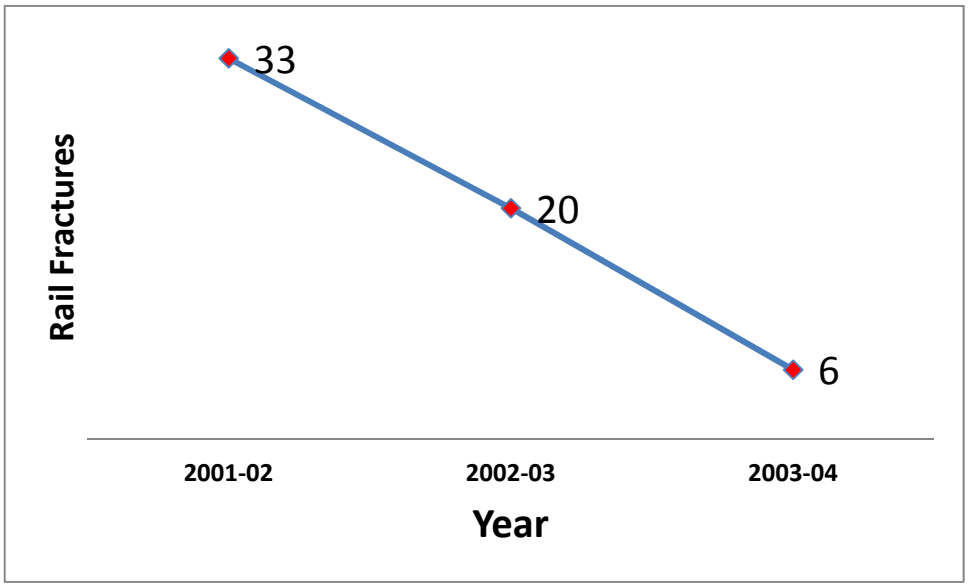
CALCULATION LOSS OF EARNING PER GOODS TRAIN RUN LESS IN VIRAR-SURAT SECTION OF WR				
31			Wagon saved per day	
22			Wagons saved per annum	0.41756*365=152.40
32				say 152 wagons saved
33		x	Earning per wagon km	
386			(Source W. Rly Financial results and important statistical Highlights)	824.36 paise
32.167			As per Annx D	
		xi	Houlage charges per wagon km	
21.12			(Source W. Rly Financial results and important statistical Highlights)	490.70 paise
			As per Annx E	
		xii	Net earning per wagon km	
			(Source W. Rly Financial results and important statistical Highlights)	333.66 paise
			(item x - item xi)	i.e., 3.33 Rupee
		xiii	Wagon km per wagon per day on line	
			(source W. Rly Financial results and important statistical Highlights)	239.9
			As per Annx F	
		xiv	Net earning for per wagon per day (Item No xii* Item No xiii)	799
		xv	Net earning on 152 per day	121427.78
				44321141
			Earning per annum	
	2	Saving in	Engine	
		i	Total engine hours per day likely to be saved in goods train	66
		ii	Total engine hours per day likely to be saved for light engine + Deptt	10
			Both way (Item ii*2)	20
		iii	Total engine hours per day likely to be saved (Item No i + Item No ii)	21.12
		iv	Average cost of operation per train engine hours (AC)	5144.21
		v	Saving in engine hours in terms of money per day	108645.72
		vi	Saving in engine per annum	39655686
	3	**Total**	**Saving**	
		i	Saving in Wagons	44321141
		ii	Saving in Engines	39655686.05
		Net	**Saving**	83976827.21

Source: *Western Railway Statistics,* (2002-03) extract.

Results after carrying out Track Renewal:

After carrying out the above work, speed restriction of 75Kmph was withdrawn and maximum permissible speed of 120 Kmph were restored and rail fractures were controlled as can be seen from graph below: -

Figure 2. Rail Fractures



Source: - *Western Railway Statistics*, (Several Years).

Conclusion

It is seen from the above that, payback period for the investments made by IR in the track renewal work mentioned above was 1.74 months.

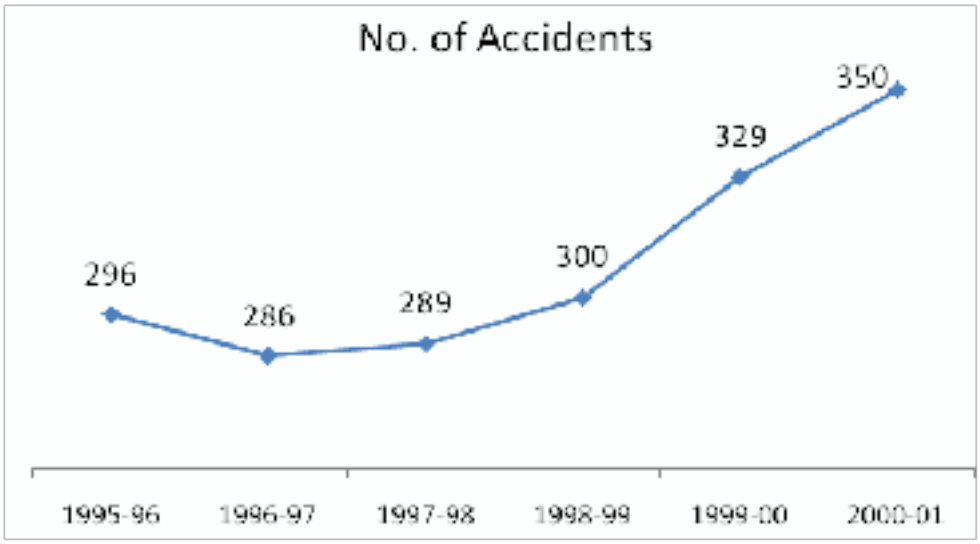
5.4 Case Study 4: - Gains from Investments made by IR through SRSF

Background:

The following were the arrears of asset renewals on Indian Railways in the beginning of 1999 [GOI, 2001a].

* Arrears of Track Renewals (BG) - 12,260 Kms.
* Distressed Bridges - 262 Nos.
* Overaged Signalling Gear - 1,560 Stations
* Overaged Coaches (BG) - 1,322 Vehicle Units
* Overaged Wagons (BG) - 34,000 (in terms of 4-wheelers)

Fig 3. Trend of Consequential Train Accidents on IR



Source: GOI, IRYB, (Several Years)

It may be seen from the above that during the period from 1996-97 to 2000-01 accidents on IR substantially increased, main reason for the same was arrears of overaged assets mentioned above. This was due to inadequate provision of Depreciation Reserve Fund to wipe out the arrears, due to financial constraints of IR. IR had reached the brink of disaster with its assets under deep distress so much so that the Railways were unable to pay even the annual Dividend to the General Exchequer. One of the major recommendations of GOI [2001a] was to set up a 'Special Railway Safety Fund (SRSF)', as a non - lapsable to be created to wipe out the arrears in renewal of over aged assets, viz. Track, Bridges, Rolling Stock & Signaling gears, etc. Thus, a Rs. 17000 Crores SRSF was created with effect from 1st Oct 2001, financed partially through Railway Revenues by levy of safety surcharge. (Rs. 5000 crores) and balance (Rs. 12000 crores) through additional financial assistance (dividend free Capital) from General Revenues. The currency of the Special Railway Safety Fund had already come to an end on 31.3.2008.

SRSF was allocated funds as under:

Track Renewals	45.0 %
Bridges	10.1 %
Signal & Telecommunication	18.0 %
Rolling Stock	19.0 %
Safety Enhancement measures	06.7 %

A review of performance of the SRSF has revealed that there were some shortfalls in the targets after completion of the extended one -year period of the Fund at the end of 2007-08. However, IR did well in most of the areas in achieving

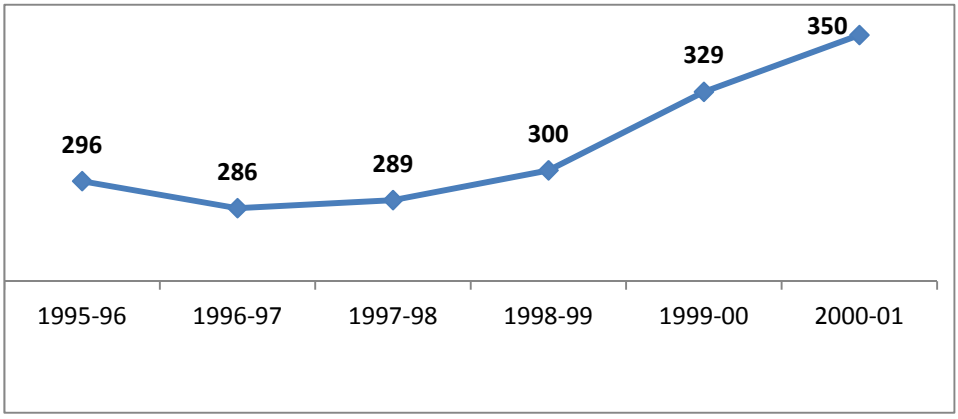
the targets set under SRSF, due to which the line capacity improved and the Railways were able to run more traffic with heavier axle loads.

Review of the performance of IR for the period 2004-09 from the safety, operational, financial point of view:

i) Sharp decline in consequential accidents on IR from 2006 to 2012

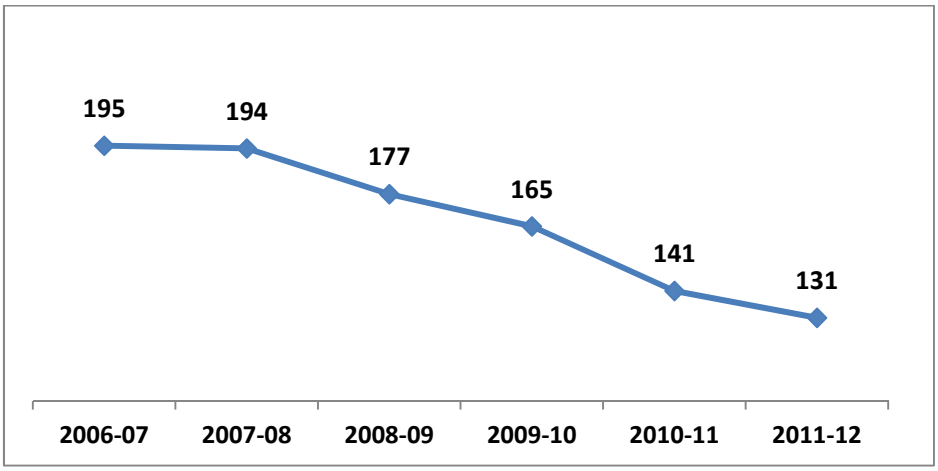
As may be seen from Figures 4 and 5 below, compared to the sharp increase in the no of accidents to 350 nos. up to 2001 given in Figure above, there has been sharp decline in no. of accident from to 131 nos. in 2011-12.

Fig 4. Consequential Accidents on IR



Source: GOI, IRYB, (Several Years)

Fig. 5: Consequential Accidents on IR



Source: GOI, IRYB, (Several Years)

ii) Sharp Growth of traffic during the first decade of this century compared to on nearly five decades of growth on IR since 1950

Growth of Passenger Traffic

It may be seen from the Table below that growth of IR's Passenger traffic output in terms of Passenger-KMs, in 08 years period between 2000-01 to 2008-09 has been as much as the growth achieved by IR in 50 years from 1950-51 to 2000-01 which is likely to increase further in next 5 years.

Growth of Freight Traffic

It may be seen from the Table below that growth of IR's freight traffic output in terms of Tonne-KMs, in 10 years period between 2000-01 to 2010-11 has been as much as the growth achieved by IR in 50 years from 1950-51 to 2000-01.

Table 20. Growth of Passenger Traffic Output on IR.
(Pass-Kms in Millions)

Year	Suburban (all classes)	Non-suburban					Grand Total
		Upper class	Second Class			Total Non-suburban	
			Mail /Exp (inc SL class)	Ordinary	Total		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1950-51	6551	3790	12537	43839	56176	59966	66517
1960-61	11770	3454	22251	40190	62441	65895	77665
1970-71	22984	4394	37856	52886	90742	95136	118120
1980-81	41086	5140	86712	75620	162332	167472	208558
1990-91	59578	8712	138054	89300	227354	236066	295644
2000-01	88872	26315	222568	119267	341835	368150	457022
2008-09	124836	49468	419649	244079	663728	713196	838032
2009-10	130917	55182	463321	254045	717366	772548	903465
2010-11	137127	62203	500631	278547	779178	841381	978508
2011-12	144057	72148	548861	281456	830317	902465	1046522

Source: GOI, [2009a].

Table 21. Growth of Freight Traffic Output on IR

Year	Tonnes (Millions)	Index (1950-51=100)	Net tonne kms(Millions)	Index (1950-51=100)	Lead (kms)	Index (1950-51=100)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1950-51	73.20	100.0	37565	100.0	513	100.0
1960-61	119.80	163.7	72333	192.6	603	117.6
1970-71	167.80	229.4	110696	294.7	659	128.5
1980-81	195.90	267.6	147652	393.1	754	147.0
1990-91	318.40	435.0	135785	627.7	741	144.4
2000-01	473.50	646.9	312371	831.5	660	128.7
2008-09	833.39	1138.5	551448	1468.0	662	129.0
2009-10	887.79	1212.8	600548	1598.7	676	131.8
2010-11	921.73	1259.2	625723	1665.7	679	132.4
2011-12	969.05	1328.8	667607	1777.2	689	134.3

Source: GOI, IRYB, (Several Years)

Originating Freight Loading Milestones of IR:

The IR crossed original freight loading Milestones, as under:

1960 - 100 MT
1980 - 200 MT
1990 - 300 MT
1996 - 400 MT
2008 - 800 MT
2012 - 1000 MT

As may be seen from above, IR took more than 100 years to reach the level of 100 MT of originating freight loading, and took more than 140 years to reach the level of 400 MT in 1996. However, the next 400 MT to 800 MT of originating loading was achieved in only 12 years. The increase in the originating loading during the first decade of this century in the recent years has been partly due to unlocking of locked up carrying capacity due to equipment failures, accidents, etc., which have considerably reduced after IR's investments in safety from SRSF.

iv) Growth in Infrastructure

Capacity augmentation in terms of infrastructure facilities (moving as well as fixed) should be an on-going process. The figures of expansion of rolling stock and fixed investment between 2004-05 and 2008-09 are as shown in Tables 22 & 23.

Table 22. Rolling Stock

Year	2004-05	2005-06	2006-07	2007-08	2008-09	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Wagons(FWU)	19992	18681	21933	22753	24115	107474
DMUs	36	27	57	33	38	191
EMUs	145	176	251	193	535	1300
MEMUs	88	88	64	33	64	337
Coaches	2623	2684	2881	3101	3193	14482
Electric Locos ((CLW)	90	129	150	200	220	789
Diesel Locos (DLW)	121	148	186	222	257	934

Source: GOI, IRYB, (Several Years).

Table 23. Fixed Infrastructure

Year	2004-05	2005-06	2006-07	2007-08	2008-09	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Wagons (FWU)	19992	18681	21933	22753	24115	107474
New Lines km)	150	180	250	156	357	1093
Gauge Conv (km)	779	744	1082	1549	563	4717
Doubling(km)	282	231	386	426	363	1687
Railway Electrification (km)	320	170	361	502	797	2150

Source: GOI, IRYB, (Several Years).

v) IR's Earnings' Growth:

The trend of earning growth of IR since 1980-81 has been as under in Table 24.

Table 24. Trends of Earnings on IR since 1980-81

Year	1980-81	1990-91	2001-02	2004-05	2008-09	2009-10	2010-11	2011-12
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Gross traffic receipts (Rs. In Crores.)	2707	12134	378859	47038	79862	86963	94535	103917

Source: GOI, IRYB, (Several Years).

It is to be noted from Table 25 that earnings on IR have also gone up significantly due to sharp increases in traffic (passenger and freight). It is to be noted that this may be partially due to sharp increases in freight tariffs but at the same time, it is to be noted that passenger tariffs moved up in the 1980s but have since then virtually stagnant.

5.5 Case study No. 5: Economic Evaluation of Investments in Rail Transport

Background

The case study that is presented in this Section does not directly deal with evaluation of investments on safety, either at a micro or macro level but is described to show the importance of appropriate investments from time to time and also the relevance of setting aside of appropriate amounts of funds for replacements and renewal of fixed assets through depreciation funds) which can play a major role in sustaining the railway network in terms of its current spread as also in its expansion in such a way that this important mode can support the growth story of the country in a forceful way.

Though since the fifties and sixties of the last century, railway systems all over the world have found it difficult to survive the intense competition from the highways (despite being more energy efficient, environmental friendly and much less expensive), in the past few decades, there have been major attempts to revive the railways in a restructured form so as to take care of emerging requirements as also being compatible with emerging developmental goals which emphasise environmentally sustainable transport systems. Many investments in railways may not be financially viable but they are mostly economically and socially viable and more beneficial the overall developmental process compared to other modes of surface transport like roadways/ highways. It is within this framework that an attempt is made here to present a case which examines how the lack of investments in rail transport in the context of IR has brought about a drastic shift of modal shares in favour of the highways over five decades since independence. In other words, modal shift has resulted in misallocation of resources which viewed from the point of view of societal (resource) costs is huge. We begin with some points to indicate fall in investments on IR which has resulted in a declining market share. When compared with developments in the past few decades in other major railway systems, it appears IR is lagging behind in terms of coverage, performance, etc. A brief comparison between other systems and IR indicates this trend. Further, the case study description follows. This is adapted to a large extent from the study in this subject matter undertaken by RITES [2009].

Declining investments in IR

It is well recognised that compared to roadways/ highways, railways are much more land and energy efficient. They are also more environmentally friendly. Any investment in Railways is not only financially viable but economically and socially more beneficial compared to other modes of surface transport like roadways/highways. Yet it is noticed that in India, IR has suffered from lack of adequate investments as seen from the following Table 25;

Table 25. Investments on IR (in Rs. crores)

Sector	Upto Vth Plan 1950-1978	VIth Plan 1980-85	VIIth Plan 1985-1990	VIIIth Plan 1992-97	IXth Plan 1997-2002	Xth Plan 2002-07	XIth Plan 2007-2012	XIIth Plan 2012-2017
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Railways	4.723	6.585	16,549	32,306	45,725	84,003	81,89,838@	4,19,221@
Transport sector	10,117	13,962	29,548	65,173	1,17,563	2,59,777	6,13,185	12,04,172
Total outlay	59.979	1,09,292	2,18,729	4,85,457	8,13,998	15,25,639#	36,76,936	76,69,807
Transport sector %age of total plan	16.9	12.8	13.5	13.4	14.4	17	16.7	15.7
Railways as %age of total plan	7.9	6.0	7.6	6.7	5.6	5.5	5.2	5.5

Excludes inter plan period 1966-69. # Original outlay
@ the outlay does not include funding from PPP or private source.
*Revised
Source: GOI, [2014b].

Declining Market Share of IR

Table 26. Mode-wise Traffic in Million Tonnes and Percentage Share In Total Traffic

Year	Total originating inter regional traffic	Railways	Highways	Coastal Shipping	Airlines	Pipelines	Inland Water transport
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1950-51	82.20	73.2 (89%)	9.0 (11%)	NA	NA	NA	NA
1978-79	283.4	184.7 (65%)	95.6 (34%)	3.1 (1%)	NA	NA	NA
1986-87	484.90	255.4 (53%)	224.0 (46%)	5.5 (1%)	NA	NA	NA
2007-08	2555.35	768.7 (30.08%)	1558.9 (61%)	59.1 (2.31%)	0.28 (0.01%)	113.5 (4.44%)	54.9 (2.15%)

Source - RITES, [2009].

It can be seen from Table 26 given above that the market share of rail transport has reduced drastically from 89% in 1950-51 to 30% only in 2007-08. The road sector has been the biggest gainer. Comparison of tonne kilometers for the different modes for the year 2007-08 indicates share of Railways at 36.06% only.

International Comparison

The Table-27 below briefly summarises the comparative position in respect of some key parameters based on figures published by International Union of Railways (UIC), Paris;

Table 27. Key Statistics of Other Railway Systems (All figures pertain to the year 2088)

Country	Population (millions)	Route Kms.	Area (million Sq.Kms.)	Net Tonne Kms.	Passenger Kms. (in millions)	Route Kms per million population	Route Kms per square Kilometer area
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
USA	330	150462	9.834	4525217	10239	0.000445	0.01532
China	1435	67515	9.597	2282238	681203	0.0000475	0.00701
German	83	33440	0.3576	70614	79456	0.0004028	0.09351
France	67	28241	0.6438	24598	93277	0.0004215	0.04386
Russia	146	85626	17.15	2491876	129371	0.0005864	0.00499
India	1369	68443	3.287	670175	1149835	0.0000499	0.02020
Japan	126	16852	0.3771	21265	1410	0.0001370	0.04468

Source: UIC, Paris [2019].

Indian Railways lags behind the developed countries (USA, Germany, France and Japan) in terms of route Kms per square Kms or route Kms per million population served which are broad indicators of level of connectivity in the country.

In terms of route length, IR is among fourth largest in the world after US Rail road and Russian & Chinese Railways. As regards freight traffic again it is fourth, but substantially lag behind these three Railway systems. In passenger traffic, even though Japan carries more passengers, Indian Railways is the highest in terms of passenger Kms. Yet it is seen that IR is not able to meet full passenger traffic peak demand in the country due to increased travel demand of a growing economy of a continental size. RITES [2009] showed that the modal share of IR in India has steadily declined and was found to be just about 60% in 2008. The study reported that the actual modal mix of transportation obtaining at present is not optimal. If the resource or social cost is calculated, as per the optimal mix, the market share of Railways would go up and which would have led to a saving of Rs. 38,470 crores. in 2008. This could have doubled by now. This needed to be reversed by stepping up the investments in Railway to augment its capacity so as to optimise the modal mix of transportation. Thus, it was made very clear that an optimal modal mix is to be achieved from the point of view of social costs and that the lack of investments had resulted in misallocation of resources leading to non-optimality of flows. RITES [2009] pointed this

important result based on a comprehensive study of modal costs that was undertaken at that time. We attempt to provide an adaptation of this study below to provide some insights into this study of costs in terms of the methodology and the data that was used. However, before we proceed to do that, we give a brief on the concept of the optimal modal split and the need to progress towards it in the Indian context.

5.5.1 The Concept of the Optimal Modal Mix in Transport

Introduction to the Economics of Sustainable Transportation

It must be recognised that the concept of optimal mix in transport is related to the overall concept of the emerging notions on economics of sustainable transportation. Major concerns about the quality of the environment, social and economic equity, and perceived threats from climatic changes have provided a basis for an emerging interest in the concept of sustainable development which, in general, refers to a state in which there is a balance of economic, social and environmental goals, including those that involve long-term, direct and indirect, impacts. It reflects a basic human desire to protect and improve the situation on earth with a focus on the integrated nature of human activities which requires coordinated decisions among different sectors, groups and across jurisdictions, local, regional, national and international. In other words, sustainable development aims to expand the objectives, impacts and options considered in the developmental process, which helps in ensuring that short-term decisions are consistent with strategic, long-term goals.

Sustainable development applied to transport systems requires the promotion of linkages between environmental protection, economic efficiency and social progress. Under the environmental dimension, the objective consists in understanding the reciprocal influences of the physical environment and the practices of the industry and that environmental issues are addressed by all aspects of the transport industry. Under the economic dimension, the objective consists of orienting progress in the sense of economic efficiency. Transport must be cost-effective and capable of adapting to changing demands. Under the social dimension, the objective consists in upgrading standards of living and quality of life.

In terms of all these dimensions, objectives are sought to be achieved through proper planning, implementation and operation system management, proper capacity enhancement and management, energy management, and environmental management. Before energy efficiency and climate change became policy concerns, sustainable transport was defined in terms of policies which were based on access-based transport planning oriented around planning for proximity. Today, the focus on energy saving and conservation, environmental impacts dominate the policy debates and frameworks of most countries in this context with basic issues of efficiency of planning, implementation and operating practices not being given the emphasis that is also required to sustain systems in the long-term. In other words, sustainable transport has a wider framework than just energy and environmental sustainability and it is being increasingly recognised that there is a need to look at the basic economics which is commonly one of the factors contained within sustainability depictions. The common thread of these depictions is that sustainability is located in the region

of overlap of the separate factors so that sustainability is the optimum mix of a number of desirable outcomes. In recent decades, economic deregulation in many economies across the world has greatly promoted non-sustainable behaviour such as high-vehicle ownership, use of high fuel-consumption-vehicles and consequent poor use of public transport. This development has given rise to the feeling that returning to more sustainable transport is unlikely until the time the policy framework within which people live drives them in this direction. But the issue is: more specifically, what are the economic elements of a sustainable transportation policy framework? These are spelt below in brief.

5.5.2 Economic Elements of a Sustainable Transport Policy Framework

The framework of an appropriate sustainable transport policy would seek to achieve, among other things, some of the following economic objectives:

* emphasis on realistic modal pricing methods to ensure that users pay the full social and environmental costs of their transport decisions and movement thereby to sustain long-term viability of the system.
* **To strike the right balance between modes of transport in serving economic development needs of a country**
* To provide for safe mobility.

We now need to proceed with the basis for a sustainable transport framework policy in the Indian context.

5.5.3 Balance between Modes- The Concept of Modal Share and Optimal Modal Split

In the 1950s, Indian Railways (IR) was the dominant mode for inland transport of goods and this was achieved not only due to its capability to cater to traffic in smalls, wagon loads as well as train-loads but equally owing to a lack of competition from road transport which was still in its infancy with inadequate required infrastructure in terms of roads and mobile units to provide an effective alternative. Moreover, with increasing investment provision on development of railway infrastructure made in the first one and a half decades of planning, there was a 63.7% decadal growth in originating traffic during the period 1950-51 to 1960-61. The historical growth of IR freight traffic is presented in Table 2.13. However, inadequate allocations in the ensuing three Five Year Plans constrained the transport infrastructure leading to an increasing gap between the demand and supply for transport. This was reflected in the progressive decline in the decadal growth of rail traffic from 40.2% during 1960-61 to 1970-71 and subsequently 16.7% during 1970-71 to 1980-81.

In the early 1980s, IR, under pressure for transporting increasing volumes of bulk commodities to meet the requirements of the economy and facing capacity constraints, decided to do away with smalls and wagon-load traffic and resorted to end-to-end running of single commodity rake loads. As a result of this change in pattern of movement, IR could carry significantly higher volumes of traffic which was reflected in the decadal growth of 62.5% achieved by 1991. However, in the process, IR practically lost most of the piecemeal wagon load traffic (including parcels) to a growing road transport system. GOI [1980], in formulating its policy recommendations, had accorded an overriding priority to the objective of energy conservation, particularly the conservation of petroleum products whose import bill absorbed over 50% of India's foreign

exchange earnings during the late 1970s. The Committee suggested a package of policy measure to conserve the use of petroleum products in transport. These measures intended, first of all, to divert traffic from roads to railways through pricing and fiscal policies. Second, they envisaged a greater use of electricity as a motive power for transport by encouraging measures such as the electrification of the railways. The railways, by the early nineties, had completed, to a large extent, the electrification targets but other measures were not undertaken with almost nothing having been done to change the pricing and fiscal policies to discourage energy-intensive use of transport. This scenario that has actually emerged is the reverse of what has been expected or desired by the policy makers. This has had has very serious implications for the country not only from the point of view of energy conservation or the balance of payments problem- the objectives traditionally pursued but also for the pursuit of what are now globally considered the most crucial objectives which any modern transport policy should seek to achieve as part of a sustainable development strategy, namely, the control of environmental impacts and the reduction in the number of deaths and injuries in transport. These impacts have, in recent years, assumed such alarming proportions that they have almost everywhere threatened the lives of users and non-users of the system alike.

While a major part of traffic has shifted to road transport, substantial quantities of POL products have shifted to pipelines. Movement of cargo by Coastal Shipping has also been on the increase while Inland Water Transport accounts for a small share of traffic. During the past couple of years, however, various policy initiatives and innovative measures have been adopted by IR which have resulted in improved productivity of assets and given a boost to traffic handling capability of the Railways. The historical performance of different modes in terms of share in total originating tonnes has been shown in Table 28.

Table 28. Historical Modal Performance (Inter-Regional Traffic)

(Million Tonnes)

Year	TOTAL ORIGINATING TONNES (MT)	MODAL SHARES IN TOTAL ORIGINATING TONNES					
		Railways	Highways	Coastal Shipping	Airlines	Pipelines	IWT
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1950-51	82.2*	73.2	9.0	-	-	-	-
		(89%)	(11%)		-		
1978-79	283.40**	184.70	95.60	3.10			
		(65%)	(34%)	(1%)	-		
1986-87	484.9**	255.40	224.00	5.50			
		(53%)	(46%)	(1%)	0.28		
2007-08	2555.35	768.72	1558.87	59.10	(0.01%)	113.50	54.88
		(30.08%)	(61.01%)	(2.31%)		(4.44%)	(2.15%)

* Exclusive of Coastal Shipping, Airways, Pipelines and IWT.
** Exclusive of Airways, Pipelines and IWT.
Source: RITES, [2009]

A central issue of transport policy and planning is to allocate rationally and at minimum resource cost the total available resources for investment between various modes of transport to match with growing requirements the economy so as to achieve an optimal modal split. But resource costs cannot be measured in isolation from the Government's socio-economic, priority objectives or financial constraints. GOI [1980], expected that the modal split by the turn of the century would be such that nearly 72% of long-distance freight would move by rail and 28% by road as against the base year split of 67% for rail and 33% by road. This has not happened. We present a brief review of the portion of the study related to estimation of modal costs on railways and highways with a view to raise awareness amongst readers on the complicated methodological steps involved (with the associated data issues) which can be used for costs estimation in the Indian context in a more systematic way than is being done now. We then proceed to examine the concept and analysis of breakeven point which defines the optimal area of operation for the movement of a commodity by a particular mode thus defining commodity specific Break-Even Distances which thus provide the basis for optimal allocation of traffic amongst modes.

5.5.4 Modal Transportation system Costs in 2008 (as adapted from RITES [2009])

This part presents a broad overview of the costing methodology followed by enunciation of detailed process adopted for estimation of transport costs and resultant financial and economic/resource cost estimates in respect of two major modes, viz., Railways and Highways separately.

The main objectives of costing studies were are as follows:

* Determination and analysis of **modal transport costs** in terms of both resource cost and financial cost for each of the above modes of transport, incorporating existing as well as future transport technological advancements.
* Indicate the **desirable share of mode of transport** on the basis of cost consideration.

While converting financial costs into economic/resource costs, transfer payments in terms of subsidies, taxes and duties were excluded. Unlike financial costs, economic/resource costs incorporate elements of social costs in terms of pollution and accidents. The economic/resource costs were thus worked out as under:

Resource Cost = Financial Cost * Shadow Price Factor + Social Cost

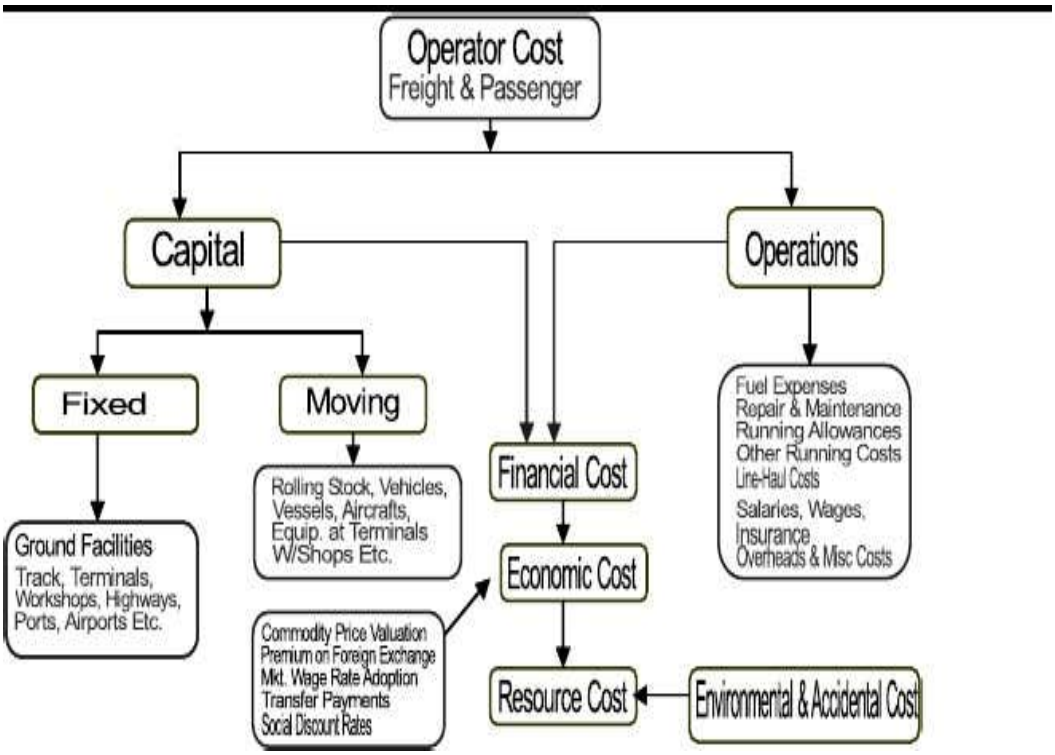
In the context of long-term planning for the transport sector, long run marginal costs are relevant. For assessing long run marginal cost, it was assumed that all the costs incurred are variable.

Broadly, operator cost data were obtained from the operators. For collection of user cost data, specially designed survey instruments were canvassed in respect of both modes.

i. Overview of Modal Costing Methodology

In the course of movement of men and material, costs are incurred by different mode of transport. As the costs assessed have to be comparable between modes, a common base is needed for assessing cost of services by different modes. The flow chart at Figure-6 provides the common platform for assessment of cost of different modes of transport.

Figure 6. Flow Chart for Estimating Modal Cost



The flow chart gives steps for arriving at costs involved in various stages. Operational costs and Capital costs were estimated for each of the modes of transport. Elements in financial cost were converted to economic cost. To the economic cost, environmental and accident costs were added to assess the resource costs.

ii. Modal Costs for Railways

Introduction

Rail transport costs, unlike road, are characterised by high fixed cost of relating to moving and fixed equipment, but lower per unit fuel and operating costs, as rail can carry large volumes. Moreover, these fixed (mostly infrastructure and some manpower) costs and variable operating costs are joint costs that have to be allocated between several kinds of products and services to arrive at the total cost of each service or product.

In order to facilitate dynamic decision making regarding investment in transport infrastructure, as well as rail operations and pricing, the system of costing should be able to record fixed and variable elements of train operations separately, thereby enabling an evaluation of whether it is profitable to continue or start different services, and also how much to charge for them. It may not be necessary, for instance to charge all the costs for a particular service, if all the fixed costs are

being recovered from some other high value traffic. On the other hand, some services may justify recovery of a profit element over and above the fully distributed cost as well. The then costing procedure used on the Indian Railways, for instance, only worked out the fully distributed costs for each service, an approach that did not facilitate determining of marginal cost for providing additional services which is necessary for comparison of cost of service by different modes of transport.

Costing of railway systems has been in vogue since its inception of the railways, and has drawn the attention of practitioners, economists, planners and policy makers. Though the tools used varied and changed with purpose on hand across time, it must be noted that rail costing has defied any standardisation owing to many complexities the main being the joint nature of costs incurred in different operations, huge sunk costs and the non-linearity of growth expenditure to outputs. Keeping this in view, the procedures adapted for rail costing have always required to address the needs of a particular exercise while also keeping the data availability in view.

The study thus had to estimate the financial, economic and social costs both for the operations and maintenance activity and capital costs for the Railways. The financial and economic costs incurred by the user of rail services are also to be included to estimate the total cost of services. The costs should be related to the rail network so that differences in the costs in moving cargo on different types of sections are brought out clearly.

The present costing exercise has as its central objective, calculation of fixed cost, and variable cost for each category of service, i.e., Goods and Passenger, for Broad Gauge Railway lines comprising 89.4 % of total rail network. Fixed costs include both Capital costs of track, locomotives, rolling stock, and signalling and fixed element of maintenance of infrastructure and some manpower element of operating costs. Variable costs that vary with output consist of maintenance and operating costs that may be directly attributed to the service or which may be joint costs for several services, which have to be divided between goods and passenger services.

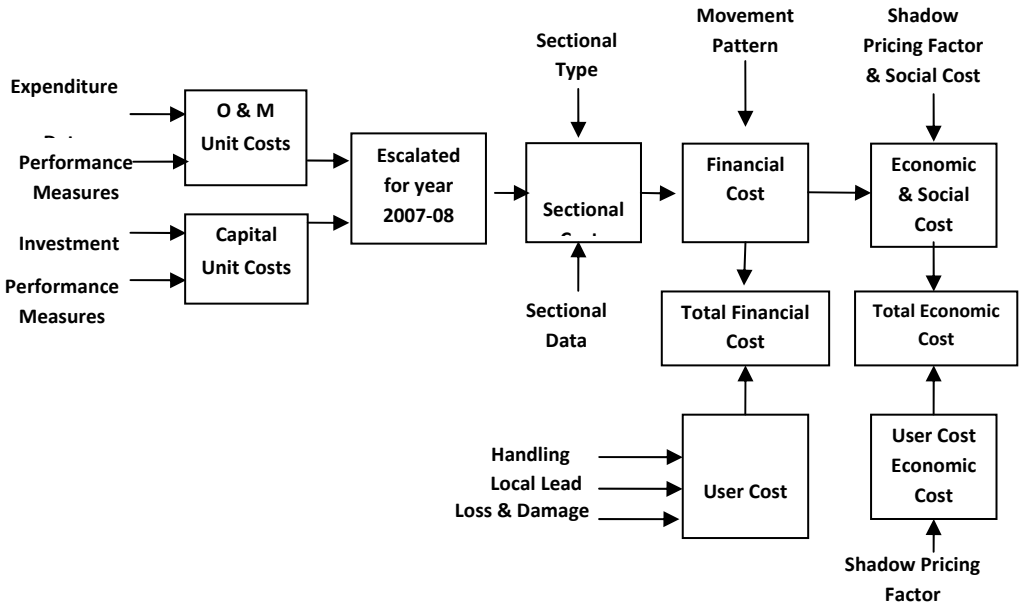
A basic scheme of various steps involved in the costing process is brought out in the flow chart given in Figure-7.

Indian Railways had an elaborate costing exercise in early 70's to develop fully distributed costs of different services. The system generated unit costs by segregating the costs into suburban, goods and coaching activities and then assigning the costs based on pre-assigned ratios. The method, while robust and well established on IR, had the following limitations in terms of its applicability applying to the current study:

* Not possible to separate the variable and fixed costs of operations
* Effects of gradients could not be segregated when dealing with costs at the sectional level

Earlier studies by RITES [1978 and 1986] estimated costs at the sectional level by collecting data from sample sections. The approach was able to relate the sectional costs to the railway operations and estimate the cost of movement for different sectional types. A major limitation of the study was the ability to collect data from representative sections. A total of 21 sections were studied in detail, 14 in Broad Gauge and 7 in Metre Gauge, to estimate the costs.

Figure 7. Flow Chart for Estimating Railway Costs



As the sample size was limited and variability on IR was very high, the assumption that costs would represent the complete section was tenous. More importantly, the sectional data was used merely to supplement the cost analysis undertaken at the divisional level.

The Approach to O & M Cost Estimation

A major problem in railway costing is to segregate joint costs incurred for moving goods and passengers. Resolution of this issue is critical to estimate unit costs of operations of any multi-product industry. To estimate these costs two methods have been popular, namely, the typical cost accountant's approach and the statistical approach. The cost accountant's approach has always depended primarily on surveys of representative situations and assigned predefined ratios to allocate the expenditure incurred for various common services. IR's then existing costing approach and that adopted by earlier RITES used this method though it is beset with many problems pointed out earlier.

The statistical approach would involve collection of data from various units and use statistical tools to assign costs to different services. This method was pioneered in the context of American railroads by Meyer, et.al., [1959]. Such a method had some inherent advantages compared to the first approach such as using all the available data to point out the variations in costs for different types of outputs. Such a method has also the advantage explicitly providing insights into the underlying relationships rather than provide any arbitrary judgement depending on a particular individual or a set of individuals. But a basic requirement for applying statistical tools to a cost approach would be the availability of data

spread a large number of sampling units. This would take care of the greater variability of the inputs and outputs (particularly the case in railways) due to the robust methodology that such an approach involves. It must be noted that Indian Railways, owing to its size, geographical diversity, and historical development has such a basis since it has 16 zones, 67 divisions and 46 workshops as administrative centres of expenditure spread over the country.

A Division is the lowest independently functioning unit where the expenditure and output (or performance factors) is recorded. Even at the divisional, there is wide variability in the expenditure pattern and outputs. The divisions vary in the quantum of expenditure and the relative proportions of the different expenditure heads depending on the outputs. However, in areas where the data was sparse or less amenable to the use of statistical methods, the survey approach was used for the study.

Sources of Data

To estimate costs, data on expenditures and outputs were required at the level of the divisions. The expenditure data were being maintained by the accounts department of the concerned division and was recorded in the Revenue Allocation Register (RAR). RAR data was normally kept at the 16 zonal headquarters but data are recorded for 162 accounting units consisting of 16 zones, 67 divisions and 46 workshops and some miscellaneous accounting units. Equally comprehensive were the details of expenditure recorded. The data on expenditure were hierarchically arranged in order of demand, minor head, subhead and detailed heads. After compilation of data for all 16 zones, it was observed that data was recorded for 2149 detailed heads. At this stage, a few comments on the data structure of RAR required to be pointed out. The RAR data recording mechanism, a process that had evolved over a large number of years, found to be very meticulous and comprehensive at the zonal level. However, the data structure for RAR was not found to be standardised / uniform across the Indian Railways. As a consequence, a lot of problems were encountered when there was need to compare data across different zones. It was found necessary to bring about some uniformity in the data structure uniform across all the zones. This was to enable comparison of costs across the zones and divisions simpler and purposeful. It was also found necessary to add more accounting units especially the diesel and electric loco sheds which were spending considerable amount of money. However, unlike the expenditure data, performance data were not being maintained at one source and it was found necessary to collect them from a number of sources.

Estimation of O & M Unit Costs:

The unit cost of transportation for various modes plays an important role in defining the importance of each mode and thus affecting the inter-modal choice of the users. Unit cost comprises both noticeable (quantifiable costs) and concealed (non-quantifiable) costs. While the quantifiable costs are worked out by using element-wise ongoing market prices, the non-quantifiable costs are estimated on normative basis, where the norms are developed not as a part of the same exercise but after going through a detailed analysis of limited data/information.

After analysing the expenditure pattern, unit costs were estimated for 7 expense categories. The expense categories and related performance units are given in Table-29.

Table 29. Expense Categories and The Performance Units

SN	ELEMENTS OF COSTS	UNIT
(1)	(2)	(3)
	Operating & Maintenance Cost:	
	Diesel Loco: R&M, POH,	Per 000’
	Fuel/Fuel Related Operating Expenses	Per 000’
1	Operating Exp. Other than Fuel	Per 000’
	Electrical Loco: R&M, POH, Over Head Equipments	Per 000’
	Fuel/Fuel Related Operating Expenses	Per 000’
	Operating Exp. Other than Fuel	Per 000’
2	Permanent Way-Track	Per 000’
3	Signal & Telecommunications.	Per Train
4	KM Cost of Other Transportation	Per 000’
5	Cost of Carrying Units: Wagons	Per Wagon
	Day Vehicles	Per Vehicle
6	Day Terminal Expenses	Per Tonne
7	Overhead Expenditure	Per Tonne

Linear regression analysis was used to estimate the link between expenditure and output. In this case, the dependent variable comprised the expenditure whereas the independent variables were the units of output.

Estimation of Unit Capital Costs

Assets are acquired and used on a continual basis and estimating the cost of capital for a particular year becomes difficult. The issue was further complicated as the methodology of the study had to adapt a uniform method for capital costs across the modes. Given the data availability in different modes of transport, it was assumed all the assets were acquired or built in 2007-08 and accordingly estimated capital costs. This was indeed a very strong assumption to make especially in the case of the railways since IR is a very old organisation and is still using assets built long time back.

The annual cost of using the capital assets is normally assessed by three different methods. First, the annual depreciation of the asset, arrived at by dividing by asset life assuming straight line method of depreciation, is assumed as the annual cost of capital. This approach de-links the financing of the capital assets from their utilisation, an issue relevant for policy perspective. In the second approach the annual deprecation is increased by adding interest to the capital. The third method uses capital recovery factor approach where interest on capital and depreciation were simultaneously considered to arrive at a fixed annual value.

As the primary objective of the study was to simulate cargo flow on the transport network it was imperative to relate the unit costs arrived to

different types of sections for movement of cargo. Both capital and operations costs firstly vary based on the number of lines in the section; hence single line and double line or multiple lines are taken as two categories. Similarly, the electric and diesel sections have different characteristics and they influence the operational and capital costs totally. Gradient of a section is a critical element in deciding capital and operations costs because speed of movement, tractive effort required and detention hours vary with the gradient. Based on this criterion, sections were divided into two categories; plain sections with gradients less steep than 1 in 100 and ghat sections with steeper gradients. The sectional costs vary due to sectional speeds, requirement of additional locomotives for movement and additional time spent for safety examination. All these factors were considered in estimating the sectional costs. Sectional speed and detention data were obtained from Freight Operating Information Systems (FOIS), train running data base for large sample of sections. The data on requirement of additional locomotives and additional train examinations was obtained from working time tables, FOIS information and discussions with the zonal operating teams. Using the above criteria average Sectional Unit Costs were estimated for Indian Railways. The unit costs are then converted to cost per tonne-km (tkm) for freight services and cost per passenger-km (pkm) in the case of coaching services by developing appropriate factors (as weights).

Costing of Commodities

The costing was out carried out for 10 representative commodity groups as given in Table-30.

Table 30. List Of Representative Commodities

1	FOOD GRAINS	6	POL
2	FRUITS & VEGETABLES	7	CEMENT
3	COAL	8	LIVESTOCKS
4	FERTILISERS	9	IRON & STEEL PRODUCTS
5	SUGAR	10	CONTAINER

Commodity wise costs were identified to be varying by three important cost influences such as percentage of distance the trains run empty after unloading or to load a cargo (referred as empty return ratio), average quantity loaded in a wagon, and average lead for the cargo. The empty return ratio for different types of wagons and average quantity loaded in a wagon was collected from the Railway Board published records. The average lead data were based on the Annual Statistical Statements. The estimated Unit Costs were than compared with actual Unit Costs. The cost variations were less than 10 per cent across the different elements thus reflecting the usefulness of the estimation procedure.

Economic and Social Costing

Taxes and subsidies are parts of any transport industry; more importantly so rail movement. To assess the economic costs taxes and subsidies of the system are corrected and shadow pricing factors worked out using the Planning Commission Project Appraisal and Monitoring Division (PAMD) guidelines. Accordingly, Unit Economics Costs were derived for the representative commodities for the Plain as well as Ghat Sections (given in Table 31 below).

Table 31. Unit Economic Costs for the 10 Commodities

Unit: Rs./TKM

SN	ELEMENTS	PLAIN SECTION				GHAT SECTION			
		DSL		ELEC		DSL		ELEC	
		SL	DL	SL	DL	SL	DL	SL	DL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	Food grains	0.63	0.59	0.53	0.52	0.98	0.91	0.80	0.74
2.	Fruits & vegetables	0.65	0.61	0.55	0.53	1.00	0.93	0.83	0.76
3.	Coal	0.68	0.64	0.57	0.55	1.04	0.96	0.85	0.78
4.	Fertilisers	0.65	0.62	0.55	0.54	1.00	0.93	0.82	0.76
5.	Sugar	0.63	0.59	0.52	0.51	0.97	0.90	0.80	0.74
6.	POL	0.74	0.70	0.62	0.60	1.15	1.06	0.94	0.86
7.	Cement	0.67	0.64	0.57	0.56	1.02	0.95	0.84	0.78
8.	Livestock	1.56	1.47	1.30	1.27	2.44	2.26	2.00	1.84
9.	Iron & Steel Products	0.69	0.65	0.57	0.55	1.08	1.00	0.88	0.80
10.	Container	0.80	0.76	0.67	0.66	1.23	1.15	1.02	0.94

Another important step involved was to assess the externalities involved in rail transport. The Inception Report mandated assessment of environmental cost and accident cost as part of the social cost. To assess the environmental cost, abatement costs worked out by Central Pollution Control Board (CPCB) to reduce carbon dioxide emissions were considered. The cost of abatement of greenhouse gases worked out to Rs 0.05/tkm for diesel traction and Rs 0.01/tkm for electric traction. The accident cost assessed by Asian Institute of Transport Development (AITD) were adopted for the study and updated to 2007-08. Accident cost works out to Rs 0.001/tkm. Total resource cost for transport by rail was obtained by adding the economic costs and the social costs.

Modal Costs for Highways

In the case of Highways (road transport), unit operating costs of carrying goods and/or passengers can be divided in two categories - vehicle operating costs and the user costs. While the vehicle operating costs are directly borne by the service providers or the vehicle owners, the user costs are incurred by the users of the service before the actual start of the modal transportation as well as after the completion of the transport service and are thus in addition to the vehicle operating costs. The later element of cost relates mainly to packaging, handling, local cartage, inventory, etc., in the case of goods transport sector. For passenger transport it related to the distance travelled by the passenger from his actual place of start (stay) to the bus terminal at origin and similar leg of journey at destination to reach his final destination.

The requisite cost structure was developed by collecting item-wise cost incurred by various agencies in financial terms. All the costs have been collected for the base year 2007-08 and used along with goods and passenger flows data estimated which were based on detailed surveys. Financial costs for different components were converted into economic terms by adopting relevant norms prescribed by the Planning Commission, Govt. of India. The cost structure

for highways was examined in terms of three elements, namely, Vehicle Operating Costs (VOC), highway costs and user costs. Financial costs were converted into economic costs, using shadow price factors mentioned earlier.

In spite of the fact that both goods and passenger transport use similar type of vehicles and perform on the same infrastructure, their operations are not similar. Moreover, in the goods sector where private operators play a significant role, public sector is more effective in the passenger transport sector, because of various reasons. In the light of this, while estimating vehicle operating cost norms, goods and passenger sectors are considered independently.

Vehicle Operating Costs

Vehicle operating costs have been estimated to reflect the entire spectrum of costs borne by the vehicle owners/operators as service providers. Since these costs vary under different operating conditions such as terrain, highway quality, commodity handled, etc., an attempt has been made to distinguish costs structure to reflect all these operating conditions. Further, with a view to ascertain cost discrimination arising on account of varying vehicle operating conditions, both due to ownership as well as operating conditions in different parts of the country, the sample frame for collecting information has been drawn from all over India.

In order to estimate the relative vehicle operating costs under different operating conditions the requisite information has been collected by canvassing specially designed questionnaires. Keeping in view the predominance of single-truck owners/operators in goods transport sector and the method of their maintaining records/information on vehicle performance and cost particulars, separate questionnaires have been used for single-truck operators and multi-vehicle operators. While for the multi-vehicle operators, the information has been culled out from their records, for the single-vehicle operators personal interview method was adopted for collection of the required information from the crew. Reverse holds good in the case of passenger transport sector, where main emphasis was given to collect information from the State Road Transport Undertakings.

In view of the fact that details of certain goods vehicle operating costs as well as operating behaviour can be elicited more accurately from the vehicle crew, the required information was collected by canvassing a specially designed questionnaire on 'Vehicle Performance and Cost Behaviour' survey along with the goods O-D survey conducted at more than 1000 check-posts all over the country. On the other hand, for the more organised passenger transport operations, similar information could be collected on the basis of sample interviews with the crew working on various routes.

Since the load-ability of trucks varies from commodity to commodity, in order to assess the actual load of different commodities carried by various types of vehicles on different routes, at all-India level, Weigh-bridge surveys were conducted at selected locations. Requisite information on trip particulars, commodity particulars, weight of empty vehicle (un-laden weight of the vehicle) and the gross weight of the vehicle including the weight of commodity, has been collected just at the start or at the end of a trip, at the existing private weigh-bridges. The process involved recording of two weigh-ments in each case. For the terminating trips, particulars of vehicle (vehicle registration No., ULW, RLW,

carrying capacity, etc.), trip particulars (origin-destination), commodity carried, gross weight the vehicle were recorded and the weight of the un-laden vehicle was recorded after the vehicle was emptied at the final destination. On the other hand, for originating trips, all information other than the Gross Vehicle Weight (GVW) was recorded when the empty vehicle is weighed before start of the trip. This information was used to determine the extent of overloading on various road section characteristics.

With a view to correlate the data collected through the goods origin-destination surveys with the road network and vehicle characteristics, operating costs have been estimated under different scenarios. In order to accommodate highway characteristics in the cost estimates, separate costs have been estimated to represent terrain (Plain, Hilly/Rolling), highway type (NH, SH, MDR/ODR) and road width (Single-lane, Double-lane, Four-lane and above 4-lane). Similarly, keeping in view the carrying capacity of different types of goods vehicles separate costs have been estimated to represent tempos (Light & Medium Commercial Vehicles), trucks (Heavy Commercial Vehicles - 2 axle), trucks (Heavy Commercial Vehicles - 3 axle) and multi-axle trailers (Heavy Commercial Vehicles - 4 axle and above).

Highways Cost (Road)

The whole road network of the country is under the direct control of government agencies. The road network is categorised as National Highways (NH) including Border Roads, State Highways (SH), Major District Roads (MDRs), Other District Roads (ODRs), Village Roads (VRs) or Projects Roads.

Highway cost are borne directly by the appropriate level of government. Since it was not feasible to develop historic Highway systems cost, a new set of costs were estimated based on the then current market price (base year costs). Relevant information was collected through various Highway Projects/studies undertaken by RITES Ltd on behalf of National Highway Authority of India (NHAI) and other government agencies in the past decade before the study. In addition, to account for annual repair & maintenance of road sections, the requisite information was collected from the concerned government site offices.

In order to estimate base year costs of each type of road section, item wise quantities of work and the related costs were worked out. Since in majority of the cases the land had already been available with the government for construction of new road section or up-gradation of the existing section, land cost was considered as sunk. The entire set of activities towards construction of a new road link was classified under the following sub-heads:

* Site clearance
* Earthworks
* Sub-Base and Base Courses
* Bituminous Courses
* Cross Drainage Works (Culverts)
* New Bridges, Underpasses, Grade Separators and
* Drainage and Protective works
* Miscellaneous

Efforts were made to select road sections spread all over the country to develop homogeneous cost norms. Based on the estimated quantities of work under each item, total input costs were estimated by using the then 2007-08 price structure applicable to that particular region. To arrive at the total capital cost of the road section

under study, Environmental Cost, Resettlement and Rehabilitation Cost, Relocation of Utilities Cost, etc., wherever applicable, were also considered in addition to expenditure towards other contingencies, construction supervision, etc. Item-wise financial costs were converted into economic terms by using appropriate conversion factors developed on the basis of detailed studies of limited sample road sections, as the highway costs are relevant only for economic costing. Similarly, to arrive at the total highway cost, data on annual repair & maintenance of selected road sections were collected from the concerned agencies.

The annual capital cost of the respective road sections, keeping in view the life of 100 years (relevant for bridges & culverts), was worked out using cost recovery factor by deploying an economic discount rate of 8% per annum. Total annual costs (capital and repair & maintenance) converted to daily units. Since different sections have different designed capacity (PCUs/Day, as per IRC Norms), and the utilisation, corresponding total costs were assigned to arrive at cost per PCU. Since goods vehicle-mix comprised vehicles with different PCU equivalents and loads carried, weighted averages were estimated and used at the national level to appropriately apportion the cost to arrive at per tonne-kilometre highway cost.

The comparative impact of highway cost is the highest under low traffic road sections as observed in the case of hilly sections that involves comparatively higher capital cost for construction, higher annual R&M and has a lower capacity *vis-à-vis* plain or rolling sections. To take account of highways costs applicable for passenger transport, cost per PCU arrived were used to work out cost per passenger on different distance slabs.

User Costs (Passengers)

Users cost in the case of passengers relates to the cost of local movement of passenger from place of stay at origin to place of final destination. Using the methodology adopted to estimate bus operating costs, vehicle operating costs of various modes of local transport have been estimated. Based on the data collected at select Metro cities and Mofussil towns on various modes used and the average distance travelled, appropriate costs to represent Metro city and Mofussil towns have been worked out. Depending on the passenger movement between various combinations, the relevant costs have been worked out. Total passenger transport costs estimated for various combinations are given in Table-32.

User Cost (Goods)

For moving cargo between any two points, the total costs would include the costs incurred by a mode operator (like rail, road and coastal shipping) and the costs incurred by a consignor or consignee so as to be able to use a mode of transport. The economic and financial costs incurred by each mode of transport were described earlier. However, a user (consignor or consignee) incurs additional costs to move cargo by different modes of transport.

To be able to move cargo by a mode of transport the cargo needs to be packed, loaded or unloaded, and moved from originating point to the nearest point where the mode is available or vice versa. However, different modes of transport call for different levels of expenses for each of the elements. Table 33 shows the user elements involved for each mode of transport.

Table 32. Passenger Movement Cost - Highways

MOVEMENT TYPE	TRIP LENGTH (KM) (RS. /PASSENGER)											
	100	150	200	250	300	350	400	450	500	550	600	650
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
FINANCIAL												
Metro City to Metro City	64.00	83.93	103.87	123.81	143.75	163.69	183.63	203.57	223.51	243.45	263.39	283.33
Metro City to Mofussil Town	57.99	78.34	98.69	119.04	139.40	159.75	180.10	200.46	220.81	241.16	261.52	281.87
Mofussil Town to Mofussil Town	60.03	84.83	109.62	134.42	159.21	184.01	208.80	233.60	258.40	283.19	307.99	332.78
ECONOMIC												
Metro City to Metro City	55.46	71.89	88.31	104.74	121.17	137.60	154.03	170.46	186.88	203.31	219.74	236.17
Metro City to Mofussil Town	50.24	67.15	84.06	100.97	117.87	134.78	151.69	168.59	185.50	202.41	219.32	236.22
Mofussil Town to Mofussil Town	51.79	72.55	93.32	114.08	134.85	155.62	176.38	197.15	217.91	238.68	259.44	280.21

Table 33. User Cost Elements Involved for Rail and Highway Mode of Transport

SN	ELEMENT	RAIL	ROAD
(1)	(2)	(3)	(4)
1	Packing	yes	yes
2	Handling	yes	yes
3	Local Transport	yes	
4	Transit Loss	yes	yes
5	Siding Charges	yes	
6	Inventory Holding Cost	yes	yes

While costs relating to Packing (excluding Coal, POL, Iron & Steel and Livestock which need no packing), handling and transit inventory are relevant to transport of goods by Railways, Coastal Shipping and Highways, and local transport which is relevant generally in the case of Railways and Coastal Shipping. The siding cost is relevant for rail transport and Coastal Shipping only and that too for specific commodities, viz., Cement, Fertiliser, Coal, Steel, POL, Wheat and Sugar. Incidentals, i.e., cost of transmittal of freight receipt is relevant mainly in the case of Railways and Coastal Shipping, as in the case of Highways, the freight receipts in most cases are sent through truck drivers. Octroi was taken into consideration in terms of financial costing only for each of the modes.

Data Sources for User Costs

For collection of requisite user cost data, a commodity related sample frame of consignors and consignees was drawn up and a comprehensive schedule/questionnaire was designed for the purpose. In collecting the data, both approaches,

i.e., mailing the schedules to sample consignor/consignee firms and personal canvassing by the RITES study team were adopted. Though, in some cases, particularly for sugar the mailed schedules did bring in response, in most other cases data had to be collected through personal interviews with the concerned parties. The major difficulties faced during the field surveys were (i) reluctance of the respondents, mainly private agencies, to part with the data and (ii) the differentials between the manner of data maintenance by the firms and the manner in which the data were demanded by project requirements. The approach adopted to overcome these constraints envisaged using the good offices of the associated Government Departments, Trade Associations and persistent interaction with individual parties. Government organisations helped a lot to acquire reasonable level of sample data.

Social Cost

Though social costs are multi-dimensional in nature, the study was confined to two significant components, namely, environment and accident costs.

Environment Cost

The transport sector is dependent on petroleum fuel which contributes significantly to greenhouse gases emissions leading to air pollution and contributing to phenomenon of Global Warming. In view of the hazardous effects of environment pollution and gaseous emissions which vary significantly under different modes, assessment of social cost plays an important role.

Assessment of Environment Cost was based on the study, "Estimating Cost of Air Pollution Abatement for Road Transport in India: Case Studies of Andhra Pradesh and Himachal Pradesh" conducted by Institute of Economic Growth in 2005. In this study cost to the environment was arrived on the abatement approach. Under this approach the cost for abatement which is treated as synonymous to the environment cost for different type of road vehicles comprised:

- Cost of upgrading the vehicular technology to make it compatible with Euro III standards
- Cost of improving the fuel quality

This study in turn had based its emission level by different modes on the data collected by Central Pollution Control Board (CPCB), the nodal agency for monitoring the pollution levels across the country. CPCB operates a nation-wide programme of monitoring ambient air quality known as National Air Quality Monitoring Programme (NAQMP). Under this programme four air pollutants viz., Sulphur Dioxide (SO2), Oxides of Nitrogen as NO2, Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM / PM10) have been identified for regular monitoring at various locations. Based on the above, emissions of various pollutants due to the movement of freight traffic through roads were arrived at.

The cost of improvement of fuel quality was taken from the Report of Expert Committee on Auto Fuel Policy popularly known as Mashelkar Committee, [GOI, 2002] which provided estimates of incremental costs for production of improved fuel quality of petrol and diesel compatible with Euro norms. Incremental cost of production of one litre diesel for BIS -2000 standards to BIS III as received from various refineries varied from Rs 0.25 to Rs. 3.35. Hence

an average incremental cost of improvement of fuel was taken as Rs 1.80. Annualised incremental cost of up-gradation of vehicular technology for conversion of same standards was taken from GOI [2002] as Rs 17212.50. On the basis of above, the environment cost per tonne-km for road freight sector was arrived at the cost for rail and coastal sector was arrived at in proportion to fuel consumption under these sectors.

Accident Cost Safety has always been an important consideration in transport sector. An accident leads to fatalities, injuries to people and damage to property resulting in economic loss to society. Accident cost varies significantly amongst different modes of transport and plays a significant role in modal choice. Therefore, a proper assessment of this component of this social cost is of great significance. The accident costs under different modes were based on the study conducted by Asian Institute of Transport Development in 2002 namely "Environmental and Social Sustainability of Transport - Comparative Study of Rail and Road" [AITD, 2002]. Given that different approaches are available for monetary evaluation of accidents, it was decided to use the Gross Output Approach as was estimated and adopted by AITD [2002]. The accident cost based on the above estimation and further inflated to 2007-08 price level worked out to:
Road - Rs. 0.062 / tkm and Rail - Rs. 0.001 / tkm

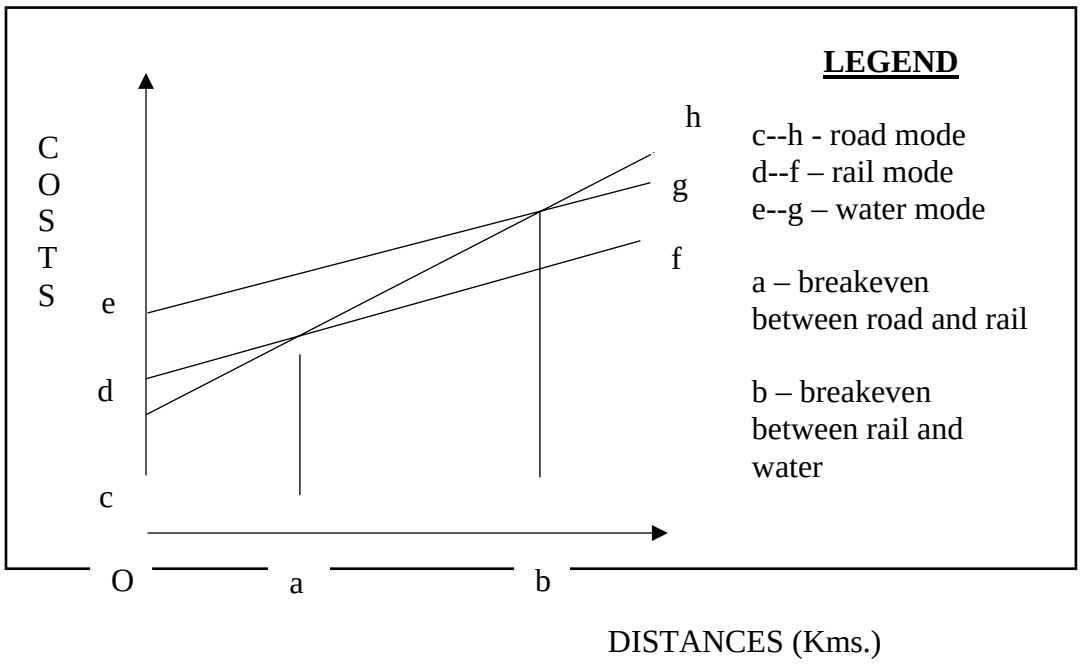
Break Even Analysis

The preceding paragraphs related to a description of the various components of modal transport costs (operator & user cost) and the procedure adopted for their estimation. The resultant modal transport cost estimates in respect of freight and passenger movement by Railways, Highways were also discussed. As mentioned earlier, we now make an attempt to identify the Break-Even Distances between rail and road transport, the two major modes, based on their comparative cost of transport. The objective behind the exercise is to identify commodity specific operational region of cost advantage of either mode for the purpose of optimal distribution of traffic amongst them. The exercise confined to 11 important commodity groups, viz., food grains, fruits & vegetables, coal and other minerals, fertilisers, sugar, POL products, cement, livestock, iron & steel, containers and miscellaneous or other commodities. Also, taking into consideration the relevance for planning at national level, economic/resource costs have been adopted for the purpose of determining the Break-Even Distances.

Concept of Break-even Distance or Point

Essentially, Break-Even Distance (BED) or Break-Even Point (BEP) represents the cut-off point between distances at which a mode has a comparative advantage sport costs (total of operator & user costs) in regard to movement of a particular commodity. In other words, this point refers to the limit up to which movement of a commodity by a mode is more cost effective and beyond which the cost advantage shifts to the other mode, thus, defining the optimal area of operation for the movement of a commodity by a particular mode which, in turn, forms the basis for optimal allocation of traffic amongst modes. See Figure below

Figure 8: Break-even Points of different Modes



Break-Even Distance depends on the relative ratios of fixed and variable costs of two different. The determination of such distances necessarily involves the estimation of the ratio of fixed and variable costs. Accordingly, elements that form the basis for estimation of variable and fixed costs become critical for this analysis. Variable costs in terms of per tonne kilometre costs include modal operator costs and, in the case of user cost, the transit inventory cost which varies with transit time, local cartage cost which varies with vehicle lead and is relevant in the case of transport by rail and handling costs which are (in general) comparatively high in case of rail transport.

Estimates of Break-Even Distances

Modal costs of rail and road vary with sectional type and in addition road modal costs also vary with length of haul. To capture the heterogeneity of the sectional characteristics, and the cost variations thereof, the first step was to assess the various sections used in moving different types of commodities by different modes of transport. The user cost for each mode was estimated through sample surveys, the details are explained in user cost section of the earlier chapter. The user cost and weighted average of modal costs were used to calculate the individual Break-Even Distances which are given in Table-34. While assessing them for Other Commodities, cost of container transport was considered as these commodities have high propensity for containerisation.

TABLE 34. BREAK-EVEN DISTANCES

SN	COMMODITY	BREAK-EVEN DISTANCE (KM)
(1)	(2)	(3)
1.	FOOD GRAINS	222
2.	FRUITS & VEGETABLES	313
3.	COAL & OTHER MINERALS	188
4.	FERTILISERS	167
5.	SUGAR	372
6.	POL PRODUCTS	126
7.	CEMENT	160
8.	LIVESTOCK	162
9.	IRON & STEEL	173
10.	CONTAINERS	307
11.	OTHERS	307

The above table shows that the highest Break-Even Distance is in the case of sugar followed by fruits & vegetables, containers, etc. Similarly, the lowest Break-Even Distance is observed in the case of POL products. As expected, Break-Even Distances clearly show the impact of terminal costs for each commodity. Break-Even Distance in the case of sugar, since there are hardly any sugar sidings inside the sugar factories as well as sugar is required to be stored outside the station limits/Railway sidings, the overall terminal costs are much higher in the case of Railways, thereby making the commodity dearer to Highways. Same remarks hold good for fruits and vegetables. In the case of containers, the commodity suffers on account of heavy handling charges at either end. POL products fall at the other end of the spectrum, because of low terminal charges, as it does not require packaging costs, handling costs and local cartage.

It may, however, be noted that Break-Even Distances are sensitive to changes in modal costs, user costs and social costs. All these costs in turn depend on inherent assumptions germane to estimation process. Thus, it is normally useful to treat Break-Even as a distance range than as a fixed point. It may be pertinent to mention that break-even distances assessed above are based on resource costs and would vary from the lead distances observed in the market as the market phenomena are based on actual freight rates charged.

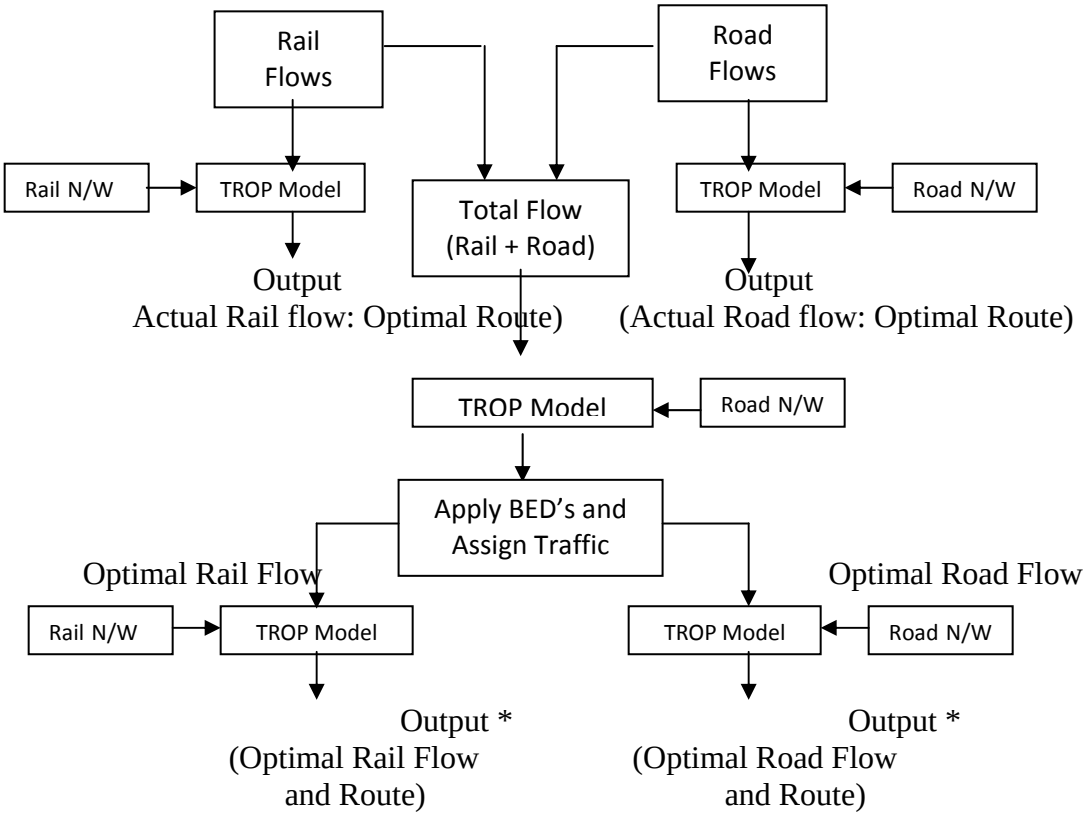
Optimal Analysis and Flows

The optimisation module of the study integrated the cost and flow data on the transport network of the country. The model was built with two objectives, first one was to model the current flows as they were moving in the base year and the second was to examine how the modes respond after the traffic is assigned to rail and road by applying break-evens. To develop optimal models two methods were followed. In the first case, the problem was addressed as a simultaneous allocation and rout e-mode mix problem. In this scenario the total demand (or supply) from a region is the difference of supply and demand of the region. Thus, if a region has more supply than demand it becomes a net supplier, and if a region has more demand than supply it becomes a net consumer. The model was named as the Transport Allocation and Route-mode mix Optimisation (TAROP) model. But it was found after some exercises that the TAROP model underestimated the total transport demand. To overcome this problem, another approach was used to model the flows as they were noticed in the base year. In this approach, every flow was modelled as it is without netting it at the regional level. This model was found to capture reasonably well the empirically observed flows. Given the flows of commodities for O-D pairs, this Model calculated the least cost route mix for transporting those commodities for each O-D pair. The model was named Transport Route-mode mix Optimisation (TROP) model.

Flows based on Break even distances for Rail and Road Cargo Movement

The model was used to analyse the interaction between costs, flows and the network. The plan of analysis is presented in the flow chart attached (see Figure below). The modal was used to size up the actual system performance by running rail flows through rail network and road flows through road network. Further analysis was undertaken by combining the rail and road flows and running the model with road network. On the outputs so obtained the Break-Even Distances were applied to segregate rail and road flows.

Figure 9. Analysis Plan Based on Break Even Distances



* Model Output gives TKMs, System Cost and Section Loadings.

The O-D pairs with cargo flows more than the Break-Even Distances were assigned to rail flow and those less than the Break-Even Distances were assigned to road.

Results

Table 35 compares the change in transport system parameters in actual conditions and after assigning the Break-Evens. Results shown for Railways and Highways (total is more due to this).

The Table indicates that total throughput increased by 44.3 (around 3 %) million tonne-kilometres while cost decreased by Rs. 38, 470 crores (around 16 %). The throughput increased slightly as rail distances are usually longer compared to road distances for a large number of O-D pairs. The cost reduction under optimal assignment of traffic is substantial. Though some of the assignments may not have met ideal conditions assumed under Break-Even Distance calculations, the analysis revealed that there was scope for readjustment of traffic on the network.

Table 35. System Overview: Actual & Optimal

MODE	ACTUAL			OPTIMAL		
	FLOW (Million Tonne)	COST (Billion Rs)	TKMs (Billon Tkms)	FLOW (Million Tonne)	COST (Billion Rs)	TKMs (Billon Tkms)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Railways	736.2	497.3	498.6	1,704.18	1,423.4	1,168.7
Highways	1,558.9	1,555.6	692.3	590.86	244.8	66.5
TOTAL	2,354.8	2,086.9	1,280.9	2,354.8	1,702.2	1,325.2

Table 36 compares the rail and road actual flows with flows in optimal conditions. From the Table it is seen that a total of 1000 million tonnes (45 % of the total flows) are assigned from road to rail. The highest quantity was in Other & Misc. commodities, accounting for 50 per cent of the quantity undergoing modal shift. This was also the cargo which is amenable for containerisation.

Table 36. Commodity Wise Actual and Optimal Flows

SN	COMMODITY	ACTUAL		OPTIMAL	
		RAIL	ROAD	RAIL	ROAD
(1)	(2)	(3)	(4)	(5)	(6)
1.	COAL	451.50	223.07	480.86	193.70
2.	CEMENT	78.80	75.98	128.68	26.13
3.	FOOD GRAIN	38.50	149.14	122.54	65.11
4.	OTHER & MISC.	37.60	629.45	554.70	112.35
5.	FERTILISERS	36.40	18.19	44.88	9.69
6.	POL PRODUCTS	36.20	153.40	149.60	40.02
7.	IRON & STEEL	27.83	141.22	127.16	41.89
8.	CONATINERS	20.87	56.60	35.69	41.78
9.	SUGAR	5.98	18.86	13.19	11.64
10.	FRUITS & VEG.	1.89	69.93	39.55	32.26
11.	LIVESTOCK	0.12	8.10	4.94	3.27
	TOTAL	735.73	1543.94	1701.81	577.85

Gap between Actual & Optimal Modal Mix

A comparative assessment of the impact arising out of the two different scenarios of modal mix, i.e., Actual and Optimal (applying Break-Even Distances based on resource cost) on the transport system during the base year (2007-08) in terms of flows, cost and throughput is presented in the Table below.

Table 37. Actual Versus Optimal Modal Mix

MODE	IMPACT OF ACTUAL MODAL MIX			IMPACT OF OPTIMAL MODAL MIX		
	FLOW Mt	COST Billion Rs	THROUGHPUT Tonne kilometres	FLOW Mt	COST Billion Rs	THROUGHPUT Tonne kilometres
(1)	(2)	(3)	(4)	(5)	(6)	(7)
RAIL	736.2	497.3	498.6	1704.18	1423.4	1168.7
ROAD	1558.9	1555.6	692.3	590.86	244.8	66.7
COASTAL	59.7	34.0	90.0	59.72	34.0	90.0
TOTAL	2345.8	2086.9	1280.9	2354.8	1702.2	1325.2

Source: RITES, [2009].

The above assessment indicates that total throughput increased by 44.3 (around 3%) million tonne kilometres while cost decreased by Rs. 2086.9 - Rs. 1702.2 = Rs. 384.70 Billion (Rs. 38,470 crores), which constitutes about 16% of the total cost incurred on transportation during the year. From the above it is seen that, actual modal mix of transportation obtaining at present is not optimal, the loss of market share of IR has led to a social loss of Rs. 38,470 crores to the Indian economy in the year 2008 which, by now, could have doubled to about Rs. 70000 Cr. RITES [2009b] in their conclusions on the optimal modal split analysis said "that analysis of break-even distances and optimal flows in the study brought out a visible criticality of 'User Cost' (particularly the handling cost) in establishing the cost effectiveness of a mode to the user. Further, in consideration of the fast growing concern for environment, social Cost has emerged as a vital factor in ascertaining the resource cost of transportation by a mode". Further, it was held that "The modal shift exercise carried out in the study has indicated that there is a significant scope for modal switch from road to rail in the case of Miscellaneous/Other Commodities up to the extent of 78%. Incidentally, the total quantity of potential traffic for switch (520 million tonnes) in this commodity group constitutes almost 50% of the total palpable quantity of modal shift from road to rail (1063 million tonnes). Other commodities in which there is strong potential for modal switch are Iron & Steel (61%), POL (61%), Fruits & Vegetables (52.5%) and Cement (35.6%)" p. 33 [RITES, 2009]. The implications of a greater share of the market share for the railways would be the huge savings in foreign exchange which could benefit the balance of payment situation and also help in benefitting the environment due to a significant decrease in the share of the highways in freight road transport.

From the above 5 case studies, three at the micro level and two at the macro level, relating to the benefits that can be derived from safety

related investments on IR, it is obvious that underlying the whole process of operations and maintenance on any railway system, is the requirement of provision of facilities for safety of operations. To ensure this, in a complicated system like a railway network, there needs to be a comprehensive mechanism to deal with the basic provision for safety, its upkeep and up gradation from time to time to take care of emerging requirements.

SECTION 6
SAFETY FRAMEWORK ON IR

The safety of trains is the end product of a seamless interaction of a number of elements, including railway staff, track, rolling stock, signals, electrical equipment, vendors, passengers and other users etc. Any human error, equipment failure, rash action by a user, etc., occurring alone or in different combinations may cause a train accident. Safety is, thus, the sum total of the efforts of men, materials, machine, money, methods, rules, procedure and management. A rigid discipline on the part of various departments of railways is an essential ingredient of safety. Each department, responsible for individual activities on railways, has laid down safety rules and procedures in the form of Manuals and procedure orders which have to be followed rigidly. And any analysis in regard to safety on railways is a process comprising problem identification, risk estimation, valuation of safety and economic analysis, and that involves several techniques .

6.1 Present Safety Framework on IR:

a. The following are the features of the present safety framework on IR:

* Railway Board (which is Ministry of Railways also) plays the role of Safety Regulator drawing statutory power and authority of President of India through Ministry of Railways.
* 16 Zonal railways including 67 divisions working under them, the Metro Railway Calcutta as also Konkan Railway Corporation work under the supervision of Railway Board in accordance with the Codes Manuals and Procedure orders issued by the Railway Board.
* The Railway Board and the subordinate's units working under the same mentioned in item-2 above function within the legal framework as per the stipulations of Indian Railway Act, 1989.

Indian Railway Act, 1989 [GOI, 1989] -Safety related Stipulations.

The following are extracts from relevant chapters of the Indian Railway Act 1989 relating to safety on IR:

(i) CHAPTER III - COMMISSIONERS OF RAILWAY SAFETY

Section 6: Duties of Commissioners of Railway Safety will be as under:

(a) Inspect any railway with a view to determine whether it is fit to be opened for the public carriage of passengers;

(b) Make such periodical or other inspections of any railway or of any rolling stock used thereon as the Central Government may direct;

(c) Make an inquiry under this Act into the cause of any accident on a railway; and

Section 7: Powers of Commissioners:

(a) Enter upon and inspect any railway or any rolling stock used thereon;

(b) May require the attendance before him of any railway servant and to require answers or returns to such inquiries as he thinks fit to make from such railway servant or from the railway administration; and

(c) Require the production of any book, document or material object belonging to or in the possession or control of any railway administration which appears to him to be necessary to inspect.

Section 8: Commissioner to be public servant.

Commissioner to be public servant. -The Commissioner shall be deemed to be a public servant within the meaning of section 21 of the Indian Penal Code (45 of 1860).

ii) CHAPTER V - OPENING OF RAILWAYS

Section 21: Sanction of the Central Government to the opening of railway.

Sanction of the Central Government to the opening of railway. No railway shall be opened for the public carriage of passengers until the Central Government has, by order, sanctioned the opening thereof for that purpose.

Formalities to be complied with before giving sanction to the opening of a railway. Formalities to be complied with before giving sanction to the opening of a railway. -

(1) The Central Government shall, before giving its sanction to the opening of a railway under section 21, obtain a report from the Commissioner that he has made a careful inspection of the railway.

iii) CHAPTER XII - ACCIDENTS

Section 113:

(a) any accident attended with loss of any human life, or with grievous hurt, as defined in the Indian Penal Code (45 of 1860), or with such serious injury to property as may be prescribed; or

(b) Any collision between trains of which one is a train carrying passengers; or

(c) The derailment of any train carrying passengers, or of any part of such train; or

(d) Any accident of a description usually attended with loss of human life or with such grievous hurt as aforesaid or with serious injury to property.

Section 114: Inquiry by Commissioner.

For the purpose of independence of the Chief Commissioner and other Commissioners of Railway Safety, they have been administratively placed under the Ministry of Civil Aviation.

6.2 Safety Architecture on IR- A critical review

A close look at Indian Railways apparent systematic approach to safety has revealed that within the railways system everybody was supposed to look after safety, but in reality, it got translated to safety of the railway system as a whole being no one's baby. Theoretically speaking, safety is supposed to be the common factor embedded in all the activities of railway production, maintenance and operations and is supposed to be a running theme in all modernisation and technological upgradation. Apart from the safety set up at the Railway Board, both at Zonal and Divisional level railways are armed with safety organisation, but, in reality, the safety organisation at the Zonal and Divisional Railway

levels are at best a co-coordinating service department mainly involved with safety audit functions.

Thus, while safety in Indian railways should have been the end product of a cohesive fusion of concerted working of track, rolling stock, signalling, electrical equipment departments along with operational and maintenance excellence, adherence to standards and other protocols, discipline, rules and procedures and coordinated functioning of various wings of the staff and officials, but in reality, it has turned out to be some disjointed efforts which are not necessarily in the best interest of safety of railway users. For example, consider the office of the Commissioners of Railway Safety. The institution of the Commissioner Railway Safety was set up to be independent of the Indian Railways as it works under the overarching umbrella of Ministry of Civil Aviation. The responsibilities, duties, functions and powers of Commissioner of Railway Safety are laid down in Chapter 3 under Sections 5-10 and Sections 114-118 of the Railways Act, 1989. A careful perusal of these sections of Railways Act indicates that the role of Commissioner of Railway Safety is limited to specifically three areas - inspection and certificate on new works if the new lines are to be opened for public carriage of passengers, certification of new rolling stock and enquiry into railway accidents. Therefore, its autonomy from Indian Railway administration is rather elusive. The Railway Board can still over-ride them and, in fact, do over-ride the Commissioners of Railway Safety many a time.

It has been widely recognised that the Railway Board has always performed a three in one role - that of a Policy Framer, an Operator and a Regulator. Numerous past Committees on the working of Indian Railways had considered this as an untenable proposition in the long run. In such a situation where the Railway Board has all-in-one authority, there has often resulted in an approach in which operational compulsions supersede safety. Further, the silo-based approach of departmental working resulted in working at cross purposes. It was ironical that the Railway Board had both the executive responsibility as well as the regulatory authority to enforce and control safety on the Indian Railway system.

Discussions with personnel of various departments of some of the zonal railways at the grass root level brought out that there is no 'Safety Manual' or 'Safety Management System' on IR at present, though there is an Accident Manual (prepared at the Zonal Railway level), to regulate accidents related matters, wherein detailed procedures are laid down to handle accidents and their follow up action. The presence of an Accident Manual without having a Safety Manual or a Safety Management System on IR presents an anomalous situation. There are different departments to deal with different subjects on IR like Civil Engg, Mech. Engg, Operating Commercial, Personnel, etc. No separate Safety Department exists to take care of the subject of safety independently. This was pointed out by GOI [1968] that went into the details regarding safety issues on IR. As a follow-up of the recommendations of the same, IR setup an independent multi-disciplinary safety department, but only around 2005. However, to regulate and guide the working of this department, no separate Safety Manual or Safety Management System was brought out, as is the case with all other departments on IR.

It may be recalled that GOI [2012a] had made some scathing comments on the way IR had gone about implementation of safety measures suggested by earlier committees. It held that the

Indian Railways severely suffers from 'implementation bug' with the most serious deficiency in safety matters being the inordinate delays and insufficiency of funds. To help bringing about more focus on safety issues, it recommended the formation of an empowered group of officers (including an officer from finance) in the Railway Board to pilot the implementation of safety enhancement recommendations and projects as accepted by the Ministry of Railways in a time bound manner with full funding and also recommended the formation of a 'Railway Safety Authority' as a statutory institution independent of Indian Railways, on the lines of similar institutions in other advanced countries, and wanted this authority to review the implementation of accepted recommendations of safety committees, from time to time for the next three to five years.

The Standing Committee on Indian Railways [Lok Sabha Secretariat 2016] note "that the Indian Railways is entrusted with the immense task of providing transportation facilities to the passengers and the freight alike while undertaking utmost care to ensure that the operations are safe and secure. They further observe that adherence to safety, an ongoing and a continuous process, is a multi-disciplinary effort in the Indian Railways. Presently, each department defines its own safety parameters for assets installed/used and monitors/maintains the parameters in the safety limits which are codified manuals, i.e. General and Subsidiary Rules and are maintained as per laid down protocol. Each department lays emphasis and keeps the concern of their own department a priority without realising that the needs could be more significant on other sides. The Committee, however, have their reservations on the existing system in IR of providing safety in the backdrop of inter department differences or even intra-department prioritisation on safety issues. They are of the view that safety being a non-negotiable subject should be dealt with in a prompt, precise and diligent manner and preferably by a separate department as inter disciplinary methods of dealing with this aspect at micro level only serves to reduce its efficiency, resulting in delayed response and compromises on safety. The Committee, therefore, recommend that the current structure of Railway Board as well at the Zonal and Divisional levels should be reviewed and the safety infrastructure of the Indian Railways should be recast to the extent that it includes at least a separate or a full-fledged Department solely entrusted with providing safety and security across its area of jurisdiction. The Ministry with their presently ongoing organisational restructuring, should seriously consider appointment of a full-fledged Member (Safety) within the Railway Board in order to provide dedicated focus to the railway safety operations. This will help and ensure synchronise micro level safety measures into a holistic and macro level safe Railway operations. They agree with the proposal of the Ministry that there will be in-house operational changes such as the Safety Directorate will now be involved in proactive auditing operations, instead of being the passive data analyst as of now. They, however, desire that this proposal should be finalised at the earliest so that necessary correctives can be taken up immediately) (Pp. 62-63).

Taking such an idea forward with a view to bringing about a paradigm change that would be consistent with the Vision 2020 of Indian Railways [GOI, 2010], which recommended the setting up of a Railway Safety Authority as a statutory body independent of Indian Railway under the government through, suitable amendments to the Railways Act, 1989.

The feeling that the emphasis on safety will hamper operations of IR needs to go and it has to be realised that safe working is definitely more orderly, efficient as well as more productive. Perhaps time has now come for taking quick action in this regard. We provide an outline of a system management system and propose a railway safety authority to regulate all aspects of safety below. Before that, we provide some salient points of such systems in advanced countries based on a brief review.

6.3 Salient points other systems

A review of the safety framework available globally in other advanced railway systems revealed that the trend is to statutorily ensure that, safety is accorded highest priority. Some of the more important legislations / guidelines in this arena, which have been enacted /issued during last one decade or so, are enumerated hereunder:

* United States of America, Rail Safety Improvement Act of 2008
* Queensland Australia, Transport (Rail) Safety Act of 2010 and Transport Rail Safety Regulations [2010]
* United Kingdom (UK), Railways and Transport Safety Act, 2003
* European Commission Rail Safety Directive No. 2004/49/EC for member countries dt. 29th April, 2004
* Ireland Rail Safety Act, 2005 in pursuance of European Commission Rail Safety Directives
* Australia, Transport Safety Investigation Act [2003] to provide for investigation of transport accidents and other matters affecting transport safety and related purposes.

Central to the recent efforts in these countries has been a system-based approach of having safety plans geared towards zero tolerance of incidence and proactive and positive safety measures. Setting up of a dedicated safety watchdog and regulator as an entity separate from the rail operator and those whose responsibility is to manage rail infrastructure has been the common running theme in recent developments. It is noted that the approach adopted by the above Railways was of a very proactive accident reduction strategy, duly including a risk mitigation strategy, technology plan and fatigue management plan is something which is critically needed in the context for Indian railways plan for a positive safety orientation.

An important component of US Act mandates the Government to establish a grant program for the deployment of train control technologies, train control component technologies, processor-based technologies, electronically controlled pneumatic brakes, rail integrity inspection systems, rail integrity warning systems, switch position indicators and monitors, remote control power switch technologies, track integrity circuit technologies, and other new or novel railroad safety technology For more details about these systems, [see Transport Canada, 2010; ONRSR Australia, 2012; ERA, 2012]. Many of these countries even have a robust legal framework in place to ensure safety in their rail networks. However, due to various reasons historical and otherwise on IR and in India such systems are yet to be put in place. We outline such a system below.

6.4 Outline of a Proposed Safety Management System to be adopted by a proposed Railway Safety Authority on IR

1. Outline of a Safety Management System

Safety is defined as 'the reduction of risk to a level, i.e., as low as reasonably and practicably possible'. The term 'Safety Management System' refers to a comprehensive business management system designed to manage safety element in the work environment. It provides a systematic way to identify risks and their control measures. It provides for goal setting, planning and measuring performances. Safety is woven into the 'fabric' of an organisation. It is a part of its culture and is the part of the way people do their day-to-day job. Since safety management systems are based on the premise that because there will always be risks and hazards in the system, proactive management practices are needed to identify and address them before they lead to mishaps.

As mentioned above, Safety Management System refers to a comprehensive business management system designed to manage safety element in the work environment. It provides a systematic way to identify risks and their control measures. It provides for goal setting, planning and measuring performances. Safety Management Systems are based on the premise that because there will always be risks and hazards in the System with a proactive management needed to identify and address them before they lead to mishaps. The safety management system must be in a form that is consistent with the Legislation that is adopted for the purpose and must include the following elements:

* Safety Policy, Annual Safety Targets and Associated Safety Initiatives.
* Safety Culture.
* Safety authorities, Responsibilities and accountabilities.
* Employee and representative involvement.
* Compliance and Applicable Regulations, rules, Standards and orders.
* Risk Management Process
* Risk Control Strategies.
* Accident and Incident reporting, Investigation, Analysis and Corrective action.
* Skills, Training and Supervision.
* Safety performance Data collection and analysis.
* Safety audit and evaluation.
* Corrective action, Approval and Monitoring.
* Documentation.

The essence of laying down a railway network's Safety Policy and creating a positive safety culture will be as under:

a. Safety Policy

* The Safety Management System must include a Safety Policy that is endorsed by the CEO and Board (or any other person or body controlling the rail transport operator).
* The policy must include a commitment to the development and maintenance of a positive safety culture and the continuous improvement of all aspects of the safety management system.
* The Safety Management System must include processes for the communication of the safety policy and safety objectives to all the people who are to participate in the implementation of the Safety Management System.

* A rail transport operator is likely to have a range of organisational policies and he must ensure that the policies of the organisation, when taken as a whole, promote a consistent set of objectives. For example, policies that set out standards of conduct, or disciplinary processes should be consistent with the principles that support a positive safety culture.

  The remaining elements of the safety management system are the means by which the safety policy is given effect.

b. Safety Culture

Safety Culture is something that emerges from and is a product of all aspects of the way things are in an organisation. In everyday language, culture is, 'the way we do things around here'. A positive Safety Culture is characterised by awareness, assessment and action on safety matters as a part of everyday business, at every level of an organisation and supported by an open communications style throughout the whole organisation. A positive Safety Culture is fundamental to an effective safety management system and the safety management system must specify the methods that will be used so far as is reasonably practicable to promote and maintain a positive safety culture.

(It may be pointed out here that a positive safety culture or attitude towards safety within an organisation is best reflected by the state of its workmen's safety at their work places. And by this yardstick IR's state of safety has not looked very healthy. In this context, it may be useful to recall what GOI [2012a] had observed which they noted saying that casualties of the railway's own staff while on duty were collected from zonal railways and the position is markedly high. About 1600 railway staff were killed and 8700 injured while working during the period 2007-08 to October 2011, which incidentally was substantially more than the 1019 deaths and 2118 injuries resulting from train accidents during the period 2007-08 to 2010-11).

An organisation with a positive Safety Culture is typically characterised by:

* communication founded on mutual trust;
* shared perceptions of the importance of safety; and
* confidence in the efficacy of preventive measures

Key elements of a positive safety culture which organisations should consider when determining the methods to meet the laid down requirements and to promote and maintain such a culture are:

* **Committed leadership:** the organisation's leaders, from its senior executives to line managers, actively encourage and participate in safety initiatives and activities. This may be through events and communications, staff mentoring, provision of resources, or providing safety incentives and awards.
* **Keeping people informed:** the organisation's members, both managers and workers, know what is going on in their organisation. This includes collecting, analysing and disseminating relevant information derived from the workforce, safety occurrences, near misses, and regular proactive checks of the organisation's safety activities.
* **Maintaining vigilance:** the organisation's members are constantly on the look out for the unexpected. They focus on problems and issues as they emerge well before they can escalate to more serious occurrences. Members are prepared to look upon these

potential risks as a sign that indicates that the system might not be as healthy as it should or could be.

* **Promoting a just culture environment:** the organisation promotes a 'just culture' which acknowledges human error and the need to manage it by supporting systems and practices that promote learning from past errors or mistakes. It encourages uncensored reporting of near miss occurrences and worker participation in safety issues. A 'just culture' is transparent and establishes clear accountability for actions. It is neither 'blame free' (awarding total immunity for actions) nor 'punitive' (enacting a disciplinary response regardless of whether acts were intentional or deliberate).
* **Promoting organisational flexibility:** the organisation is capable of adapting effectively to meet changing demands. This relies on being prepared for and practiced in handling changing circumstances with people competent to lead and carry out tasks. Flexibility allows local teams to operate effectively and autonomously when required, without the need to adhere to un-necessarily inflexible rules.
* **Encouraging willingness to learn:** the organisation is willing and eager to learn from its workers, its own experiences and from corporate safety databases. The key here is that organisations and their members use the information to improve safety and act on the lessons derived.

In developing and maintaining a positive safety culture, account should be taken of:

* The importance of leadership and commitment of senior management;
* The executive safety role of line management;
* The need to involve rail safety workers at all levels;
* The need for openness of communication;
* The need for human factors to be positively addressed;
* Awareness and recognition of opportunities for safety improvement; and
* Willingness to apply appropriate resources to safety.

As a part of compliance with Applicable, Regulations, Rules, Standards and Orders, the above Safety Management System will also need to include all Codes, Manuals and Procedure orders of the railway Board applicable to the various departments and also those safety rules on IR which have been issued from the Railway Board as policy but have not been included in the codes and manuals for mandatory implementation.

6.5 Key Objectives and Functions of Railway Safety Authority

It should result in giving safety the highest priority in railways. Instead of merely looking at the incidents, accidents, failure and safety infringements its objects among other things should include -

* Substantial improvement in safe railways operations and managing all aspects of railways working
* To identify and minimise risks with the railway's operations
* To ensure special provisioning for the control and mitigation of specific risks to safety arising out of railways operations. Minimisation or elimination of risks to safety to the best level practicable should be the hall mark of working of Railway Safety Authority.

* To inculcate the discipline of zero tolerance to all types of incidents of safety significance including substantial reduction of failures which can be causative factor of such incidents and
* To enhance confidence of public by promoting greater safety of passengers or freight by rail.

The working of the Office of Rail Regulator in United Kingdom and provisions of the Rail Safety (Improvement) Act, 2008 of United States of America provide excellent templates for the vision, strategy, functions, responsibilities and enforcement powers of the proposed Railway Safety Authority in the Indian context. Such an authority among other things should have powers to ask the Indian Railways and other railway operators in India to develop a short term (1 year), medium term (3-5 years) and perspective (10 years) Safety Management System Plan with the clear intent of substantial improvement in safety and drastically reducing the number of accidents, incidents, injuries and fatalities involving railroad working including but not limited to collisions, derailments and human factors, substantially improving the consistency and effectiveness of enforcement and compliance programs pertaining to safety, having a programmed completion target of safety related/safety enhancement works including enhancement of line capacity, renewal of assets, infusion of technology and fostering a culture of improving research efforts to promote and substantially improve the safety and performance of railways.

SECTION 7
CONCLUDING REMARKS

It is more than obvious from our study that safety related aspects of operations have not been given the priority that is required from an organization like the IR, which has a huge network to be handled in terms of passenger and freight. Despite successive Safety Committees on IR emphasising proper and adequate provisioning of funds to DRF to take care of renewal and replacement of over aged assets, inadequate provisioning to Depreciation Reserve Fund (DRF) continues. The hugely inadequate allocations for safety are not understandable, especially given the significant returns that can be expected from improvements in railways operations and thereby in revenue generation following proper and reasonable safety related investments. This has been revealed clearly by ground level case studies undertaken by us and reported earlier. Evans [2013] argued that because of strong institutional, legal, and political pressure, a number of railway safety measures are adopted despite low benefit-cost ratios. Indeed, for users and operators, safety is considered the fundamental value of a railway, in particular for high-speed railways (HSR), where it is expected that if railways are perceived as a safety threat to neighbors, the environment, customers, or staff, society will choose not to use them. Useful safety measures and thus good performance can thus have a dramatic impact on the quality of such cost-intensive investments as HSR. This could be particularly true in the case of countries like India where high-speed systems are being planned and are even being executed. From the perspective of a railway organization, acknowledging the importance of safety implies that an integrated safety approach may be necessary to gain trust from the public and the government [Hale, 2000]. In such an integrated approach, the basic design of a technology should aim to simultaneously minimize the consumption of material, energy and land; environmental pollution; as well as external and occupational safety and health risks. In addition, Hale [2000] describes the need for

the railway industry to have a dynamism of safety culture to cope with ever-changing safety issues that emerge from a changing socio-economic environment.

It is also important to have a realistic estimation of the assets requiring replacements for correct provisioning of DRF. IR needs to take immediate steps in this regard. Therefore, IR needs to step-up its investments in safety to unlock its capacity, presently hampered by equipment failures, accidents, other unsafe practices, etc. This will not only benefit IR but also the Indian Economy and the country as well. Hopefully, Rashtiyaq Rail Sanraksha Kosh (RRSK), role as spelt out by Debroy and Desai [2017] is fulfilled as per the emerging requirements.

A systemic weakness on IR concerns the failure to maintain data regarding detentions to the traffic due to accidents and to measure actual direct and indirect losses suffered by IR. Generation and maintenance of such data is necessary to have a proper view of losses suffered on this account and take appropriate policy decision as a result of which remedial steps could be taken up immediately. The absence of proper guidelines in the form of a 'Safety Management System' which clearly defines and spells out norms relating to building of infrastructure, operations and maintenance is being felt within the railway administration as was revealed during in-depth discussions with many officials from the various concerned departments of the organization. We have provided an outline of such a system as part of our study. IR needs to take necessary steps in this direction. Declining planned investments in IR have led to significant erosion of IR's market share. Our case study in this regard reported above, has brought out that the actual modal mix of transportation obtaining at present is not optimal. If the resource or social cost is calculated, as per the optimal mix, the market share of Railways will go up and which would have led to a saving of Rs. 38,470 crores in 2008. This could be valued at Rs. 80,000 crores given the continuance of the existing modal shares in 2018. This needs to be reversed by stepping up the investments very significantly in IR to augment its capacity so as to head towards optimising the modal mix of transportation in India.

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DOCUMENTATION

The purpose of this section is to make available to the readers official documents such as reports of committees, commissions, working groups, task forces, etc., appointed by various ministries, departments, agencies of central and state governments and international organisations, which are not readily accessible either because they are old, or because of the usual problems of acquiring governmental publications, or because they were printed but not published, or because they were not printed and remained in mimeographed form. We also present in this section, official documents compiled from scattered electronic and/or other sources for ready reference of the readers. It will be difficult and probably not worthwhile to publish the documents entirely. We shall publish only such parts of them as we think will interest our readers. The readers are requested to send their suggestions regarding official documents or parts thereof for inclusion in this section.

We are also keen to publish Papers, Notes or Comments based on the material included in this section. We invite the readers to contribute the same to our journal, which we shall consider for publication in subsequent issues of the journal, after the usual refereeing process.

In the present section, we publish excerpts from:

1. Fund Deployment Framework for Rashtriya Rail Sanraksha Kosh (RRSK) - A Discussion Note, by Bibek Debroy and Kishore Desai.

2. Extract from Report of The Railway Accidents Inquiry Committee, Part I, November 1968, (Chairman: Shri K.N. Wanchoo), Chapter VI.

3. Extract from Report of High Level Safety Review Committee, 2012, Government of India, Ministry of Railways, (Chairman: Anil Kakodkar).

FUND DEPLOYMENT FRAMEWORK FOR RASHTRIYA RAIL SANRAKSHA KOSH (RRSK) - A DISCUSSION NOTE

Bibek Debroy and Kishore Desai

1. Background and Context

1.1 Absolute safety in Railways is a topmost priority for the Government. Railway accidents not only lead to immense loss of lives and property, but also impact the psyche of general public for whom railways is a primary mode of transport. Commenting on safety, a Parliamentary Standing Committee on Railways recently noted[1] *"The Committee wish to remind the Ministry that a rail accident does not merely involve damage to rail infrastructure alone. There is a huge cost to society as well, society pays dearly through lost lives, lost livelihood, loss of productivity, disability, medical expenses, disruption of traffic, loss of the wagons, etc. However the highest cost is the loss of passenger confidence which may translate into loss of revenue in future for the railways. The Committee are of the firm view that taking the issue of safety and investments on safety lightly may cost the railways very dearly in terms of share in transportation of passenger and freight and thereby decrease in Revenues"*.

1.2 From time to time, the Ministry of Railways (MoR) has been taking various initiatives to improve safety in its system. Expert Committees in the past have conducted detailed review of safety related aspects and recommended measures to correct systemic deficiencies. Recently, in 2011, a High Level Safety Review Committee [HLSRC, 2011] under the Chairmanship of Dr. Anil Kakodkar examined all technical and technology related aspects in connection with safe running of train services in the country. The HLSRC recommended a range of inter-departmental measures requiring an investment of about INR 1 lakh crores. In 2012, another expert committee under the Chairmanship of Shri Sam Pitroda deliberated on modernization of Indian Railways (IR). As part of its proposals, this committee also recommended safety related measures entailing investments of around INR 40,000[2] crores.

1.3 Keeping the above recommendations in mind, the fund requirement for IR was assessed[3] by Adviser/Safety, Adviser/Infra and AM/Budget, which was reviewed in Board meeting on 01.08.2012 and critical review was done thereafter. After final review by AM/Budget and Advisor/Safety on 28.08.2012, an investment requirement of about INR 1.0 lakh crores was projected by the MoR. Since then, the MoR has continued implementing necessary initiatives including many of the expert committee recommendations particularly that of HLSRC.[4] However, availability of funds remained constrained *vis-à-vis* the requirements.

1.4 To expedite implementation of safety works, the Ministry set up an internal committee[5]

Bibek Debroy is Member, NITI Aayog, Government of India
Kishore Desai is Officer on Special Duty, NITI Aayog

1. Source: 12th Report of the Parliamentary Standing Committee on Railways on "Safety and Security in Railways" submitted December 2016

2. Source: Note on "Creation of RRSK for enhancement of safety of Indian Railway System" by MoR

3. Source: Note on "Creation of RRSK for enhancement of safety of Indian Railway System" by MoR

4. Out of 106 recommendations of HLSRC, 68 recommendations have been fully accepted and 19 partially accepted. Of these, 22 recommendations have been fully implemented and the remaining recommendations are under various stages of implementation. Source: 12th Report of the Parliamentary Standing Committee on Railways on "Safety and Security in Railways" submitted December 2016.

5. Committee comprising ED/CE/Projects, ED/FX-I, ED/Mechanical/Projects, ED/Signal/Development and ED/EEM was set up vide Railway Board letter no. ERB-1/2015/23/44 dated 21.10.2015. The Committee submitted its report on 17.12.2015

of senior Railway officials to consider the need for a dedicated safety fund along the lines of Special Railway Safety Fund (SRSF) created in 2001. Building upon the earlier studies, the committee outlined measures (department-wise works) requiring an overall investment of about INR 1,54,000 crores. Out of this, funding of around INR 1,19,000 crores was proposed to be met through a dedicated safety fund called "Rashtriya Rail Sanraksha Kosh" ("RRSK"). The balance was proposed to be met from IR's own sources.

1.5 Subsequently, after discussions between MoR and Ministry of Finance, the Finance Minister announced creation of "Rashtriya Rail Sanraksha Kosh" ("RRSK") with a corpus of INR 1 lakh crore over a period of 5 years. Para 74 of the Union Budget 2017-18 speech stated *"For passenger safety, a Rashtriya Rail Sanraksha Kosh will be created with a corpus of Rs. 1 lakh crores over a period of 5 years. Besides seed capital from the Government, the Railways will arrange the balance resources from their own revenues and other sources. Government will lay down clear cut guidelines and timeline for implementing various safety works to be funded from this Kosh.*"

1.6 Pursuant to the Budget 2017-18 announcement, the Ministry of Railways requested[6] Dr. Bibek Debroy (Member, NITI Aayog) to extend help in the task of *"identifying other critical areas and guiding principles for deployment of RRSK funds for bringing out perceptible improvement in safety scenario over Indian Railways".*

1.7 Thereafter, a recommendatory framework to deploy RRSK funds was submitted to the Government for review and necessary action. In the meantime, given the critical importance of safety, a larger public debate on this subject is also being facilitated. Relevant portions of the analysis are being shared to increase awareness about various policy measures being taken by the Government to make IR 100% safe.

2. Objective and Structure of this Note

2.1 Para 74 of the Union Budget speech 2017-18 makes it amply clear that the fundamental purpose of creating RRSK is to ensure funds for implementing Safety works on Railways. That said, it is not easy to clearly delineate safety works from those that indirectly enhance safety in Railways. Take for instance network decongestion projects such as doubling or tripling. A decongested network is prone to accidents due to limited margin for error and hence decongesting such network enhances railway safety. So one can argue a case to consider network decongestion projects as part of safety works. Besides this, safety also needs an integrated inter-departmental approach. For example, even if track condition is fine, a running train may derail due to defects in wheels or other bogie components. So if funds are deployed to strengthen track infrastructure only, it would not serve a meaningful purpose. While we acknowledge such complexities, we are cognizant of the size of RRSK corpus available every year. Hence, while suggesting an appropriate framework for deploying RRSK funds, an independent objective attempt to analyse various aspects of Railway accidents has been made. Based on key insights drawn from this analysis, guiding principles have been suggested keeping in mind the funding limitations as well.

2.2 With the above explanatory background, the following are the key objectives of this note:

a) To suggest guiding principles for deployment of RRSK funds so that a perceptible improvement in safety scenario can be achieved in the Indian Railway system;

6. Source: MoR letter no. 2015/CE-II/Plg/1 dated 21.02.2017.

b) To suggest other critical areas that would enable MoR utilize RRSK funds in an efficient and effective manner;
c) Review of RRSK funding drivers, such as the safety strategy (department-wise actions identified by MoR), quantum of investment requirements (whether they are appropriate or not), technologies proposed by MoR to improve safety in the IR system, etc., has not been undertaken in this note. The scope of the study is primarily limited to items a) and b) above.

2.3 For undertaking the necessary analysis to meet the above objectives, the following structure is followed:

a) Section 3 - Analysis of Accidents: This section aims to analyse various aspects of accidents in an objective data-driven manner. Key questions such as which types of accidents are the biggest concerns in terms of loss of lives and injuries, which directorates require more funding support, where do derailments occur more frequently, etc., are examined critically.
b) Section 4 - Mapping Sources of funds & expenditure of existing safety works: To map sources of funds and expenditure pattern practiced currently for implementing inter-departmental safety works.
c) Section 5 - Overview of RRSK: Outlining the fund structure and key elements of RRSK.
d) Section 6 - Safety Investment Projections: Presenting the overall safety investment needs (department-wise and work-wise breakup) as estimated by IR's committee of senior officials.
e) Section 7 - RRSK Fund Deployment Framework: Suggestions related to appropriate framework and activity priorities for deploying RRSK funds.
f) Section 8 - Other related suggestions: Related suggestions to complement RRSK funds for overall improvement in safety situation.
g) Section 9 - Conclusion

2.4 The next section analyses various aspects of accidents.

3. Assessment of Accidents: The fundamental driver for RRSK fund deployment framework

3.1 MoR records details related to every Consequential Accidents on its system. Consequential Accidents[7] are defined as train accidents having serious repercussions in terms of loss of human life, human injury, loss to Railway property or interruption to Rail Traffic for more than specified threshold values. Consequential accidents are further classified into the following categories:

a) Derailments (accidents on account of derailment or trains);
b) Level Crossing (LC) related accidents (accidents on road-rail interfaces such as Manned and Un-manned LCs);
c) Collisions;
d) Fire related accidents and
e) Others / Miscellaneous (this covers all other incidents not covered above. For example, accidents due to natural incidents: landslide, flash floods, etc., sabotage, improper loading/unloading, train running over cattle or any fixed structure, etc.)

3.2 In this document, Accidents primarily mean "Consequential Accidents" as specified above.

7. Source: Railway Board letter no. 2000/Safety(A&R)/19/20 dated 31.10.2000.

Assessment of Accidents (by categories): LC and Derailment accidents constitute 90% of all accidents on IR system

3.3 Review of data related to consequential accidents on IR network indicates that over the six year period 2012-13 to 2016-17, a total of 586 accidents took place on IR network. These accidents led to 1011 casualties and left 1634 people injured. Year-on-Year (y-o-y), the total number of accidents on IR network has declined (from 12 accidents in 2012-13 to 104 in 2016-17), with 2014-15 being an exceptional year. However, in terms of casualties and people injured, there are no clear y-o-y trends. The raw data of consequential accidents (including the breakup of various aspects, by accident classifications) is presented below.

Table. Details of consequential accidents (2012-13 to 2016-17 and cumulative)

S. No.	Description	2012-13	2013-14	2014-15	2015-16	2016-17	Cumulative
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	**Total Number of Accidents**	122	118	135	107	104	586
2.	**Break-up of Accidents by types**						
	Derailments	49	53	63	65	78	308
	Manned LC's	5	4	6	6	0	21
	Un-manned LC's	53	47	50	29	20	199
	Collisions	6	4	5	3	5	23
	Fire	9	7	6	0	1	23
	Others	0	3	5	4	0	12
3.	**Total number of casualties by Accident types**	204	152	292	122	241	1011
	Derailments	5	6	104	36	196	347
	Manned LC's	18	6	31	12	0	67
	Un-manned LC's	123	98	130	58	40	449
	Collisions	27	1	15	1	5	49
	Fire	31	35	0	0	0	66
	Others	0	6	12	15	0	33
4.	**Total number of Injured persons by Accident types**	381	234	457	188	374	1634
	Derailments	159	93	265	100	327	944
	Manned LC's	25	2	21	10	0	58
	Un-manned LC's	81	116	85	41	19	342
	Collisions	76	7	58	12	28	181
	Fire	40	6	0	0	0	46
	Others	0	10	28	25	0	63

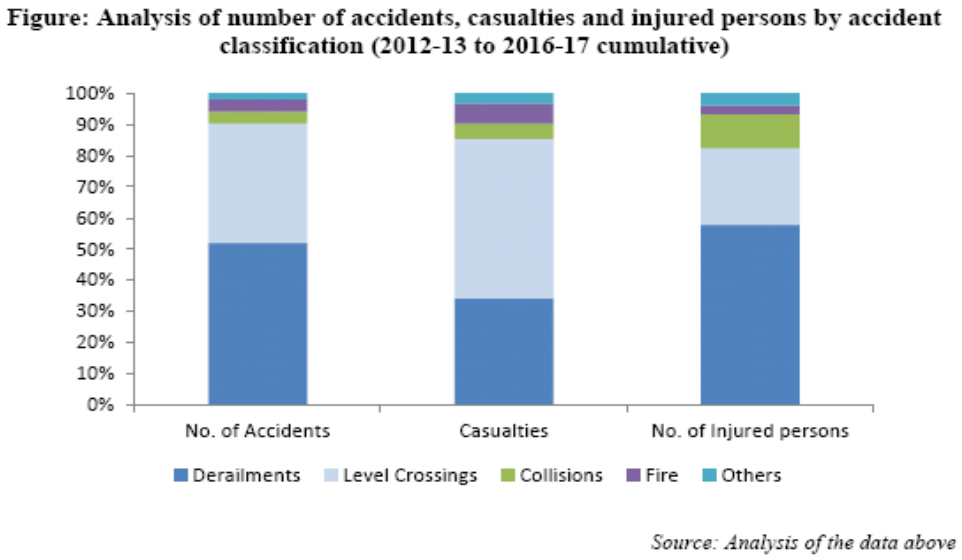
Source: Railway Board, Ministry of Railways

3.4 Analysis of the above data, cumulatively over the period 2012-13 to 2016-17, throws the following crucial insights:

a) Derailments accounted for more than 50% of the total consequential accidents while Level Crossing (LC) related accidents (on both manned and unmanned) accounting for about 40%. *Together, Derailments and LC related accidents accounted for 90% of total accidents on IR networks;*
b) 51% of the total casualties over the above period were on LC related accidents, while about 35% of casualties on derailments. *Together, Derailments and LC related accidents accounted for about 85% casualties;*
c) *Similarly, derailments and LC related accidents together accounted for about 82% injured persons.*

3.5 The analysis above is presented graphically below. Therefore, for a meaningful reduction in number of accidents and casualties/injured persons, *initiatives for reducing/eliminating Derailments and Level Crossing accidents have to be accorded highest priority.*

Figure. Analysis of number of accidents, casualties and injured persons by accident classification (2012-13 to 2016-17 cumulative)



Source: Analysis of the data above

Assessment of Accidents (by directorate-wise responsibility): Civil Engineering Directorate needs priority focus

3.6 The Ministry of Railways has an established process for identifying and fixing responsibilities post an accident. This process facilitates cause analysis and helps MoR delineate system deficiencies responsible for each accident. For instance, say that review of a derailment accident shows that the primary cause for that derailment is "Rail fracture". In this case, the directorate-wise

responsibility for the above derailment accident would be fixed onto the Civil Engineering Directorate. On the other hand, there may be instances where multiple causes together may have contributed towards an accident. For such cases, the directorate-wise responsibility would be apportioned equally to each directorate responsible for that accident.

3.7 The directorate-wise responsibility mix is typically classified into the following categories:

a) Engineering (Civil) (accidents where cause relates to failure on account of Engineering Directorate - failure of tracks, points, turnouts, fittings, etc.);
b) Mechanical (accidents where cause relates to failure of Mechanical Directorate - Locomotives, Coaches, Wagons, Wheels, etc.);
c) Electrical (cause relates to failure of Electrical Directorate - OHE's, Traction Distribution assets, EMU's, E-Locomotives, etc.);
d) Signal & Telecommunications (S&T) (cause relates to that of S&T Directorate - signaling systems, interlocking systems, communication, etc.)
e) Traffic & Commercial (cause relates to Traffic & Commercial accounts - faulty loading, unloading, operations without correct setting and securing of routes, etc.)
f) Failure other than Railway Staff (cause relates to Non-Railway Staff - failure of Road users, bus/car/two-wheelers/trucks, etc.)
g) Incidental (cause relates to incidents: landslide, flash floods, etc.)
h) All Others (cause relates to reasons that have not been covered above)

3.8 Review of the accident data over the period 2012-13 to 2016-17 shows that, on a cumulative basis, "Failure Other than Railway Staff (FORS)" and "Engineering (Civil)" directorate have been responsible for the maximum number of accidents (234.5 and 158.8 number of accidents respectively out of a total 586 number of accidents over that period). This is understandable as the previous section clearly showed that Level Crossings related accidents (cause - Failure Other than Railway Staff) and Derailments (one of the primary causes being track defects) account for the bulk of railway accidents. On a y-o-y basis, the performance of Engineering Directorate shows consistent deterioration, (i.e., the number of accidents on account of Engineering Directorate have increased y-o-y). On the other hand, various steps for securing level crossings (by manning them, developing Road Over Bridges (ROBs), Road Under Bridges (RUBs), etc.), have helped reduce accidents on account of FORS over the above period. The data for directorate-wise responsibility mix is presented below:

Table. Responsibility Mix (Number of Accidents department-wise) over 2012-13 to 2016-17

S. No.	Directorate-wise	2012-13	2013-14	2014-15	2015-16	2016-17	Cumulative
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Engineering (Civil)	25	29.5	31.5	33.3	39.5	158.8
2.	Mechanical	11	8.3	15.5	12	12.3	59.1
3.	Electrical	4	8.3	7.5	4.5	6.5	30.8
4.	Signal & Telecom.	4.5	6	1	2.8	2.3	16.6
5.	Traffic & Commercial	7	1.8	9.5	5.3	6.8	30.4
6.	Failure Other than Railway Staff	59	57	57	38	23.5	234.5
7.	Incidental	7	4	8	9	7	35
8.	All Others	4.5	3.1	5	2.1	6.1	20.8
	Total	**122**	**118**	**135**	**107**	**104**	**586**

Source: Railway Board, Ministry of Railways

Note: Several data points in the above table are in decimals (and not whole numbers). This is because, per detailed review of each accident, its cause can be attributed to multiple departments. For example, assume one derailment takes place because of both wheel and track related infirmity. In such a case, that derailment accident will be attributed to both Engineering and Mechanical directorate. Hence each of these directorates would account for 0.5 and 0.5 number of accidents.

3.9 Analysis of the above data, cumulatively over the period 2012-13 to 2016-17, throws the following crucial insights:

a) *Non-railway users are responsible for the largest number of Railway accidents over the above period (about 40%).* This is in sync with the analysis undertaken above (category-wise accidents) as LC related accidents accounted for about 40% of the total accidents;

b) Previous analysis showed that derailments accounted for more than 50% of total accidents. However, Engineering Directorate was responsible for 27% of all accidents. These observations imply that all derailment incidents can't be solely attributed to track related defects. While failure of engineering assets (tracks, welds, etc.) would derail a running train, failure of wheel and other rolling stock components can also potentially derail a train. Hence, other directorates such as Mechanical, Electrical, etc., also contribute to derailment incidences. That said, Engineering Directorate can be still considered to account for the largest share of all derailments.

c) On a y-o-y basis, there has been a 60% increase in the number of accidents for which Engineering Directorate was responsible.

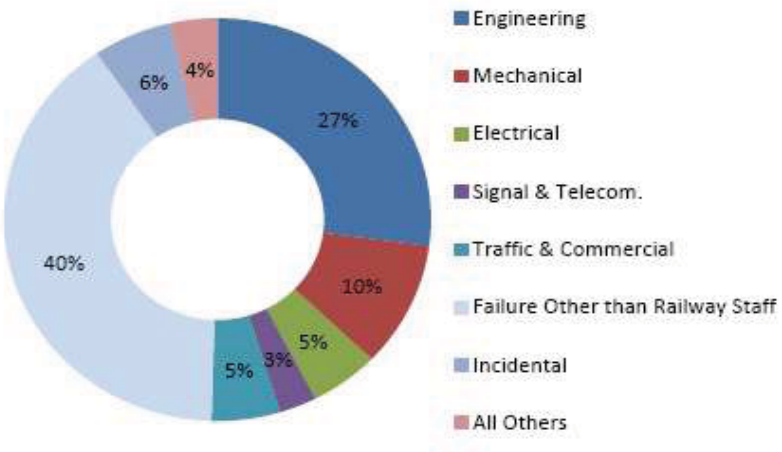
d) *Together, Engineering Directorate, Mechanical Directorate, Electrical Directorate and Other than Railway Staff (primarily road-users) are responsible for about 83% of all accidents over the above period;*

3.10 The cumulative share of responsibility-mix is presented graphically below. Assessment of accidents (category-wise) in the last section showed that, for a perceptible improvement in railway safety, initiatives for reducing/eliminating Derailments and Level Crossing accidents have to be accorded highest priority. The department-wise responsibility analysis in this

section shows that the following departments need to be specially focused on for safety improvement:

a) Level crossing works to eliminate failures on account of Other than railway staff (road-users);
b) Civil Engineering department works need special focus given its major contribution to derailments and its y-o-y performance record;
c) Works undertaken by other directorates such as Mechanical and Electrical focused on improving wheel and rolling stock safety to eliminate/minimize derailments.

Figure: Analysis of Accidents (Directorate-wise responsibilities) cumulative over 2012-13 to 2016-17



Source: Analysis of above data

Analysis of Accidents (contribution of human failures): About 87% of accidents can be traced to human errors

3.11 Continuing the above analysis, on a cumulative basis over the period 2012-13 to 2016-17, data indicates that *human failures contributes to about 87% of all accidents* as compared to failure of equipment, technology or other reasons. This failure can either be of railway staff (such as gangmen, loco-pilots, traffic and commercial staff, etc.,) or non-railway people. For example, level crossing accidents happen because road users (bus drivers, car drivers, truck/lorry drivers, etc.,) fail to avoid crashing with a running train. Similarly, derailments can happen due to staff's failure in timely detection of track or rolling stock component (wheels, gear parts, bearings, etc.,) defects, failure of loco pilots in adhering to speed restrictions, Signal Passing at Danger (SPAD), etc. Failure of railway staff contributes to about 47% of all such accidents while the balance being contributed by non-railway people.

3.12 Further, *y-o-y trends indicate that the share of accidents on account of failure of railway staff have been continuously increasing over the*

perio*d 2012-13 to 2016-17*. For example, in the year 2016-17, while human failure accounted for about 83% of all accidents, failure of railway staff accounted for 62% of that. This is a worrying trend as it shows that there significant reliance on human inputs continues on activities which are safety critical. The table below presents break-up of number of accidents attributed to railway staff, non-railway staff and other reasons over the period 2012-13 to 2016-17.

Table. Accidents on account of failure of railway staff, non-railway staff and others (2012-13 to 2016-17)

S. No.	Failure-wise	2012-13	2013-14	2014-15	2015-16	2016-17	Cumulative
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Failure of Railway Staff	46	51	60	55	64	276
2.	Failure of other than Railway Staff	59	57	58	38	22	234
3.	Failure of Equipment	6	3	4	2	2	17
4.	Sabotage	3	3	3	1	2	12
5.	All other factors	8	4	10	11	14	47
6.	**Total no. of accidents**	**122**	**118**	**135**	**107**	**104**	**586**
7.	Failure of Railway staff as a % of Total	37.7%	43.2%	44.4%	51.4%	61.5%	47.1%
8.	Failure of Railway & Non-Railway staff as a % of Total accidents	86.1%	91.5%	87.4%	86.9%	82.7%	87.0%

Source: Railway Board, Ministry of Railways

3.13 The key take away from the above arguments is that initiatives that reduce potential of human errors in IR system such as automated inspection & asset monitoring techniques, replacement of overaged assets (tracks, signaling etc.) and upgradation of asset maintenance infrastructure etc. needs priority emphasis.

Deep-diving Derailments (department-wise and route-wise assessment)

3.14 The paragraphs above clearly indicate that other than LC related accidents, derailments are the biggest cause of concern for Indian Railways. While the onus of LC related accidents falls to a large accident on road users, derailments happen due to railway system deficiencies. That derailment is linked to inter-departmental failures, adds to its complexity.

3.15 Data shows that over the period 2012-13 to 2016-17, Engineering Directorate contributed to about 44% of derailments that happened over this period. This implies that failure of track related infra has been the most important cause of derailments. This observation corroborates the findings presented earlier that Engineering Directorate contributes to the largest share of derailments. Mechanical and Electrical Directorate together have contributed to about 16% of derailments over that period. Together, these three directorates have contributed to 60% of all derailments. The table below presents the department-wise data for derailments over the above period.

Table. Department-wise contribute to derailments (number of derailments)

S. No.	Derailments (department-wise breakup)	2012-13	2013-14	2014-15	2015-16	2016-17	Cumulative	% Share
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	Mechanical	4.5	5	7.5	8.5	8	33.5	11.4%
2.	Engineering	17	22	24	28	37.5	128.5	43.6%
3.	S&T	3.5	5	0	3	2.4	13.9	4.7%
4.	Traffic/Coml	3	1	4.5	4.5	6.8	19.8	6.7%
5.	Electrical	1	2	5	2.5	2	12.5	4.2%
6.	Incidental	7	4	8	9	7	35	11.9%
7.	All Others	12	10	12.5	7	9.8	51.3	17.4%
	Total	**48**	**49**	**61.5**	**62.5**	**73.5**	**294.5**	**100.0%**

Source: Railway Board, Ministry of Railways

3.16 Further, it is also important to note that derailments happen mainly on Broad Gauge (BG) routes. IR classifies its routes under various classes (A, B, C, D, D Special, etc.). The details of such classes along with examples of key routes that fall into them is given in the table below.

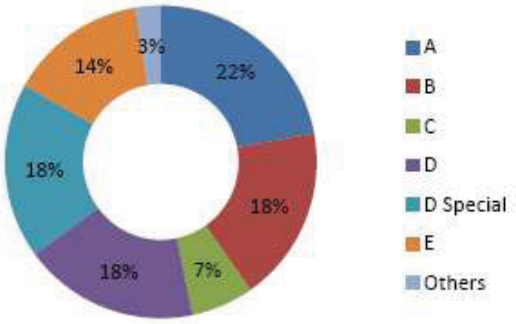
Table. Details of route classification in IR network

Classification	General Features	Some Examples
A	Lines in BG sections typically rated for speeds up to 160 km/h	High Density Network (HDN) routes such as New Delhi - Howrah, New Delhi-Mumbai Central, Howrah - Nagpur-Mumbai, etc. Many of these routes have capacity utilization of more than 100%.
B	Lines in BG sections typically rated for speeds up to 130 km/h	Allahabad-Katni-Jabalput-Itarsi- Bhusaval, New Delhi-Kalka, Kharagpur-Vijaywada, Vadodara-Ahmedabad, etc.
C	Suburban networks	Mumbai suburban system, Kolkata suburban system, etc.
D	Lines in BG sections typically rated for speeds up to 100 km/h	Guntur-Guntakal, Salem-Bayappanahalli, Securandabad-Dronachalam, etc.
D Special	Lines in BG sections typically rated for speeds up to 100 km/h with high traffic density or high expected traffic growth	Lucknow-Kanpur, Lucknow-Sultanpur-Varanasi, Nagda-Bhopal, Kharagpur-Adra, etc.
E	Lines in BG sections typically rated for speeds below 100 km/h	
All others	Other categories including Narrow Gauge and Meter Gauge lines	

Source: P-Way track classifications, irfca.org website

3.17 Analysis of route-wise derailments indicates that about 83% of derailments that happened over the above mentioned period were in A, B, C, D and D Special class. High density routes typically considered in A class contributed for about one-fourth (22%) of total derailments. While routes under A and B class together accounted for about 40% of all derailments, D and D Special class contributed to a similar quantum of about 36%. The graph below shows the route-wise derailments.

Figure: Break-up of derailments across IR network (class-wise routes) cumulatively over 2012-13 to 2016-17



Source: Railway Board, Ministry of Railways

3.18 While detailed analysis of derailments (directorate-wise mix) largely corroborates findings of the previous paragraphs, route-wise analysis indicates that derailments are largely concentrated in A, B, D and D Special networks of IR.

Summary & Conclusions

3.19 Detailed analysis of data in the paragraphs above clearly helps dissect various key aspects of Railway accidents: share of various types of accidents, directorate-wise responsibility of these accidents, contribution of human failures as compared to equipment or technology failure and so on. Based on the above assessments, the following key insights emerge:

a) Together, Derailments and LC related accidents accounted for 90% of total accidents, 85% casualties and 82% injuries on IR networks. Initiatives for reducing/eliminating Derailments and Level Crossing accidents therefore need to be accorded highest priority;

b) Engineering Directorate, Mechanical Directorate, Electrical Directorate and Other than Railway Staff (primarily road-users) are responsible for about 83% of all accidents over the above period. Out of this, Civil Engineering and Other than Railway Staff account for 67% of accidents. Meaning most derailments and LC accidents are accounted by these stakeholders. On a y-o-y basis, there has been a 60% increase in the number of

accidents for which Civil Engineering Directorate was responsible. With such disproportionate contribution to accidents and deterioration of y-o-y record, there is clearly a strong case for ensuring highest priority to Engineering works. This implies that, besides works for reducing/eliminating LC accidents, works undertaken by Civil Engineering, in particular, and other directorates - Mechanical and Electrical that lead to reduction/elimination of derailments need to be targeted on priority. Such works may involve programs enhancing safety of track and rolling stock (particularly wheels and bogie component in rolling stock). Further, considering the y-o-y trends for Civil Engineering department, works related to Civil Engineering need stronger prioritization;

c) Human failures contribute to about 87% of all accidents. Within human failures, contribution of railway staff failure has consistently increased over the last 5 years. Therefore, inter-departmental initiatives that reduce potential of human errors in IR system such as automated inspection & asset monitoring techniques, replacement of over-aged assets (tracks, signaling, etc.,) and up-gradation of asset maintenance infrastructure etc. needs priority emphasis.

3.20 The above insights would drive the basis for devising guiding principles for deploying RRSK funds. The desired outcome of this framework should be a clear perceptible improvement in safety across the railway system.

4. Mapping Sources of funds & expenditure of existing safety works

4.1 Having assessed various aspects of accidents, it is now important to map sources of funds and key areas of expenditures on railway safety works. As indicated earlier, investment on safety works is an ongoing process and MoR has been investing regularly to improve systemic safety in Railways. While the number of accidents that happen on Railways are still alarming, there has been a gradual decrease in both the number of accidents and number of casualties/injuries over the last five years (except 2014-15).

4.2 Coming to sources of expenditures first. Expenses for safety works are made both on Revenue account as well as Capital account. Revenue expenses primarily relate to expenditures incurred on repairs & maintenance of key assets such as Permanent-Way (P-Way comprising track infrastructure), Motive Power (locomotives, EMUs, etc.), Carriages & Wagons (Coach, Wagons, etc.,) and Plant & Equipment. Similarly, Capital expenses primarily relate to capital activities involving creation or upgradation of assets such as Road Over Bridges (ROBs)/Road Under Bridges (RUBs), track renewals, bridge works, Overhauling rolling stock (POH/IOH) etc. There has been limited expenditure so far in acquiring state-of-the-art technologies for asset condition inspections and monitoring.

4.3 In terms of sources of funding, Revenue expenses are typically funded through IR's internal funds (own revenues). Capital expenses, on the other hand, are majorly funded through a combination of the following sources:

a) Gross Budgetary Support (GBS) from the Ministry of Finance;
b) Safety Fund (MoR's share of the cess on Petroleum fuel accruing to the Central Road Fund (CRF));
c) Depreciation Reserve Fund, DRF (primarily used for replacement of assets);
d) Development Fund (DF) (used for funding Railway capital works).

4.4 The table below shows item-wise sources of funds and sources of expenditures over the period 2012-13 to 2016-17(RE).

Table. Mapping Sources of funds and sources of expenditure on safety works (All figures in INR Crores)

S. No.	Description	2012-13	2013-14	2014-15	2015-16	2016-17 RE	Sources prior to formation of RRSK
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1.	Revenue Expenditure (Gross) on Safety						
2.	Repairs & Maintenance of P-Way	8234	9172	10282	10888	13539	IR's own revenues
3.	Repairs & Maintenance of Motive Powers	3924	4465	4783	5273	6108	IR's own revenues
4.	Repairs & Maintenance of Carriages & Wagons	9213	10331	11276	11952	14351	IR's own revenues
5.	Repairs & Maintenance of Plant & Equipment	4805	5406	6027	6254	7832	IR's own revenues
6.	Traffic Minor Head 600 - Safety	11	8	11	16	35	IR's own revenues
7.	Total Revenue Account	26187	29382	32379	34383	41865	IR's own revenues
8.	Capital Expenditure (Gross) on Safety						
9.	Road Safety Works - Level Crossings	528	504	442	470	679	Safety Fund
10.	Road Safety Works - ROBs/RUBs	1057	1482	1792	2133	9658	Safety Fund
11.	Track Renewals	5426	4985	5372	5586	6740	DRF
12.	Bridge Works	322	390	441	520	592	DRF + DF
13.	S&T Works	939	905	1006	894	954	GBS+DRF+DF
14.	Workshops (POH/IOH) of Rolling Stock	1324	1552	872	1530	2573	GBS+DRF+DF
15.	Total Capital Account	9596	9818	9925	11133	21196	
16.	Total (Rev + Capital)	35783	39200	42304	45516	63061	

Source: Railway Board, Ministry of Railways

4.5 The following important points are worth noting:

a) All revenue expenditures related to safety works are funded through IR's own revenues. This practice will continue even after formation of RRSK;

b) Prior to the creation of RRSK, Level Crossing (LC) related works were funded primarily through the MoR's share of the cess on Petroleum fuel accruing to the Central Road Fund. This was also in-line with the stipulations of the CRF Act 2000 that restricted deployment of CRF funds to other activities besides LC related works (Note the Finance Act 2016 has amended this stipulation, the impact of which has been discussed in later paragraphs);

c) Prior to the creation of RRSK, safety works besides LC related works, were funded through other Railway Capital Accounts such as DRF, DF and portion of GBS

received from the Ministry of Finance.

4.6 Going forward RRSK is expected to become the primary funding source for safety works over the medium term. Existing sources such as DRF, DF, etc., may continue funding the balance unmet requirements, subject to availability of funds.

5. Overview of RRSK - A safety fund with a broad mandate

5.1 As mentioned earlier, Rashtriya Rail Sanraksha Kosh (RRSK) has been created with a corpus of INR 1 lakh crores over a period of 5 years starting FY 2017-18. This implies a yearly funding of INR 20,000 crores till FY 2022-23. An amount of INR 20,000 crores has already been allocated to RRSK for FY 2017-18. The funding structure of RRSK is presented in the table below:

Table. RRSK Funding Structure (All amounts in INR Crores)

RRSK Structure (All amounts in INR Crores)	2017-18 BE
Budgetary Support from Ministry of Finance	5000
Transfer from DRF	4000
Transfer from Railway Safety Fund (MoR's share of CRF)	10000
MoR's Internal Sources	1000
Total	20000

Source: Budget 2017-18 documents

5.2 Further, the 2017-18 Budget documents also grants a broader mandate to the utility of RRSK. It states *"for capital expenditure on Railway safety works including the construction of over/under bridges on rail road crossings and erection of safety works at un-manned rail-road crossings, New Lines, Gauge Conversion and Electrification"*. This means that RRSK can also be used for new lines, gauge conversion & electrification projects including the safety works related to level crossings, track related works, rolling stock works, etc.

5.3 As mentioned earlier, the Finance Act 2016 amended Section 10 of the Central Road Fund Act 2000. The extract of this amendment[8] is reproduced here - *"fourteen per cent of the cess on high speed diesel and petrol for railways safety works,* including the construction of road either under or over the *railways by means of a bridge and erection of safety works at unmanned rail-road crossings, new lines, conversion of existing standard lines into gauge lines and electrification of rail lines: Provided that no repair, maintenance or renovation work shall be carried out from the allocation of cess under this sub-clause;"*. This amendment also empowers MoR to utilize its share of CRF on other safety works besides those related to level crossings (construction of ROBs/RUBs, etc.).

5.4 The net effect of the above two stipulations is that RRSK can be considered as a Safety Fund with a broader mandate to make the IR system fail safe. There are no notable restrictions or exclusions in its fund deployment options. Accordingly, all works specified in the document prepared by the inter-departmental Committee of ED's titled "Creation of RRSK for enhancement of safety of Indian Railway System" are technically eligible to be funded through RRSK.

5.5 Accordingly, the table below shows the BE outlays (from RRSK and other IR funds) for various Safety related Planheads.

8. Source: Item no. c, Part VII, Clause no. 230 of Finance Act 2016.

Table. BE 2017-18 outlays across Safety Planheads and their sources of funding
(All numbers in INR Crores)

Planhead (in INR Crores)	Funded from RRSK	Funded from other sources	Total Outlay	% Funding from RRSK
(1)	(2)	(3)	(4)	(5)
Traffic facilities - Yard remodelling & others	914	2171	3085	29.6%
Rolling Stock	1731	23463	25194	6.9%
Road Safety LC's	705	0	705	100.0%
Road Safety ROBs/RUBs	4512	1700	6212	72.6%
Track Renewals	9961	0	9961	100.0%
Bridge Works	738	0	738	100.0%
S&T Works	2247	83	2330	96.4%
Other Electrical Works	40	857	897	4.5%
Traction Distribution Works	501	40	541	92.6%
Machinery & Plant	300	350	650	46.2%
Workshops including PU's	400	2935	3335	12.0%
Training/HRD	70	55	125	56.0%
Credits/Recoveries	2119	NA	NA	NA
Total	**20000**		**53774**	**37.2%**

Source: Railway Board, Ministry of Railways

5.6 The above BE proposal shows the following:

a) For FY 2017-18, RRSK is being proposed to fund about 37% of safety works planned by MoR. The balance is being funded by other sources;
b) Key Engineering safety works (Track renewals and bridge works) are being funded completely through RRSK. Earlier, DRF was the main source of this funding. On the other hand, other funding sources have complemented RRSK in funding LC related works.

5.7 This implies that for safety works, fungibility in funding source exists. Therefore, while RRSK may not be sufficient to fund entire safety investment requirements of IR, it may still be feasible to identify sources to meet the balance requirements.

6. Safety Investment Projections - About INR 1,19,000 crores of works requested for funding through RRSK

6.1 As mentioned earlier, MoR had set an Inter-departmental Committee of senior officials in October 2015 to project investment requirements of safety works. With a final objective to achieve **Zero Accidents** in IR system, the committee outlined measures (department-wise works) requiring an overall investment of about INR 1,54,000 crores. Out of this, funding of around INR 1,19,000 crores was proposed to be met through RRSK. The balance (about INR 35,000 crores) was proposed to be met from IR's own sources. The table below shows the high-

level department-wise safety investment requirements as projected by this committee (Source: Report of the inter-departmental committee dated December 2015).

Table. Overall Investment Projections for funding inter-departmental safety works (All amounts in INR Crores)

S. No.	Item	Anticipated outlay from DRF/SRF	Proposed outlay from RRSK	Total
(1)	(2)	(3)	(4)	(5)
1.	Civil Engineering	20000	30032	50032
1.1	Track Renewal Works	1750	3250	5000
1.2	Bridge Rehabilitation Works			
1.3	Other Track Safety Works (Broken Rail Detection system, Isolation of tracks, Vehicular ultrasonic testing system etc.)		11697	11697
1.4	**Total Civil Engineering**	**21750**	**44979**	**66729**
2.	Safety Works at Level Crossing (Elimination of LC, ROB/RUB etc.)	7500	43444	50944
3.	S&T Works	5090	10140	15230
4.	Rolling Stock related works		9263.55	9263.55
5.	Electrical related works	500	9495	9995
6.	Human Resource Development		1861.45	1861.45
7.	**Total All Directorates**	**34840**	**119183**	**154023**

Source: MoR Inter-departmental committee report on "Creation of RRSK for enhancement of safety of Indian Railway System".

6.2 Item-wise break-up of proposals envisaged to be funded through RRSK (totaling INR 119183 crores) is reproduced below for additional reference. As can be seen, initiatives cutting across departments have been proposed below to achieve Zero Accidents.

Table. Item-wise details inter-departmental safety works proposed to be funded through RRSK (All amounts in INR Crores)

S. No.	Items / Work Proposals	Projected Requirements (INR Crores)
(1)	(2)	(3)
A.	Civil Engineering	
1.	Track works	30032
2.	Bridge rehabilitation	3250
3.	Vehicular ultrasonic testing system for rail/welds	900
4.	Provision for broken rail detection system	1624
5.	Adoption of Flash butt welds and weld quality improvement	145
6.	Measures of safety enhancement and improved maintenance	2915
7.	Isolation of track from surrounding area	3995

(Contd.)

Table. Item-wise details inter-departmental safety works proposed to be funded through RRSK
(All amounts in INR Crores) *(Concld.)*

S. No.	Items / Work Proposals	Projected Requirements (INR Crores)
(1)	(2)	(3)
8.	Provision of Ballast less track at critical location	912
9.	E-Monitoring of engineering assets for timely preventive action	200
10.	Provision of diagnostic aids for bridges	381
11.	Up-gradation and modernization of girder fabrication facilities	325
12.	Arrangement for movement and unloading of P-way Materials	300
	Total Civil Engg	**44979**
B.	**Safety Works at Level Crossings (Elimination of LC, ROB/RUB/Subways etc.)**	**43444**
C.	**S&T Works**	
1.	Train Protection warning system/Train collision avoidance system	2750
2.	Up-gradation of standard of interlocking	1630
3.	Replacement of overaged signaling gears at stations by electrical/electronic interlocking and in block sections	2540
4.	Centralized on-line monitoring, predictive maintenance and event analysis	680
5.	Provision of mobile train radio communication on A, B and C routes of IR	1800
6.	Provision of OFC and Quad cables on IR	740
	Total S&T	**10140**
D.	**Mechanical Engineering**	
1.	Freight Design and maintenance	2082
2.	Coach design and maintenance	1014.05
3.	Diesel locomotive maintenance, crew management and disaster management	6167.5
	Total Mechanical Engg.	**9263.55**
E.	**Electrical Engineering**	
1.	Replacement of over aged Traction Distribution (TRD) assets	6500
2.	Conversion of unregulated OHE to Regulated OHE	1125
3.	Replacement of masts/Portals having critical implantations	425
4.	Replacement of old and over-aged transformer, cables, earthing, panels, wiring etc. for operating installations	300
5.	Audio/Video Recordings in loco cabs of all electric locos	210
6.	Automatic Wheel Profile Monitoring System	500
7.	Crew Friendly cab with air conditioning	435
	Total Electrical Engg.	**9495**
F.	**Human Resource Development**	**1861.44**
G.	**GRAND TOTAL**	**119183**

Source: MoR Inter-departmental committee report on "Creation of RRSK for enhancement of safety of Indian Railway System".

6.3 Compared to the requested funding of INR 1,19,183 crores as above, RRSK has a corpus of INR 1,00,000 crores. Clearly, all safety works requested by MoR cannot be funded through RRSK. The difficulty increases if one compares overall requirements of INR 1,54,000 crores *vis-à-vis* the RRSK fund corpus. Given this practical constraint, *prioritization of safety works is unavoidable.* Hence, MoR will necessarily need to complement funds from other sources (Extra Budgetary, PPPs, DRF, DF or other innovative means) to finance the balance unfunded safety program. **With this, the next section discusses the recommended framework for prioritization of Safety Works.**

7. RRSK Fund Deployment Framework

7.1 The objective of this section is to suggest a suitable framework MoR may consider for deploying RRSK funds. The framework essentially enumerates guiding principles which may be used for deciding works which need to be funded through RRSK on a priority basis. This is not to say that other safety works are not as important. As mentioned earlier as well, safety is a holistic subject and it requires a multi-disciplinary effort to make the system fail safe. Efforts of all Railway directorates are therefore equally important and equally critical. However, as funds are a constraint, it is not possible to fund every safety work through RRSK. The Government would need to tap into other sources to fund works that can't be funded through the same.

Framework Objective

7.2 Before proposing a framework to deploy RRSK funds, it is important to define the end goals/objectives targeted to be met through this fund. Ideally, the objective should be Zero Accidents and resultantly Zero accident related casualties or injuries. But this may be ambitious given the existing complexities of railway operations. Therefore, a more realistic objective is to minimize number of accidents and thereby create an environment where casualties, injuries or any loss to property is minimized. Such a situation would lead to a *"perceptible improvement in safety scenario over Indian Railways*" - as desired by MoR. Keeping this objective in mind, the paragraphs below discuss the recommended fund deployment framework.

Recommended Principles for prioritization

7.3 Identifying a range of inter-departmental safety initiatives, the committee of senior MoR officials projected funding need of about INR 1,19,183 crores from RRSK. Against this, the approved RRSK corpus is INR 1,00,000 crores. Clearly, everything cannot be funded through RRSK. Given this practical constraint, prioritization of safety works is unavoidable. Accordingly, the paragraphs below aim to outline the principles for prioritizing safety works.

7.4 The section on "Assessment of Accidents" brought out key insights pertaining to areas which require immediate and urgent attention for safety enhancement. The important findings are reproduced below for reference (Reference period of data assessments: 5 years from 2012-13 to 2016-17):

a) Together, Derailments and LC related accidents accounted for 90% of total accidents, 85% casualties and 82% injuries on IR networks. What this means is that initiatives for reducing/eliminating Derailments and Level Crossing accidents need to be accorded highest priority;

b) b) The next question to examine is which directorates/stakeholders account for the above accidents? Engineering, Mechanical, Electrical and Other than Railway Staff (primarily road-users) are responsible for 83% of all accidents. Out of this, Civil Engineering and Other than

Railway Staff account for 67% of accidents. Meaning most derailments and LC accidents are accounted by these stakeholders. On a y-o-y basis, there has been a 60% increase in the number of accidents for which Civil Engineering Directorate was responsible. With such *disproportionate contribution* to accidents and deterioration of y-o-y record, there is clearly a strong case for ensuring highest priority to Civil Engineering works.

This implies that, besides works for reducing/eliminating LC accidents, works undertaken by Civil Engineering, in particular, and other directorates - Mechanical and Electrical that lead to reduction/elimination of derailments need to be targeted on priority.

c) Human failures contribute to about 87% of all accidents. 46% of these are a result of railway staff failure and 41% failure of non-railway (road users). What this means that derailments/LC take place in the first place because people fail to respond or correct themselves appropriately. Hence, initiatives that eliminate opportunities of relying *primarily* on people need priority emphasis. This could be combination of works such as automated inspection & asset monitoring techniques, replacement of over-aged assets (tracks, signaling, etc.), eliminating un-manned level crossings and up-grading asset maintenance infrastructure, etc.

d) The interesting thing to note is that there is no contradiction in observations above. Take derailment for instance. Derailment happens due to infirmity in rail track or wheels. There could be various ways through which this can happen. Reliance on human inspection can create chances where gangmen may have failed to point out a crack or defect in rail. Similarly, delays in renewing tracks overdue for replacement may create opportunities where rail may fail. Inability to monitor condition of wheels (profile, etc.,) on a real time basis may create opportunities where train may derail due to wheel defect. So it's a complex combination of directorates (Engineering, Mechanical/Electrical) as well as human failure that "causes" derailment. Hence the observations in a), b) and c) above are completely consistent with each other.

e) To conclude, *minimizing/eliminating derailments and LC related accidents is the clear priority. All LC related works need to be funded adequately. For derailments, inter-departmental initiatives and those of Civil Engineering in particular need to be* funded. *Without the above priorities, achieving a perceptible improvement in railway safety may be unlikely.*

7.5 Given the above findings and considering the end objective of minimizing accidents and thereby loss of lives and property, the following principles are recommended for funding prioritization:

a) **Priority 1:** Overall, the case for prioritizing Civil Engineering Works (for minimizing derailments) and LC related works is **strongly evident.** Therefore, it is suggested that RRSK should ensure that most requirements of Civil Engineering works and LC related works are met. So, in this sense, these areas are suggested to have the first charge on RRSK;

b) **Priority 2:** The second charge on RRSK is suggested to be of those works/initiatives of Electrical and Mechanical Engineering Directorates which target derailments. Such works may, for example, include up-grading rolling stock maintenance infrastructure, technologies to monitor wheel profile, cracks, broken parts, adopting coaches with improved safety features (LHB, ICF coaches with CBC), etc.

c) **Priority 3:** Finally, balance RRSK funds are suggested to be deployed on works/initiatives which target reducing chances of human errors in critical areas of operations. Such initiatives may include investments on improving working conditions and training of safety critical staff such as loco-pilots, strengthening signaling systems to avoid instances of SPAD, using technology to monitor health of tracks/wheels/rolling stock components relevant for wheel track interactions, etc.

d) It may be noted that there may be overlaps in the above prioritization principles. For example, technologies such as broken rail detection system and vehicular ultrasonic testing systems may not only be treated as Priority 1 items (civil engineering works), but they may also be treated as Priority 3 items (reducing chances of human error in inspecting integrity of tracks). For all such cases, it is suggested that MoR may take a judicious call given their in-depth understanding of technical aspects of railway safety. While doing so, MoR may give due consideration to the underlying intent of prioritization, *which is to eliminate instances of derailments and LC accidents.*

7.6 These prioritization principles are also consistent with the overall safety vision articulated by MoR recently. As part of its vision,[9] MoR has committed achieving a safe and secure railway operating environment leading to *"Near Zero Fatalities"* within a time bound manner. Some key thematic targets include: a) Eliminating all Unmanned Level Crossings (UMLC's) on Broad Gauge (BG) network by 2020; ii) Upgrading rolling stock; and iii) Accelerating renewal of overdue tracks and ensure absence of backlogs in future.

Suggested RRSK Deployment Scheme

7.7 Basis the above prioritization principles and in-sync with the Safety Vision of MoR, an attempt has been made to suggest a RRSK deployment mix. It may be noted here that this deployment mix is *indicative* as there are areas where MoR may need to do more assessments. For example, it is suggested that funding for Engineering Works should first be undertaken on Classes A (High Density Networks), B, C, D and D Special. Any savings on account of not undertaking works of other route classes should be diverted to Priority 2 and 3. Further, the obvious underlying assumption is that only Capital Works are to be covered. Revenue works are not proposed to be funded through RRSK.

9. Source: Indian Railways - Vision and Plans 2017-19 released by MoR in January 2017.

Table. Recommended RRSK deployment scheme (Over a 5-year period)

Directorate	Funding Requested from RRSK (INR Crores)	Recommended Funding (INR Crores)	Priority	Remarks
(1)	(2)	(3)	(4)	(5)
LC Related Works**	43444**	43444**	1	Understand this is MoR's share. Recommend if MoR's share can be brought down through innovative models like State Govt. funding, PPPs or Ministry of Road Transport & Highways (MoRTH) funding
Civil Engineering Works	44979	44979	1	Recommend works on A, B, C, D and D Special routes be done first and savings on non-priority routes, if any, should be passed on to other unfunded works under Priority 2 and 3 below
Electrical + Mechanical	18758.55	11577	2 and 3	Recommend works that target eliminating/minimizing derailments and improve conditions of safety critical staff such as loco-pilots. MoR may request each directorate to delineate those works appropriately. Examples include up-grading rolling stock maintenance infrastructure, technologies to monitor wheel profile, wheel defects, broken parts, adopting coaches with improved safety features, crew-friendly cabs, audio-video recording in cabs etc.
S&T	10140			Recommend works that target eliminating/minimizing derailments such as technologies for eliminating SPAD instances etc.
HRD	1861.45			Recommend investment on training staff to adopt and understand technologies to eliminate opportunities of human errors.
Total	119183	100000		Recommend balance unmet requirements to be funded from other IR sources including innovative funding from EBR, PPPs etc.

Source: Internal Analysis.

7.8 **A caution on the recommended RRSK fund deployment for LC works is warranted here. As per the extant policy guidelines, the costs for undertaking LC works (ROB/RUB construction, etc.,) are shared between MoR and State Governments or for some cases Ministry of Road Transport and Highways (MoRTH) as well. Some

relevant principles[10] of this cost-sharing framework are re-produced below:

a) *ROB/RUB works are undertaken by Railways in lieu of existing level crossings on cost sharing basis if the traffic density at the level crossing is one lakh or more Total Vehicular Units (TVUs) (TVU- a unit* obtained by multiplying the number of trains to the number of *road vehicles passing over the level crossing in 24 hours) otherwise on 'Deposit Terms' basis.* ***Cost of Land is borne by State Government.*** *Construction of ROB/RUBs in lieu of existing level crossings which have traffic* density of less than 1 lakh TVUs is considered on *'Deposit' Terms, proposal for which is sponsored by concerned State Govt. duly agreeing to bear the entire cost of construction and recurring maintenance charges thereof. Similarly ROBs at new places where no level crossing exists' are also provided on 'Deposit' Terms.*

b) *Railways share* ***50% cost*** *of the total work for a two lane Road Over Bridge, i.e., 7.5 meter wide carriage way with 2 footpath of 1.5 meter width on either side.*

c) *Railways share* ***50% cost*** *of 4 lane ROB/RUB provided minimum TVU of the level crossing is 3 lakhs comprising not less than 6000 road vehicle units.*

7.9 Hence, for most of the LC works, Railways bears only a proportion of total costs (and not the entire). Rest of the cost is borne by State Government. The problem with such arrangement is that, despite MoR deploying its share through RRSK, LC works cannot be completed till the balance funding is *not* made available by State Governments. To elaborate this further, assume a ROB costing say INR 50 crore is to be constructed to eliminate an LC. Even if MoR funds INR 25 crore for this work through RRSK, the work can't be completed till the concerned State Government releases the balance amount. Therefore it is *recommended* that RRSK funds should not be deployed for *those LC works where contribution from States/other authorities is not available.* Savings on account of non-deployment of such funds should be allocated instead to derailment related projects of other directorates (Electrical, Mechanical, S&T, etc.). *This approach will ensure that RRSK funds are deployed efficiently and effectively without getting locked up on projects that can't be implemented in a timely manner.*

7.10 Finally, it is again re-iterated that an unbiased independent attempt has been made to devise RRSK deployment scheme. This is based on an objective analysis of accident related data and is *open to further review and wider debate. Ample flexibility* has been proposed where MoR can deploy savings from expenditure on Priority 1 areas to other areas. For example, savings on account of engineering works on routes other than A to D Special class, can be utilized on Priority 2 and Priority 3 areas. Further, opportunities also exist particularly on LC related expenses where MoR share could come down through collaboration and additional support from other agencies (PPPs, MoRTH, etc.).

7.11 However, Accidents happen due to complex factors and hence it is important to implement other initiatives, as well, that could not be funded through RRSK. Despite not having a dedicated safety fund in the past, safety plan-head funding pattern earlier showed that MoR has been able to find appropriate funds in the past. It is hoped that the same pattern continues in future for unfunded works.

10. Source: Relevant extracts from "Policy Issues related to Level Crossings and ROBs/RUBs No. 2007/CE I/LX/90" as received from the Ministry of Railways

8. Other related suggestions

8.1 Taking a step back, the end goal of setting up RRSK in the first place is to create an environment where no accidents happen. That would mean zero casualties or injuries or loss to property. Deploying RRSK funds is a crucial means to achieve this. But it would defeat the purpose if funding does not make the desired impact. It is therefore suggested that *RRSK outlays are linked to specific outcomes* which are measurable and can be monitored from time to time. This would require the respective directorates to design outcomes against initiatives being funded from RRSK. Some suggestions are given below. It is also recommended that the Railway Board devises a strategy to take course-correction measures in case fund deployment does not lead to clear measurable improvement in railway safety.

Table. Suggestions for linking RRSK outlays to Safety Outcomes

Directorates	Suggested Outcomes for measuring impact of RRSK Outlays
(1)	(2)
Civil Engineering	* % reduction in rail fractures/defects (measuring impact of track renewals) % increase in fractures/defects detected through USFD/Broken rail technology (measuring impact of using new inspection technologies) Reduction in derailments accidents on routes where investments made (Overall investment impact)
Mechanical & Electrical	% reduction in accidents attributed to these directorates % increase in wheel failures detected through new technology
Overall	% reduction in LC accidents and derailments % reduction in casualties or injuries related to LC and derailments

8.2 The second related suggestion to improve overall safety situation is to consider a paradigm shift in the way safety is operationalized in IR institution. The HLSRC Committee headed by Dr. Kakodkar had recommended creation of a new statutory outfit "Railway Safety Authority". The Committee had proposed various details related to the same - its organizational structure, scope and powers, statutory position, linkages with the Railway Board and the Ministry, functions, etc. This is broadly in line with global best practices[11] where railway systems prepare a systematic analysis of the safety risks faced and the set of measures needed to mitigate the risks. The independent safety authority reviews and approves the safety case and oversees its implementation.

8.3 It is therefore suggested that MoR considers appropriate changes in the way safety organization is structured and dealt with in its institution currently.

8.4 Finally, it is also suggested that MoR considers relooking/redesigning existing Railway timetable. Several High Density Network (HDN) sections in IR network operate with capacity utilization greater than 120% (even up to 150% and beyond for some). One of the key

11. Source of these inputs: World Bank Team comprising Ms. Martha Lawrence, Mr. Benedict Eijbergen, Karla Carvajal and Mr. Atul Agarwal

reasons for this is mixed traffic that runs on the railway network. Mail/ Express/ Rajdhani/ Shatabdi, Ordinary passenger trains, goods trains all ply on the same route with different speeds and priorities. Majority trains that carry passengers do not run to optimal capacities thereby choking the available network. For example, some trains may run with configuration of 12 coaches, others with 14, 16, 18 and so on. This issue is further aggravated as slow ordinary passenger trains often stop at a large number of stations thereby clogging entire network. Such heavy capacity utilization poses significant risk to Railway safety as undertaking track maintenance or inspection activities becomes difficult on a daily basis.

8.5 Hence redesigning Railway timetable in a manner that sufficient margin is available for safety checks is imperative. Ongoing network decongestion and expansion projects on HDN routs (doubling, tripling, quadrupling, DFCC, etc.,) would surely give above safety margins. However, till the time these projects are being commissioned, MoR may consider rationalizing trains (by combining few trains; increasing coaches or wagons, rationalizing stops) as an alternate approach.

9. Conclusion

9.1 MoR had set an Inter-departmental Committee in October 2015 of senior officials to project investment requirements for executing safety works. With a final objective to achieve **Zero Accidents** in IR system, the committee outlined measures requiring an overall investment of about INR 1,54,000 crores. Out of this, funding of around INR 1,19,000 crores was proposed to be met through a new dedicated Railway Safety Fund called "Rashtriya Rail Sanraksha Kosh" ("RRSK"). The balance (about INR 35,000 crores) was proposed to be met from IR's own sources. Pursuant to discussions between the Railway Minister and the Finance Minister, RRSK was announced in 2017-18 Budget speech with a corpus of INR 1 lakh crore over a period of 5 years.

9.2 Clearly, all safety works cannot be funded through RRSK. Given this practical constraint, prioritization of safety works is unavoidable. Objective analysis of data related to railway accidents over the last 5 years (2012-13 to 2016-17) throws the following crucial observations:

a) Together, Derailments and LC related accidents accounted for 90% of total accidents, 85% casualties and 82% injuries on IR networks;
b) Engineering, Mechanical, Electrical and Other than Railway Staff (primarily road-users) are responsible for 83% of all accidents. Out of this, Civil Engineering and Other than Railway Staff account for 67% of accidents. On a y-o-y basis, there has been a 60% increase in the number of accidents for which Civil Engineering Directorate was responsible.
c) Human failures contribute to about 87% of all accidents. 46% of these are a result of railway staff failure and 41% failure of non-railway (road users).

9.3 The above observations clearly mean that initiatives for reducing/eliminating Derailments and Level Crossing accidents need to be accorded highest priority. While there are identified works to eliminate LC accidents (constructing ROBs/RUBs, etc.), eliminating derailments requires inter-departmental action. There is a strong case to adequately fund Civil Engineering works first given the observations above and given its disproportionate contribution to accidents. Hence, in this regard, Civil Engineering Department works are recommended to have the first charge/priority on RRSK.

9.4 Civil works need then to be complemented by works of the following directorates - Mechanical and Electrical that target reduction-/elimination of derailments. Initiatives of other directorates (S&T, HRD etc.) which target reducing chances of human errors in critical areas of operations are recommended to have the third charge/priority.

9.5 Basis the above principles, a suggested RRSK deployment scheme has been developed. The same is re-produced below for **review and further debate:**

Table. Recommended RRSK deployment scheme (Over a 5-year period)

Directorate	Funding Requested from RRSK (INR Crores)	Recommended Funding (INR Crores)	Priority	Remarks
(1)	(2)	(3)	(4)	(5)
LC Related** Works	43444	43444	1	Understand this is MoR's share. Recommend if MoR's share can be brought down through innovative models like State Govt. funding, PPPs or MoRTH funding
Civil Engineering Works	44979	44979	1	Recommend works on A, B, C, D and D Special routes be done first and savings on non-priority routes, if any, should be passed on to other unfunded works under Priority 2 and 3 below
Electrical + Mechanical	18758.55	11577	2 and 3	Recommend works that target eliminating/minimizing derailments and improve conditions of safety critical staff such as loco-pilots. MoR may request each directorate to delineate those works appropriately. Examples include up-grading rolling stock maintenance infrastructure, technologies to monitor wheel profile, wheel defects, broken parts, adopting coaches with improved safety features, crew-friendly cabs, audio-video recording in cabs etc.
S&T	10140			Recommend works that target eliminating/minimizing derailments such as technologies for eliminating SPAD instances etc.
HRD	1861.45			Recommend investment on training staff to adopt and understand technologies to eliminate opportunities of human errors.
Total	**119183**	**100000**		Recommend balance unmet requirements to be funded from other IR sources including innovative funding from EBR, PPPs, etc.

*** Recommend RRSK funds to be not deployed for those LC works where contribution from States/other authorities is not available. Savings on this account should be re-appropriated to works of other directorates (Mechanical, Electrical, S&T etc.) targeting derailment.*

9.6 It is also suggested that RRSK outlays are linked to specific outcomes which are measurable and can be monitored from time to time. This would require the respective directorates to design outcomes against initiatives being funded from RRSK. This would also enable Railway Board to take course-correction measures in case fund deployment does not lead to clear measurable improvement in railway safety.

9.7 Another related suggestion to improve overall safety situation relates to setting up a new statutory independent outfit "Railway Safety Authority". This suggestion has already been recommended by the HLSRC headed by Dr. Kakodkar. This is broadly in line with global best practices where railway systems prepare systematic analysis of the safety risks faced and the set of measures needed to mitigate the risks. The independent safety authority reviews and approves the safety case and oversees its implementation. Finally, it is suggested that MoR considers relooking/redesigning existing Railway timetable. Timetable should be redesigned in a manner that sufficient margin is available for daily safety checks.

9.8 Ensuring safety in railways is an absolute imperative for the Government. Together, all the above measures are expected to significantly enhance safety in railways. Implemented efficiently, these suggestions have the potential to structurally transform the safety situation thereby enabling MoR realize its vision of "Near Zero Fatalities" in the next few years.

REPORT OF THE RAILWAY ACCIDENTS INQUIRY COMMITTEE PART I, NOVEMBER 1968

CHAPTER VI. SUMMARY OF OBSERVATIONS AND RECOMMENDATIONS

623. In the following paragraphs, we have summarised the observations and recommendations made by us in the foregoing chapters of this Report. Our endeavour has been to condense into this summary the more salient parts of our observations so that their purport is rendered in a concise form for the reader's convenience. We would, however, emphasise that a full and proper appreciation of what appears in the summary is possible only by going back to the observations in the main paragraphs which set out the background and the relevant facts and figures pertinent to the observation.

CHAPTER I - INTRODUCTORY

(1) We have decided to take a period of five years commencing from 1st April, 1963 and ending on 31st March, 1968 for the purpose of review of the position of accidents. (Para 3)

(2) We have decided to include in Part 1 of our Report (a) a statistical appreciation of the trend of accidents since the setting up of the Kunzru Committee and (b) an appreciation of the action taken by the Government on the Kunzru Committee's recommendations and our evaluation in regard to these. These cover item (i) of the terms of reference set down for us.

(3) We have decided that the second part of our Report would be devoted to suggestions to minimise accidents further as required in item (ii) of the terms of reference. We may find it necessary to amplify in Part II of our Report some of the observations made in the light of further information and elucidation. (Para 7)

CHAPTER II - STATISTICAL APPRECIATION OF IMPORTANT CATEGORIES OF TRAIN ACCIDENTS

(4) We have decided to confine our study mainly to the four principal categories of accidents, namely, collisions, derailments (including those caused by train wrecking), accidents at level crossings and fires in trains. In addition, other categories which are accidents only technically but are otherwise potential hazards, like averted collisions, breach of block rules and drivers passing signals at danger have been surveyed in broad terms. (Para 8)

(5) The Kunzru Committee had surveyed the incidence of certain categories of accidents from 1957-58 to 1962-63. In order, therefore, to bring out a comparative perspective, we have, where possible, juxtaposed the corresponding figures for the years 1957-58 to 1962-63 in our study (Para 9)

(6) There was a significant decrease in the number of accidents in each of the four categories, namely, collisions, derailments, accidents at level crossings and fires in trains during the five years ending 1967-68 as compared to the 6-year period ending 1962-63. The decline over these years was fairly steady except for a slight reversal of the trend during 1967-68. (Para 11)

Collisions

(7) The number of collisions on both the broad and the metre gauges came down considerably on all the Railways individually during the years 1963-64 to 1967-68 as compared to the preceding six years. (Para 20)

(8) We find that the wide gap in the incidence of collisions per million train kilometres between the broad gauge and the metre gauge, pin-pointed by the Kunzru Committee, has been considerably narrowed down during the last five years primarily because of the improvement on the broad

gauge, even though the incidence on the metre gauge continued to be lower than on the broad gauge. (Para 21)

(9) We see no reason for fixing different targets for the broad gauge and metre gauge in respect of collisions and we are unable to subscribe to the view that the higher incidence of collisions on the broad gauge is inevitable. (Para 21)

(10) The incidence of goods train collisions per million goods train kilometres has been showing a more or less downward trend; The position in regard to passenger train collisions has been fluctuating. The incidence of passenger train collisions per million passenger train kilometres on both the broad and the metre gauges showed an increase in 1967-68. (Para 24)

(11) The largest proportion of collisions on the broad gauge during the period 1963-64 to 1967-68 was between 'two trains or between a train and light engine'. Such collisions constituted 50.6 per cent of the total number of collisions on the broad gauge. The incidence of such collisions shot up in 1962-63 and though since then, some decline has been registered, the incidence has continued to be high (Para 26)

(12) The percentage of collisions 'between a train and a rake or load or vehicles stabled on a running line' during the period 1963-64 to 1967-68 was substantial. This is a pointer to the fact that lever collars and similar reminder appliance do not seem to be in regular use and this habit needs to be ingrained into the station staff. (Para 27)

(13) The incidence of collisions between 'a train and a trolly or a lorry' on the broad gauge registered a substantial decrease in the last five years when compared with the preceding six years. Considering that in most of such collisions responsibility rests squarely on the official incharge of the trolley or lorry who is usually a responsible railway official, there is considerable scope to reduce and, if possible, eliminate such accidents. (Para 28)

(14) The incidence of collisions between 'a train and buffer ends or other stationary objects' on the broad gauge has been fluctuating over the last 11 years and in particular during the first four years of the five-year period reviewed by us, the incidence has registered a rise from one to six. (Para 29)

(15) There has been a decline in the number of collisions on the metre gauge under each group except those between 'a train and buffer ends or other stationary objects' when comparing the five years 1963-64 to 1967-68 with the previous six years ending 1962-63. (Para 30)

(16) Our observations about the use of lever collars and reminder appliances, made earlier in the case of broad gauge, apply equally to metre gauge also. (Para 30)

(17) The average number of collisions caused by the reception of trains on blocked lines or despatching them into blocked sections in the years 1963-64 to 1967-68, taking the broad and the metre gauges together, remained more or less the same as during the preceding six years. (Para 34)

(18) The average number of collisions caused by drivers disregarding signals or failing to control trains during the five years ending 1967-68 remained more or less the same as during the preceding six years. (Para 34)

(19) The incidence of collisions due to failures of the station staff was the heaviest on the Central, the Northern and the South Eastern Railways; due

to failures of drivers on the South Eastern and the Eastern Railways, and due to non-protection of trollies or lorries on the Southern Railway. (Para 36)

(20) Of the total number of collisions attributable to failures of station staff, nearly 71 per cent of these occurred at the time of reception of trains and 21 per cent at the time of dispatch of trains. Of the collisions caused at the time of reception of trains, nearly half were due to lines being occupied and of the collisions which occurred at the time of despatch of trains, more than half of the collisions occurred due to obstruction of line. (Para 38)

(21) Of the total number of collisions caused by the failures of drivers more than half occurred due to the drivers disregarding or overshooting the signals governing them. (Para 10)

(22) The factor of speed has no marked correlation with the incidence of collisions within the authorised speed ranges. (Para 41)

Derailments

(23) The incidence of derailments shows a generally declining trend over the years on both the broad and the metre gauges, though on the broad gauge the position has been more or less static since 1965-66. (Para 48)

(24) The incidence of derailments on the metre gauge has continued to be consistently higher than on the broad gauge despite the lesser train kilometrage on the former. This has been there all through and was so even during the years 1057-58 to 1962-63. (Para 49)

(25) While overall, there has been an improvement in the incidence of derailments, the position, relating to midsection derailments has not kept pace with the improvement as registered in station derailments. (Para 50)

(26) The deterioration in position in regard to the midsection derailments on the broad gauge during the five years ending 1967-68 was contributed by the Northern, the Southern and the South Eastern Railways. (Para 50)

(27) There was a sharp rise in the midsection derailments on the metre gauge on the Northeast Frontier Railway. (Para 50)

(28) There was an increase in the number of passenger train derailments on both the gauges and of goods train derailments on the broad gauge during 1967-68 as compared to the previous year. (Para 51)

(29) The Southern Railway on the broad gauge and the Northeast Frontier Railway on the metre gauge are at the top in respect of passenger as well as goods train derailments per million passenger and goods train kilometres respectively. (Para 52)

(30) On the broad gauge, the incidence of passenger train station and midsection derailments was the highest on the Northern Railway and of goods train station and midsection derailments on the Central and the South Eastern Railways. (Para 33)

(31) On the metre gauge, the derailments involving both passenger and goods trains at stations were the heaviest on the North Eastern Railway and in midsection on the Northeast Frontier Railway. (Para 55)

(32) The incidence of derailments attributable to each of the broad causes, viz., staff failures, permanent way failures, carriage and wagon defects, engine defects and miscellaneous causes

declined substantially on both the broad and the metre gauges in the five years ending 1967-68 as compared to the preceding six years, except in the case of engine defects on the metre gauge; the number of derailments on the metre gauge due to engine defects increased from 164 in the six years ending 1962-63 to 228 in the subsequent five years. (Para 55)

(33) The midsection derailments attributable to staff failures rose on the broad gauge from 66 during the six years ending 1962-63 to 95 during the five years ending 1967-68. On the metre gauge, the total number of midsection derailments attributable to this cause came down from 269 to 202. (Para 56)

(34) The total number of derailments attributable permanent way failures came down substantially during the period under review as compared to the preceding six years: the number of midsection derailments attributable to this cause, however, increased significantly. (Para 37)

(35) The number of derailments attributable to carriage and wagon defects-both station and midsection-showed a decrease on both the broad and the metre gauges during the five years ending 1967-68 as compared with the preceding six years. (Para 58)

(36) The incidence of derailments attributable to engine defects showed a clear decline in the five years ending 1967-68 as compared with the previous six years on the broad gauge. On the metre gauge the incidence due to this factor went up in respect of both midsection and station derailments. (Para 61)

(37) There was a substantial reduction in the incidence of station and midsection derailments attributable to 'miscellaneous causes' during 1963-64 to 1067-68 as compared with 1957-58 to 1962-63 on both the broad and the metre gauges on all the Railways except the Northeast Frontier Railway. (Para 65)

(38) We have studied further the broad causes of derailments by classifying them according to their nature in order to have a closer look at each of the causes. (Para 67)

(39) A large proportion of derailments attributable to staff failures on both the gauges was caused by incorrect setting or non-locking or faulty operation of points. Disregard of the approach and departure signals and failure to regulate or control trains on the broad gauge, excessive speed and faulty driving on the metre gauge were the other main contributory factors. (Para 67)

(40) The largest number of derailments due to incorrect setting or non-locking of points and due to drivers' failures occurred on the Central Railway on the broad gauge and on the North Eastern Railway on the metre gauge. (Para 68)

(41) A substantial number of derailments attributable to permanent way failures on both the gauges was caused by sinkage or track and other causes which are manifestations of unsatisfactory maintenance of track. (Para 69)

(42) The incidence of derailments due to poor maintenance of track has been the heaviest on the Southern and the South Eastern Railways and due to sinkage of track on the South Eastern and the Northeast Frontier Railways. (Para 70)

(43) The chief carriage and wagon defects responsible for derailments on both the gauges were defective or broken springs or suspensions, broken axles or journals, defective wheels or tyres and breakage of undergear, vacuum or brake fittings. (Para 72)

(44) The incidence of derailments due to defective or broken springs or suspensions was the highest on the South Eastern and the Southern Railways due to broken axles and journals on the Northern and Western Railways and due to breakage of undergear and brake fittings on the South Eastern and the North Eastern Railways. (Para 73)

(45) The largest single primary factor in derailments due to engine defects on the broad gauge was defective wheels and tyres. On tile metre gauge too, this was the largest single factor next to 'other engine defects'. (Para 74)

(46) The incidence of derailments due to defective wheels and tyres was the highest on the Southern Railway on the broad gauge and the Western Railway on the metre gauge. (Para 75)

(47) We find that in a large number of cases of derailments, the cause is shown as 'accidental'. We apprehend that by treating the causes of derailments whole-sale as 'accidental', the administration's attention is unlikely to be pin-pointed on the source of trouble. It would appear to indicate as if the enquiring officers were bringing a departmental approach to bear on the question and avoiding the fixing of pointed responsibility. (Para 77)

(48) We find that the speed factor does not have a direct correlation with the incidence of derailments. (Para 81)

Accidents at level crossings

(49) Nearly 69 per cent of the accidents at level crossings during the last five years occurred at unmanned level crossings which constitute 62 per cent of the total number of level crossings. The remaining 31 per cent of the accidents took place at manned level crossings which constitute 38 per cent of the total number of level crossings. This broadly confirms the conclusion, earlier drawn by the Kunzru Committee also, that the manning of level crossings does not provide a completely satisfactory remedy against the accidents at level crossings. (Para 89)

(50) The incidence of accidents per manned and unmanned level crossing taken separately as well as together has been reduced appreciably during the last five years as compared with the six years ending 1962-63. (Para 90)

(51) The number of passenger trains involved in accidents at level crossings was more than of goods trains on both the broad gauge and the metre gauge systems; the disparity was greater in the case of metre gauge. (Para 91)

(52) The number of accidents at manned level crossings involving passenger trains increased from 9 to 14 on the broad gauge and from 1 to 5 on the metre gauge during 1967-68 as compared to the previous year. This is a disturbing feature. (Para 91)

(53) In the accidents at manned level crossing during the last five years, about 53 per cent railway staff and 47 per cent road users were involved in acts of omission and commission. (Para 96)

(54) The largest proportion of the accidents at both manned and unmanned level crossings involved motor trucks, the bullock carts coming next. Between themselves, these two were involved in about two-thirds of all the accidents at level crossings during the last five years. (Para 100)

(55) The number of accidents at manned level crossings was the highest during 00.00 to 04.00 hours, closely followed by that during 20.00 to

24.00 hours: during these 8 hours of night, 42 per cent of the total number of accidents at manned level crossings occurred. The need for intensive and surprise checks of gates at night is, thus, clearly indicated. (Para 103)

(56) The largest number of accidents at unmanned level crossings, i.e., about 38 per cent of the total number of accidents at unmanned level crossings occurred during the day, viz., from 08.00 to 16.00 hours and another 37 per cent during the hours of partial daylight, viz., 04.00 to 08.00 hours and 16.00 to 20.00 hours. (Para 104)

Fires in Trains

(48) We find that the speed factor does not have a direct correlation with the incidence of derailments. (Para 81)

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08.00 to 16.00 hours and another 37 per cent during the hours of partial daylight, viz., 04.00 to 08.00 hours and 16.00 to 20.00 hours. (Para 104)

Accidents on narrow gauge lines

(67) The number of accidents on the narrow gauge came down substantially during the last five years as compared to the six years period ending 1962-63. The decline is reflected in the incidence of all categories of accidents except collisions; the incidence of collisions during the two periods was more or less equal. (Para 123)

(68) There were nine collisions, all involving passenger trains, on the narrow gauge during the last five years; six of these were between two trains including between a train and a light engine. Six of the collisions were caused by reception of trains on blocked lines or incorrect setting of points. (Para 124

(69) Derailments constituted nearly 83 per cent of all the important accidents on the narrow gauge during the last five years. (Para 123)

(70) The number of station and midsection derailments on the narrow gauge was 68 and 247 respectively during the last five years. (Para 127)

(71) Out of the 315 derailments, 74 occurred due to staff failures, 31 due to track defects, 70 due to carriage and wagon defects, 31 due to engine defects and 109 due to miscellaneous causes. (Paras 128 to 132)

(72) The Kunzru Committee had attributed the high incidence of derailments due to carriage and wagon defects and engine defects partly to the high percentage of over-aged locomotives and rolling stock on the narrow gauge. We find that: -

(i) the percentage of overaged locomotives on the narrow gauge has increased On all the Railways except the Northern Railway. On the Northeast Frontier Railway, all the locomotives 0n 31-3-l968 were overaged:
(ii) the percentage of overaged coaches has been reduced on all the Railways except the Eastern Railway, all the 88 carriages on the Eastern Railway were overaged. on 31-3-1968; and
(iii) there was a marginal reduction in the percentage of overaged stock on the Northern, the Southern, and the South Eastern Railways: all the other Railways recorded an increased percentage; in particular, the number of overaged stock on the Eastern and the Southern Railways was high. (Para 13.9)

(73) All the accidents at level crossings on the narrow gauge occurred at unmanned level crossings the number of passenger trains involved in such accidents was about twice that involving goods trains. (Para 135)

Breach of block rules

(74) A steadily falling trend is noticed in the number of cases of breach of block rules as also the incidence per million train kilometres on both the broad and the metre gauges. (Para 141)

(75) The highest incidence of breach of block rules on the broad gauge and the metre gauge respectively was on the Central and the Southern Railways. (Para 144)

(76) More than half, i.e., 53 per cent of the cases of breach of block rules were comprised of drivers' entering the block section without an authority or with an incorrect authority to proceed. 111 another 39 per cent cases the irregularities were on the part of the station staff who

received trains on blocked lines or despatched them into occupied sections or closed the line when the section was not clear, etc. (Para 146)

(77) We find that the block irregularities take place preponderantly on the single line. (Para 117)

Disregard of signals by drivers

(78) We find that out of 895 cases of disregard of signals, 266 resulted in mishaps, i.e., collisions, derailments or accidents at level crossings and 48 of the 266 cases related to passenger trains. (Para 1.53)

(79) There has been a substantial reduction in the average number of cases of disregard of signals overall as also on the broad gauge. On the metre gauge, however, there was a marginal deterioration. (Para 155)

(80) The incidence of disregard of signals in respect of both passenger and goods trains was the heaviest on the Western Railway on the broad gauge and the North Eastern Railway on the metre gauge. (Para 1.57)

(81) On the broad gauge the average number of cases in respect of each type of signals came down during the last five years when compared with the preceding six years except where two or more signals were disregarded together. (Para 159)

(82) On the metre gauge there was an increase in the incidence of disregard of approach signals and a marked deterioration in respect of departure signals. This deserves due notice of the Railways concerned. (Para 139)

(83) Signals on automatic territory were disregarded to the extent of nearly 7 per cent of the total number, (Para 159)

(84) There was some deterioration in the incidence of disregard of signals on the South Eastern, the Western, the Southern and the Northern Railways during the years 1963-64 to 1967-68 as compared with the preceding six years. (Para 160)

(85) During the last five years, three or more signals were disregarded together on no less than 19 occasions and all the four signals of a station were ignored at the same time in 6 cases. The disregard of two signals or more at the same time by the drivers indicates not merely a momentary lapse but a total aberration of the faculties of perception and control. We suggest that this would be a fruitful field for study by the Psycho-Technical Cell. (Para 161)

(86) Nearly 81 per cent of the cases of disregard of signals on the broad gauge and 78 per cent of such cases on the metre gauge took place at stations provided with lower quadrant two aspect signalling. (Para 162)

(87) On a number of occasions, signals were disregarded at stations equipped with multiple aspect upper quadrant and colour light signals on both the gauges. The need for educating the drivers in correctly observing the aspects of multiple aspect signals and correctly reading their indications is, thus, highlighted. (Para 162)

(88) In relation to the total service of errant drivers, we find that the largest number of instances involved drivers with less than 5 years service followed by drivers whose length of service ranged from 5 to 10 years. Drivers with more than 15 years of service were involved in disregard of signals oftener than those with service ranging from 10 to 15 years. This phenomenon resents another useful field for study for the Psycho-Technical cell (Para 165)

(89) We consider that a driver who disregards a signal is an incipient accident maker and should hc classified as accident-prone. Public safety demands that he should not, as far as possible, he placed on driving duty thereafter. (Para 164)

(90) We find that of the 682 drivers held responsible for the disregard of signals. over 60 per cent were in the age group of 45 years or less. More than half of the drivers 367 in all, were using spectacles. These figures also furnish useful data for a clinical study of drivers by the Psycho-Technical Cell. (Para 165)

Averted collisions

(91) There was a marked reduction in the number of averted collisions on both the gauges during the last five years as compared with the six years ending 1962-63. (Para 167)

(92) The largest number of averted collisions occurred between two trains including between a train and a light engine on both the gauges. Next came averted collisions between 'a train arid a rake or vehicles or load stabled on a running line'. This highlights the need for enforcing the use of lever and slide collars until track circuiting becomes available. (Para 171)

(93) The incidence of each type of averted collisions was higher on the broad gauge as compared to the metre gauge. (Para 171)

(94) We find that of the staff found responsible for averted collisions, nearly 78 per cent were traffic staff and 14 per cent loco running staff. (Para 173)

CHAPTER III - SERIOUS ACCIDENTS DURING THE YEARS 1963-64 TO 1967-68 - CAUSES AND CONSEQUENCES

(95) During the years 1963-64 to 1967-68, 79 serious accidents occurred on the Railways. In 78 of these accidents, statutory inquiries were held by the Commission of Railway Safety and in one case by a Commission appointed under the Commissions of Inquiry Act, 1952. (Para 178)

(96) The serious accidents during the last five years constituted 1 per cent of the total number of important accidents; these contributed 89 per cent of the deaths, 61 per cent of the injuries and 19 per cent of the damage caused by all the important accidents involving passenger and goods trains. (Para 180)

(97) The number of serious accidents increased from 74 in the five years-1957 to 1962-to 79 in the five years-1963-64 to 1967-68. (Para 182)

(98) The accidents attributable to failures of drivers and station staff, sabotage and accidents at level crossings were equal in number namely, 56 during the two five-year periods. (Para 182)

(99) A study of the 56 accidents during the years 1963-64 to 1967-68 reveals that: -

(a) the drivers caused 38 per cent of these, either by disregarding signals or by running at excessive speeds or by violating other safety rules;
(b) station staff were responsible for 23 per cent of these by incorrect setting of points or by receiving or despatching trains on blocked lines or sections;
(c) 30 per cent of these resulted from willful tampering with track or other acts of sabotage, and
(d) 9 per cent were level crossing accidents for all of which road users were found to be responsible, (Para 183)

(100) The number of serious accidents due to failures of drivers and station staff or defects in track, rolling stock, engines and fires in trains registered a reduction during the last five years as compared to the preceding 5 years. (Para 185)

(101) The increase in the number of serious accidents was almost entirely due to rise in the number of cases attributable to acts of sabotage, failures of road users and other miscellaneous causes, like rash acts of outsiders, natural calamities, explosions and undermined causes. (Para 186)

(102) The increase in the number of accidents caused by tampering with track or other acts of sabotage is a continuance of rising trend over the last 15 years which rose from 6 cases in the years 1952-1957, to 12 cases in next five years, and to 17 during the years 1963-64 to 1967-68. This evidence of lawlessness in our national life cannot but be viewed with disquiet. (Para 187)

(103) The large increase in the number of casualties in serious accidents during the last five years as compared to the preceding 5 years was mainly on account of the two accidents on the Northeast Frontier Railway due to sabotage and a case in which the whole train was washed away by a tidal wave on the Southern Railway. (Paras 188 and 189)

CHAPER IV - AN APPRECIATION OF THE RECOMMENDATIONS MADE BY THE KUNZRU COMMITTEE AND OF ACTION THEREON.

(104) A precise assessment as to what extent the declining tendency in the incidence of accidents was a direct result of the implementation of the recommendations of the Kunzru committee is difficult to make. Nonetheless it is clear that the recommendations of the Kunzru Committee did make an impact in promoting safety in train operation on the Railways during the last five years. (Para 192)

(105) (i) Our review of the more important of the recommendations made by the Kunzru committee is based primarily on the information furnished to us by the Railway Board; but wherever we had in our possession data relevant to the implementation of any of the recommendations gathered either from the Railway administrations or from other sources, such data have been used to amplify our comment.

(ii) The other observations of the Kunzru committee which are factual in nature or are suggestions which emphasise the observance of existing procedures and practices have been placed in an Appendix alongwith action taken as reported by the Railway Board and without our comments thereon. (Para 193)

Staff

(106) (i) We find that the available capacities for training have been utilised partially and the percentage of utilisation of capacity in case of certain categories of staff has dropped on some of the Railways.

(ii) We urge that the factors which militate against the proper utilisation of training facilities should be located and remedied. (Para 202)

(107) We find that while on some of the Railways no educational qualifications have been laid down for switchmen, on other different standards of education have been prescribed. (Para 204)

(108) We are unable to appreciate the wide variations in the duration of initial and refresher courses on the different Railways for certain categories of staff. We suggest that a uniform

practice in this regard should be adopted on all the Railways taking into account the requirements of the average employee in each category. (Paras 205 & 206)

(109) We consider that certain minimum educational qualifications and the duration and nature of training to meet the job requirements should be prescribed for the maintainers who have actually to maintain the sophisticated signalling gadgets. We find that, at present, there is no uniformity on the different Railways. The frequency of refresher training for them also needs to be specified. (Para 207)

(110) It is necessary that the training of staff should be examined in all its aspects, streamlined and rationalised. (Para 208)

(111) We find that many Instructors in the Training Schools are those who had been selected on ad hoc basis. We were informed that many of them are "rejects" from the open line. Some of the Instructors in the Schools are there for more than a decade. We consider these aspects unhealthy and suggest that only persons with outstanding record of work to their credit on the open line should find their way into the Schools as Instructors. In our view, the tenure of Instructors should be three to five years so that training in the schools is not divorced from practical working on the line. (Para 210)

(112) We find that in some cases the heads of the Zonal Training Schools remained at their posts for less than three years. We presume that whenever such transfers are ordered, the interests of training of staff are kept in view. (Para 211)

(113) There is no uniformity in the practice of giving refresher courses to certain categories of staff on the different Railways. We consider that the categories of staff in need of refresher training should be given such training on all the Railways without any exception. (Paras 219 & 221)

(114) We feel that much remains to be done if the backlog in refresher training is to be cleared and the recommendation of the Kunzru Committee effectively implemented. (Para 221)

(115) Overall, the extent of shortages in the various categories of staff on 31-3-68 ranged between 1.4 per cent and 3.0 per cent except in the category of assistant drivers where the shortage was to the extent of 5.9 per cent. Over individual Railways, in some categories, the shortages have been glaring, but by and large the extent of shortage has been diminishing. We urge that this matter should continue to receive the urgent attention of the Railway administrations. (Para 248)

(116) We feel that the measures necessary to curb overtime working by staff have not received the attention they deserved, in spite of the great stress laid on the subject of working conditions of staff by the Kunzru Committee. (Para 262)

(117) We are unable to appreciate fully the object of clamping down the leave reserves at the level obtaining on 4-2-1967 notwithstanding its inadequacy as the directive of the Railway Board of that date sought to do. We strongly recommend that the question of overtime working and leave reserves should be examined early. We see no conceivable reason why the minimum limits of leave reserves fixed by the Railway Board should not be immediately implemented. (Para 262)

(118) We find that on some of the Railways, the trips of running duty hours of more than 12 hours ranged between 15 per cent and 20 per cent of the total number of trips performed by the

goods train drivers during 1067-68. Every Railway had instances of trips exceeding even 20 hours of running duty. (Para 267)

(119) We urge that steps should be taken to ensure that the limit laid down in respect of duty hours of running staff is observed. Whenever, on any section, chronic long hours seem inherent, steps should be taken to change the crew at a suitable place so as not to infringe the prescribed duty-hour limitations. (Para 269)

(120) We have examined the average time taken by the various Railway Service Commissions for recruitment of certain categories of staff. We find that the time schedule prescribed for the various categories by the Railway Board has often been exceeded by all Railway Service Commissions. (Paras 274 & 275)

(121) We are informed that many of the panels of selected candidates are either partially used or not used at all by the Railway administrations on the plea of the vacancies anticipated at the time of the placing of indents not materialising. We consider it necessary that the Railway administrations should assess their requirements on a rational basis, the Service Commissions should observe the time schedule and offers of appointments to the selected candidates should be made within a reasonable time. (Para 276)

(122) We are informed that the procedure for recruitment of Class IV staff is cumbersome and results in delays. We are of the view that this aspect needs consideration and simplification of procedure for recruitment of Class IV staff and elimination of undue restraints in this behalf would be a step in the right direction. (Para 279)

(123) There was unanimity in the views furnished by the Railways and the evidence tendered before us emphasising the need for giving weightage to the sons of railway employees for recruitment o Railway service in order to ensure loyalty and efficiency through continuity of tradition of service. We shall advert to this in Part II of our Report. (Para 282)

(124) We find that the Northern Railway has fixed the percentages for direct recruitment in case of traffic apprentices and assistant signal and block inspectors higher than the respective percentages prescribed by the Railway Board. The Railway has not furnished any reason for adopting the enhanced percentages. (Para 286)

(125) We find that the Railways have in several cases made direct recruitment in certain categories in excess of the percentages prescribed by the Railway Board. In our view, direct recruitment should be regulated judiciously so that reasonable changes of promotion of staff already in service are not diminished in a particular year as is likely to be the case if an attempt is made to clear the accumulated deficiencies in one or two years. (Paras 287-289)

(126) We consider that for an administration to run efficiently and successfully, the position and morale of supervisors arc matters of utmost importance. (Para 291)

(127) We find wide variations in the jurisdictions of the various categories of supervisors on the different Railways. Very little seems to have been accomplished to bring about a measure of uniformity in the jurisdiction of inspectors over the various Railways. In our view, the evolving of yardsticks and their application with local adjustments as may be considered necessary, is essential. (Paras 298-299)

(128) In our view, the programme of personalised training on man-to-man basis needs to be re-oriented with an emphasis on the personal

contact and understanding between the officer or supervisor and the individual worker and specific individual attention to the latter. (Para 307)

(129) We find that the investigations conducted by the Psycho-Technical Cell are still in an experimental stage. We consider that if the value of psycho-technology as a means to promote safety in train operation has been recognised by the Railway Board every thing possible should be done to accelerate the process. We hope that when the stage arrives for the application of these tests in the selection of personnel, such tests will be handled by well qualified and responsible staff so that they become neither a mere routine not a source of harassment to the staff. (Para 310)

(130) We find that nearly 60 per cent of the employees held responsible for causing two or more accidents were in the category of drivers. In our view, this study may provide a pointer for psychological counselling and rational persuasion of these and other staff so that in future they may be able to render a relatively accident free service. (Para 311)

(131) We find that in spite of the fact that the strength of staff has increased practically in all categories, the percentage of those provided with railway quarters has also kept pace and in the case of some categories the position has shown definite improvement. We however, feel that a lot more remains to be done. We consider that in case of railway staff concerned with train operation, the provision of railway quarters is a matter of necessity rather than an amenity and would prove conducive to increasing the element of safety in train operation. (Paras 316-318)

(132) The morale of officers and the impact it has on the running of an organisation are indeed matters to which we attach great importance. Instances of intervention by influential outsiders in routine decisions taken by officers were brought to our notice. We agree that such factors inevitably tell on the morale of officers and their disposition to take right decision. We intend to give further thought to this in Part II of our Report. (Para 321)

(133) We find that the time taken in the finalisation of accident cases on some of the Railways is far beyond the targets laid down by the Railway Board. In particular, the long interval of time between the date of finalisation of accident enquiry and the acceptance of findings by competent authority is difficult to appreciate. (Para 325)

(134) While there is no gainsaying the fact that the present procedure of disciplinary action by its very nature is cumbersome and time-consuming, we find, as a result of a case study of some accidents, that there is not much substance in the widely held notion that the errant employees often resort to dilatory tactics. Our case studies show that if any thing, it is more the incidental delays occurring in the departmental office itself which account for the major portion of the delays. We consider that there is scope for considerable improvement if such delays in the processing of the case in the departmental offices are minimised. (Para 327)

(135) We consider that it would be advantageous if a provision is made in Section 101 of the Indian Railways Act to the effect that no court shall take cognisance of an offence under this Section and the cognate sections of the Indian Penal Code without the sanction of the authority who is entitled to remove the railway servant from office. Such authority would be in the best position to determine whether there should be a prosecution and if so who should be prosecuted. Where the police authorities feel that the competent authority is withholding sanction wrongly,

they can always approach the Railway Ministry for getting the necessary sanction. (Paras 337 & 338)

(136) We would like to think that in most accident cases, departmental action would meet the ends of justice and prosecutions of railway staff would be necessary only in a comparatively few cases of a serious nature. (Para 340)

Safety organisation, rules and other operating matters

(137) We are informed that the functions performed by the Safety Organisation are in the nature of "internal audit" on the aspects concerning safety in train operation and are highly useful and important. (Para 343)

(138) We have been advised that the Railway Board have appointed a Committee of officers recently to go into the general rules with a view to revising and simplifying these. We hope that the views expressed by the Kunzru Committee about the multiplicity of rules and the need for standardising the working practices will be kept in view while revising the rules. (Paras 347 & 348)

(139) In our view the minimum distance necessary for the protection of a trolley or a lorry should be uniform on all Railways. (Para 353)

(140) We find that from the anomalies and the deficiencies in the Working Time Tables of the Railways pointed out by the Kunzru Committee still persisted in the April 1968 issues. We urge that the Working Time Tables should be subjected to a thorough scrutiny before issue so that such anomalies and deficiencies do not recur. (Paras 357 & 358)

Permanent way

(141) We commend the progress made on track renewals and hope that the pace of renewals will be maintained. We hope that the speed restrictions attributable to worn or obsolete track will continue to be eliminated. (Para 364)

(142) We hope that the pace of welding of rails would be maintained, and even further accelerated. (Para 367)

(143) We find that there is an overall shortfall in the procurement of wooden sleepers on both the broad and the metre gauges over the past four years. We suggest that through renewals of wooden sleepered track on non-track circuited section may be carried out with CST-9, or steel trough and pre stressed cement concrete sleepers and the released serviceable second hard wooden sleepers used for random renewals. (Paras 371 & 372)

(144) We are unable to appreciate the reasons for the administration's mobility to develop the concrete sleepers to suit Railways' special requirements over the last many years. We urge the Railway administration to make special efforts for introducing the pre-stressed concrete sleepers on the Railways on an extensive scale in view of the unfavourable supply position of wooden sleepers and their increasing demand for modern signalling. (Para 375)

(145) We feel that greater efforts are called for to enhance the procurement of clean ballast from 5 to 9 million cubic metres per annum. (Para 383)

(146) We consider that the curve alignment register should embody the physical characteristics of each curve and first two or three columns

should contain the correct version and super elevation figures against each 'station'. (Para 384)

(147) In our view the replacement of the mate's diary by the 'gang inspection register' was quite unnecessary. We are informed that instructions have since been issued dispensing with 'gang inspection register'. (Para 386)

(148) We consider it important that the results of the trials of the improved methods of track maintenance, like 'measured shovel packing', 'directed maintenance', etc., are assessed early so that the Railways may be in a position to modernise their methods of maintenance of permanent way. (Para 392)

(149) We presume that no serious difficulty is being experienced with the use of 'on track' automotive tie tampers on the trunk routes and main lines. We feel that the output of tie tamping and ballast cleaning machines, compared to the current manual methods, would justify their continued use. (Para 395)

(150) We consider it necessary that the Assistant Engineer concerned should invariably be associated with the testing of the track by the Hallade track recorder and that the charts should be documented at the end of he day's run and defects, listed for prompt action by sectional permanent way inspector. (Para 398)

(151) We suggest that the construction and the equipment of the test cars should be completed on priority and that at least one test car for the metre gauge should be made available, as soon as possible. (Para 401)

(152) We find that the R.D.S.O. was asked to look into the question of track recording trollies only recently-in April 1968. It seems that action on this part of the recommendation of the Kunzru Committee had not been taken earlier. We understand that the proposal has since been given up. (Para 402)

Level crossings

(153) While we agree that it is not necessary to provide a rigid standard of yardstick, we do feel that some norm should be fixed for all Railways which may help them in deciding whether a particular unmanned level crossing should be manned and whether a manned level crossing requires upgrading. (Para 406)

(154) We are of the view that the five-yearly censuses should not be given up. (Para 407)

(155) We understand that the Railway Safety Works Fund was started sometime ago. We were advised that there had been hardly any expenditure out of this fund, primarily because the existing procedure for the operation of the Safety Works Fund is cumbersome. (Paras 409 & 410)

(156) We suggest that some procedure should be evolved by which 10 per cent of the amount in this Fund should be earmarked for manning the unmanned level crossings and upgrading of the manned level crossings and the Railway administration should be authorised to draw directly from this fund upto this amount for this purpose. (Para 411)

(157) We also suggest that the remainder of the Fund, i.e., 90 per cent should also be utilised to the best advantage by providing road overbridges or under bridges which would, undoubtedly, help in reducing the number of level crossing accidents. (Para 412)

(158) We do not consider that undulations and bumps on approaches to unmanned level crossings would have any advantage. We, therefore, do not think this matter need be pursued further. (Para 414)

(159) We consider the amendment to Motor Vehicles Act in States making it obligatory for drivers of passenger buses before passing an unmanned level crossing to stop and to cross them with the conductor of the bus walking ahead of the bus a wise provision and hope that the violation of this provision of the Law would be sternly viewed and the offenders brought to book. (Para 415)

(160) We consider that the basic object of interlocking of gates with signals is to ensure the safety of road traffic and it should be provided where the road traffic is heavy. We do not subscribe to the view that the measure of safety provided by the installation of warning bells is as good as that by interlocking gates with signals. (Para 422)

(161) We find that 24 per cent of the works involving interlocking of gates with signals still remain to be completed though the Railway Board had directed the Railways to complete these works during the Third Five Year Plan on a priority basis. The Board's directive seems to have gone partly unheeded. (Para 423)

(162) We are advised that the Railway Board do not consider the automatic half barrier suitable for Indian conditions and that the experiment may be taken as no longer alive. (Para 428)

(163) In our view, it is desirable that the responsibility for avoiding accidents should rest with the road users in the case of unmanned level crossings. We would not, therefore, advocate installing of bells and road flasher signals as it would result in unnecessary waste of money without comparable advantage in the matter of avoiding accidents in our conditions. (Para 429)

Signalling

(164) The assurance given by the Railway Board that all signalling and interlocking works brought forward from Second Five Year Plan and those included in the Works Programmes during the first three years of the Third Five Year Plan would be completed by the end of the Third Five Year Plan has not been completely fulfilled. The factors enumerated for delay cannot be deemed as unanticipated or such as could not be visualised at the time of planning and programming these works. (Paras 431-434)

(165) We find that there are a number of stations on the broad and the metre gauges which have not been provided with rudimentary interlocking though the Railway Board had directed the Railways to complete this work by 31-3-1964. We hope that this safety provision will be completed in a short time. (Paras 436 to 439)

(166) We find that a number of stations on the double line on some Railways are either nor provided with block instruments or are provided with block instruments with control on last stop signals only and not complete lock and block working. We feel that the recommendation of the Kunzru Committee in this behalf should have been fully implemented long ago in the interests of safety. (Paras 441 to 443)

(167) We find that only 41 per cent of the number of stations programmed to he provided with multiple aspect signalling of the upper quadrant or colour light type on 31-3-64, have heen so provided. (Para 446)

(168) We consider the achievements in respect of the provision of modern techniques of signalling to be inadequate in view of the increasing speed and density of traffic. In our view, the recommendation of the Kunzru Committee assumes urgency with the increasing introduction of diesel and electric traction and running of heavier trains at higher speeds. We urge that special efforts should be made to accelerate the progress in the use of modern signalling techniques. (Para 450)

(169) We note that the rate of progress in the provision of track circuiting so far has been slow. Judging from the performance of the last five years, it is obvious that unless energetic steps are taken to improve the pace of execution of track circuiting works, the target of 200 stations per year, set by the Board, may not be achieved We consider that the introduction of track circuiting at stations is an important step towards ensuring safety in train working. (Paras 455-456)

(170) In our view, the progress of efforts towards adoption of Automatic Train Control, on which the Kunzru Committee had laid stress, has been slow. We feel that had the trials and installation of Automatic Train Control been initiated earlier, certain signalling firms in India would have become interested in this field of manufacture already. (Paras 459-460)

(171) We find that the incidence of failures of signalling and interlocking gears, after a marked decrease in 1963-64, has been steadily increasing every year. The same pattern is discernible in case of failures of block instruments, where, however, a reversal of the trend is noticed during 1967-68. (Para 464)

(172) We urge that efforts to reduce track circuit failures to the maximum extent possible should be intensified. (Para 467)

(173) We find that the shortfall in the replacement of worn out frames during 1967-68 was considerably less than in the previous years but the number of worn out block instruments in need of replacement during 1967-68 was the highest of the past five years. (Paras 469-470)

(174) We stress the need for clearing shortfall in the overhauling and replacement programmes for lever frames and block instruments, investigating the factors responsible for failure of signalling and interlocking gears and laying down a yardstick for determining the strength of block, electric and mechanical signal maintainers. (Para 471)

Rolling Stock

(175) We suggest that the final trial of an overhauled locomotive should be carried out, as far as possible, at a speed 5 to 10 per cent higher than the maximum permissible speed of the locomotive, and a speedometer used for the purpose. (Para 475)

(176) We suggest that braking distance trials for graded sections on the broad gauge and for level and graded sections on the metre gauge should be carried out without delay. (Para 484)

(177) We consider that the distance between the distant and the first stop signals on high speed routes and the length of the signalling section in automatic signalling territory should not be less than the emergency braking distance. (Para 485)

(178) We hold the view that all locomotives working trains should be equipped with speedometers on a phased programme but it is essential that a target should be laid down in regard to the provision of this aid on all locomotives. (Para 489)

(179) (i) We find that during 1967-68 the majority of the Railways were unable to achieve the target laid down for the broad and the metre gauges in respect of engine failures. (ii) We notice that the performance on the Western. the Eastern and the Southern Railways on the broad gauge and the Central, the Northeast Frontier and the North Eastern Railways on the metre gauge was much below the target. (Paras 493 & 494)

(180) The need to improve the performance of diesel and electric engines is indicated. (Para 496)

(181) We find that the handbooks for drivers in use on the Eastern and the Northern Railways do not contain information about the defects likely to develop on engines on the run. The Northeast Frontier Railway has yet to bring out a handbook for drivers. (Para 497)

(182) The overaged locomotives on the metre gauge need further attention in maintenance in order to improve their performance. (Para 502)

(183) We consider the adoption of a uniform basis for fixing the time schedule for train examination and for determining the strength of examining gangs by all the Railways not only available but essential for the proper examination of trains and urge that any further delay in implementing the Kunzru Committee's recommendations should be avoided. (Para 511)

(184) (i) In our view, the Central and the North Eastern Railways should devote greater attention to the maintenance of rolling stock in their depots.

(ii) The results of spot checks by Neutral Control Flying Squad for 1967-68 highlight the deficiencies in train examination which should be speedily removed. (Paras 513 and 515)

(185) The increasing incidence of hot boxes on coaching stock on both the gauges over the last three years is a pointer to the need for the effective implementation of the recommendations of the Director, Research (Hot Boxes) and a further critical study, if necessary. (Para 521)

(186) We note a marked improvement in the incidence of hot boxes on goods stock on the broad gauge. (Para 523)

(187) There was an overall reduction in the number of coaches and wagons overdue periodical overhaul on Indian Railways as compared to the position obtaining on 31-3-63, the position in respect of coaches on the North Eastern and the Northeast Frontier Railways was however unsatisfactory. We urge that efforts to reduce the number of coaches and wagons overdue periodical overhaul still further should continue. (Paras 530, 531 Pc 533)

(188) We note that there has been a marked reduction in overaged coaches on both the broad and the metre gauges. (Para 538)

(189) There has been a reduction in the number of overaged wagons on the broad gauge hut there has been a notable increase in the number of such wagons on the metre gauge. We urge the Railways to make sustained efforts to reduce the number of overaged wagons particularly on the metre gauge. (Para 539)

(190) We note that there has been an improvement in respect of passenger train partings on both the gauges. There has also been a considerable improvement in the incidence of goods train partings on the broad gauge and a slight improvement on the metre gauge. We hope that the measures which brought about the

improvement in the position of train partings will be sustained and intensified. (Paras 544, 546 & 548)

Stores, post-accident relief measures and other matters

(191) We consider that though there has been some improvement in the availability of stores. there is considerable scope for further improving the position. (Para 552)

(192) In our view, the over-dependence of the Ministry of Railways on the Directorate General of Supplies and Disposals for their requirements and the effect this has on the availability and procurement of stores is a matter of considerable concern. (Para 555)

(193) We find that while the extant rules do not preclude non-acceptance of the lowest tender if it is otherwise not acceptable, in practice such discretion is rarely used in favour of reliable firms. We feel that a bolder attitude in such cases will be in public interest. (Para 556)

(194) We found that some of the Railways were ignorant of the existence of the standardised lists of safety items of stores as prescribed by the Railway Board. We hope the Railway Board would clarity the position to the Railways. (Para 558)

(195) We consider that inventory control in an enormous undertaking like the Indian Railways is a vital factor. It is apparent that modern methods will have to replace many of the old stores procedures. (Para 359)

(196) It would appear that the measures suggested to prevent tampering with track have proved ineffective. We are not unaware of the complex and difficult nature of this problem. We would urge that the steps for the security of the track against the dangers posed by the saboteurs will have to be persevered in and implemented with vigour. In our view, there must be close and continuous coordination between the Ministry of Home Affairs, State Government and the Railways if the designs of the saboteur are to be kept under restraint if not thwarted. (Para 566)

(197) We find that the work of rewiring of some coaches according to the revised wiring circuit remains to be completed on the Western Railway. (Para 568)

(198) We hope that the Kunzru Committee's recommendations in regard to the replacement of 4-wheeler medical vans with the bogie medical vans will be fully implemented within the shortest possible time. (Paras 572-573)

(199) We hope that special efforts will be made to complete the work in regard to the provision of sidings with double ends for stabling medical relief vans; this work has been outstanding for the last three years or so. (Paras 574-575)

(2OO) (i) We are sorry to observe that despite the Kunzru Committee's exhortation and the urgency of the matter no definite policy has been formulated by the Government in regard to the narrow gauge lines and this vital issue is still crying for a solution. (Para 578)

(ii) We recommend that the action taken by the British Government in a not dissimilar situation, should be taken by our government with a view not only to ascertaining the facts which may broadly be already known to the Railway administrations but also in educating and mobilising public opinion on the subject. (Para 579)

CHAPTER V - RESEARCH DESIGNS AND STANDARDS ORGANISATION (RDSO)

(201) We find that the work done in the RDSO in recent years has been notable and we would like to record our appreciation. (Para 581)

(202) We suggest that formal planning and allocations of resources should be arranged well in advance in respect of important items to avoid time lags. (Para 584)

(203) We feel that the recommendation of the Kunzru Committee regarding the bifurcation of the research organisation into two separate research directorates is no longer a live issue as the range of expansion of the RDSO during the last five years has more than covered the field that the Kunzru Committee had in mind. (Paras 585 and 587)

(204) We consider that the equipment and capacity of non-railway research and technical bodies including Universities to undertake the solution of problems peculiar to Railways is very limited in India. (Para 589)

(205) We agree that a 12 monthly frequency for meetings of the Central Board of Railway Research seems justified. We note that a three-year tenure of membership of this body has been adopted. (Para 592)

(206) We find that the delays in finding solutions to certain problems highlighted by the Kunzru Committee have in most cases been overcome. We would stress that there should be no slackening of efforts for still further improvements, particularly towards greater safety in all aspects of railway working. We consider that in the case of sophisticated and costly items, special measures including utilising the most expert advice obtainable are called for. (Para 594)

(207) We have satisfied ourselves that the Railway Board have given full weightage to the observations made by the Kunzru Committee for modernising the techniques regarding the design and building of bridges. (Para 597)

(208) We find that there is a separate directorate in the RDSO which handles all aspects of signalling and is currently engagad in introducing several modern developments. (Para 599)

(209) The need for Railways to collaborate technically with foreign firms in the manufacture of electrical and signalling equipment in India is no longer as great as before due to growing industrialisation in both the public and private sectors. (Para 599)

(210) We find that the RDSO had already been expanded and better equipped during the past five years and that further steps are in progress for its future growth. We favour its being looked upon as a standing Task Force. (Paras 602 and 603)

(211) In our view, the prescribing of a rigid percentage to be spent on the RDSO is not a feasible proposition. We agree that rigid suh-division of budgetary allotments between the various sections within the RDSO are also unnecessary. (Paras 604 & 605)

(212) We accept the view that suitability for discharging their duties efficiently plus some flair for designing and research should be the criterion for selecting railway officers for the RDSO. We urge that the Railway Ministry should do its best to staff the RDSO with the most suitable men available. (Paras 606, 607 & 608)

(213) We think that a period of 4 to 5 years should be the normal tenure of officers in the

RDSO. We would leave the age of superannuation to be considered in the wider context of public and 'service' considerations. (Paras 608 & 609)

(214) We agree with the Railways that the creation of a liaison organisation in the RDSO for the purpose of carrying out test checks on the quality of maintenance and standards of manufacture of railway equipment on the Railways will tend to dilute the responsibility already placed on supervisory and inspecting authorities and also result in some duplication. (Paras 610 & 611)

(215) We agree with the Kunzru Committee that the Documentation Section needs to be adequately expanded and modernised. We hope that the Railway Board would adopt a suitable policy speedily. (Para 614)

(216) We consider that an early revival of the liaison between the RDSO and the manufacturers of railway equipment is very much in the interests of the Railways themselves. (Para 615)

(217) We recommend that the results of the performance research studies, under actual working conditions, be carefully examined by the Railway Board, at Diretors' and higher levels for improving the standard servicing and maintenance practices on Zonal Railways. (Para 617)

(218) We agree with the Kunzru Committee that we should not hesitate to import equipment which is not readily available in the country as otherwise we shall be depriving ourselves of the most progressive and up-to-date ideas embodied in such equipment. (Para 618)

(219) We feel that there will be considerable advantage if experts in safety measures answering well on railways in advanced countries, can be invited to visit Indian Railways in the near future to give their appreciation of the present position and of how train operation can be made safer. (Para 620)

(220) We find that the Railway Board have accepted the recommendations of the Kunzru Committee regarding the status and powers of the Director General of the RDSO. (Para 621)

(221) We suggest that the tenure recommended for other responsible posts in the R.D.S.O. should also apply to its head, who should always be closely associated with the selection of individuals to fill important posts in the organisation. (Para 621)

(222) we express our appreciation of the detailed examination by the Kunzru Committee of various aspects of the R.D.S.O. and are of the view that many of the improvements made during the past five years in this organisation are largely due to this factor. (Para 622)

K. N. WANCHOO
Chairman

M. R.MASANI M.P.
Member

S.R. VASAVADA M.P.
Member

F.C. BADHWAR
Member

P. B. AIBARA
Member

K.D. MADAN
Secrelary
NEW DELIII,
23th November, 1968

REPORT OF HIGH LEVEL SAFETY REVIEW COMMITTEE, 2012
GOVERNMENT OF INDIA, MINISTRY OF RAILWAYS

Chapter IX
Conclusion

9.1 The Committee had a very satisfying time in interacting with various stakeholders and visiting work places on Indian Railways. Our impression that Indian Railway is committed to the nation got strengthened during our working with Indian Railways for the past about 5 months. The commitment and passion with which railway men of all stature and class work is truly commendable and can take Indian Railways to great heights.

9.2 The Committee also brings it on record that the contents of this report are largely based on the shortcomings observed on Indian Railway system and good points, though many, have not been detailed or discussed for the sake of brevity.

9.3 The Committee has given several recommendations in the previous chapters of this report. Some of the recommendations have financial implications while many of the recommendations do not require funds for their implementation. The requirement of funds to implement such funds specific recommendations indicating funds required against individual items is shown in table 7.

Table 7. Proposed Investment on Safety over 5 years as per HIGH LEVEL SAFETY REVIEW COMMITTEE

Figures in Crores of Rs.

S. No.	Items	Total Estimated Cost
(1)	(2)	(3)
1.	Advanced Signaling system to prevent collision with increased line capacity.	20000
2.	Elimination of all level crossings (manned and unmanned) by Grade separation (RUB/Limited High Subway/ROB.)	50000
3.	Switching over to production of all new coaches to LHB design. Following is the break up:	10000
	(a) Cost differential of LHB and ICF coaches (@ Rs. 1 Cr.)	7500
	(b) Additional Capacity in production units.	1500
	(c) Maintenance infrastructure in workshops and coaching depots.	1000
4.	No discharge toilets in coaches (bio toilets / vacuum toilets).	3000
5.	Weigh bridges.	10
6.	Improvement in infrastructure in workshops and open line depots.	5000
7.	Track friendly bogies for wagons.	2000
8.	Identification tag on all types of rolling stock, communication backbone on the entire system, IT enabled applications such as Wheel Impact Load Detectors (WILD), hot box detectors, On-sight High Speed Camera at examination points, Acoustic bearing and bogie monitoring system.	1000
9.	Self propelled USFD and track measurement machines.	1000
10.	Track Maintenance Machines including rail grinding M/C	5000
11.	Mobile Flash Butt welding Plants (@15 Cr. Per Machine). 1 each for the divisions.	1000
12.	Formation improvement works	2000
13.	Capacity enhancement in training CTIs, ZRTIs, STSs. Divisional Training Schools.	500
14.	Proliferation of portable simulators for loco pilots and ASMs.	100
15.	Railway Research & Development Council, Advanced Research Centres,, RDSO upgradation, etc.	2500
16.	Capacity Enhancement works to decongest existing network to facilitate corridor maintenance blocks	Included in Modernisation Report
	TOTAL	113,110

9.4 The Committee is aware of the tight financial condition of IR. **Methodology proposed for raising of funds for this purpose is shown in table 8.**

Table 8

S. No.	Mode of funding	Annual Amount in Crores of Rs.
(1)	(2)	(3)
1.	Safety Cess on Passengers	5000
2.	Matching grant from Central Govt.	5000
3.	Deferred dividend (against Social burden)	5000
4.	Road Cess	1000
5.	RLDA earnings	4000
	Total	**20,000**

9.5 **A non-fungible non-lapsable safety fund generated with safety cess as above is proposed.** It is possible to find the required resources for the critically needed safety expenditure through an innovative non-fungible and non-lapsable Dedicated Safety Fund for which the annual inflow comes from the captive passenger traffic. Following concept is proposed for this purpose:

As per latest statistics emerging out of Indian Railways (numbers available till 20December), total number of passenger traffic during first nine months of the current financial year has increased to approximately 6000 million and it is expected that total number of passengers during the financial year 2011-12 will approximate to 8000 million for the year i.e. nearly 22 million per day. It is also worth nothing that number of non-suburban passengers is growing at a rate, faster than that of the suburban passengers. During first half of the financial year non-suburban passengers have grown at the rate of 6.7% while the suburban traffic has grown at the rate of 4.22 % over the last year numbers. The split between suburban and non-suburban traffic is reaching the welcome 50:50 mark and soon non-suburban traffic is likely to cross the fifty percent mark. Another feature of railways passenger movement is that the number of reserved journey passengers has increased to 6-7 million per day.

For nearly a decade passenger fares on Indian Railways have not been increased despite substantial increase of the input cost during the period. It is important to note that in the passenger segment, other than possibly AC Chair-car and AC Three-tier; all other segments have been making losses and are heavily subsidized by the freight traffic. Present financial position of Indian railways is precarious and the most critical investment needed for the safety and line capacity augmentation of the railways systems has been badly neglected.

It is upfront suggested that because freight rates already are carrying heavy subsidy burden of subsidizing passenger services, freight traffic should be left alone and no safety surcharge shall be levied on the

same. It is recommended that the safety fund should be dedicated non-fungible and non-lapsable so that this money is not mixed up with the general exchequer is specifically spent for the purpose of which the same is created and accrual of one year can be used in the subsequent years. The principal instrument for annual inflow in the Safety Fund will be a Safety Surcharge to be levied on every passenger ticket. It is clarified that safety surcharge will have a differential rate and all classes of passengers including the free riders on Indian Railway System will have to pay the safety surcharge. Such a surcharge should be given a statutory status by making a small amendment in Railway Act if found necessary. The surcharge will be step up in nature, i.e., those travelling reserved class will be paying more than those travelling non-reserved and in the reserved category higher the class of journey higher will be the rate of surcharge.

A calculation of total daily safety surcharge accrual is as under. For the purpose of calculation certain assumptions have been made. It has been assumed that there is a 50:50 split between suburban and non-suburban traffic, that total number of reserved passengers per day is 7 million and 92.5% of the total reserved passengers travel by Sleeper Class. It has also been assumed that out of total passengers travelling in AC Reserved Coaches, 65% belong to AC III tier / AC Chair Car Category, 25% in AC Sleeper and 10% in AC First. For suburban passengers safety cess has been assumed at Rs. 3 per ticket, for non suburban unreserved tickets it has been assumed at Rs. 6 per passenger, for reserved sleeper class it has been taken as Rs. 10 per ticket, for AC Sleeper /AC Chair car it is assumed as Rs. 20 per ticket, for AC Sleeper Rs. 30 per ticket and for AC First Rs. 50 per ticket:

Table 9.

Class of Journey	Daily number of passengers	Safety Surcharge per ticket (Rs.)	Daily Safety Surcharge accrual (Rs. Crore)	Annual Safety Surcharge Accrual (Rs. Crore)
(1)	(2)	(3)	(4)	(5)
Suburban	11 million	3	3.3	1204.5
Non-suburban	11 million			
(a) Non-suburban	4 million	6	2.4	876.00
(b) Reserved Sleeper Class (assum	6.475 million	10	6.475	2363.4
(c) Reserved AC III, AC Chair	.341	20	.682	249.00
(d) Reserved AC II Tier	.131	30	.393	143.45
(e) Reserved AC I	.054	50	.27	98.55
(f) Total			**13.52**	**4935**

It can be seen from above that the Safety Special Cess will be netting a minimum of Rs. 14 Crore per day and the annual collection can safety cross Rs. 5000 Crore. Such a collection from Safety Cess shall be exclusively used for the purpose of the Safety Related Expenditure being recommended by the Safety Committee.

9.6 Deferment of dividend to the tune of Rs. 5,000 Crores per year is proposed. This is justified as social service obligation being borne by Indian Railways is about Rs. 15,000 crores every year due to low ordinary class fare, sub-urban and non-sub-urban season fare, a variety of concessions granted on passenger tickets, transportation of certain commodities below cost and working of un-economic branch lines.

9.7 With Railway raising about 5000 Crores per annum through safety cess, a matching grant from Central Government for safety related works is fully justified and demanded.

9.8 ***Implementation of Accepted Recommendations***

9.8.1 **Indian Railways severely suffers from implementation bug.** This has caused non-implementation of some of the important accepted Recommendations given by the past Safety Review Committees. In this regard, this Committee would like to quote **Para 2.2.1 of Chapter 1 (Page No. 12) of the previous Report of Railway Safety Review Committee 1998 (Part 1):**

"If this Committee were to make only one recommendation it would be for IR to rigorously monitor implementation of safety items already known and languishing at various stages of consideration/ execution. The most serious deficiency in safety matters is that these are inordinately delayed or insufficiently funded."

9.8.2 It will be unfortunate if recommendations of this Committee as accepted by the Ministry of Railways also meet with the same fate. **The Committee recommends an empowered group of officers (including an officer from finance) in Railway Board to pilot the implementation of safety enhancement recommendations and projects as accepted by the Ministry of Railways in a time bound manner with full funding. Other projects should be appropriately pended or slowed down for the time being to accommodate funding of these key projects.**

9.8.3 The Committee also recommends that newly constituted Railway Safety Authority under the Govt. of India also reviews the implementation of accepted Recommendations at a prescribed periodicity, say, once every 3 months for the next 2 to 3 years.

Summary of Recommendations

1.0 General Safety Matters

1.1 IT system based on email / SMS should be introduced to report safety related matters by railway and non-railway persons. (Para 2.4.10)

1.2 Redundancies should be built in the system such as track circuiting by two diverse means at vulnerable locations so that normal operations are least hampered due to single point failure. (Para 2.5)

1.3 IT based system should be set up within 6 months to collect and collate all train accidents whether consequential or of little significance, near misses, safety related asset failures, etc., (Para 2.5)

1.4 Projects for augmentation of line capacity on busy routes and maintenance facilities for coaches and wagons in open line and workshops should be funded and executed on top priority in mission mode. (Para 2.7)

1.5 No new trains should be introduced without adequate capacity for operation and maintenance. (Para 2.7)

2.0 Organizational Structure

2.1 Restructuring of IR should be examined and studied by a Separate Expert Group. (Para 2.8.2)

2.2 Earlier system of only Operating and technical officers being considered for general posts of GMs and DRMs should be restored. Only capable officers should be selected as DRMs and posted in divisions with a minimum tenure of 3 years. (Para 2.8.3)

3.0 Empowerment at Working Level

3.1 Enhanced powers should be delegated to GMs and DRMs in regard to safety matters as under (Para 2.9.5):

1. Powers of General Managers to be enhanced to 3 times for sanction of works under all Plan Heads except New Lines and M & P items. These should also be applicable under out-of-turn basis, depending on the urgency. Powers of DRMs also to be accordingly enhanced to 3 times.
2. General Managers to be given full powers for re-appropriation of funds from one work to another under the same Plan Head and source of funds under all the Plan Heads, except New Lines.
3. General Managers to have full powers to re-appropriate funds under Revenue under the same Demand from one PU to another within the overall budget allotment.
4. DRMs to be fully empowered to decide the process/procedure such as Spot Purchase Committee, Single/Limited Tenders, etc.

iv. To accept tenders floated by the division.

v. To enter into repair or Annual maintenance Contracts (AMC) through OEM or otherwise

vi. To purchase stock items in case of shortages and non-stock items upto Rs. 3 Lakhs per case but without any monthly ceiling

6. DRMs to be empowered to award works of essential nature related to operation and maintenance assets on quotation basis for 3 months as a stop gap arrangement.
7. DRMs to have full powers for hiring of resources including utility vehicles.
8. DRMs to have full powers to sanction construction of RUBs, limited height subways and ROB under Road Safety works.
9. Powers those vested with DRMs of the Division to be enjoyed by the Chief Workshop Managers (CWM) in respect of their workshops.

3.2 Powers to sanction cash awards for good performance in safety related matters should be enhanced to three times. (Para 2.9.6)

3.3 Enhanced delegation of powers to the divisions should be directly mandated by the Railway Board as a onetime measure. (Para 2.9.7)

4.0 Safety Related Works and Issues

4.1 Core Safety Groups should be formed under the convenorship of the Additional General Manager/Safety (a new post carved in zonal headquarter as part of the new safety architecture) at headquarter level and Sr. Divisional Safety Officer at divisional level. Principal Heads of Departments at HQ level and branch officers at divisional level of Civil, Mechanical, Electrical, Signaling, Operating and Finance should be the members. (Para 2.10.1)

4.2 Group of Officers headed by AGMs and ADRMs at the Headquarter and divisional levels respectively should convene meetings once every week to clear all the pending Engineering and Signaling Plans. (Para 2.10.2)

5.0 Vacancies in Critical Safety Categories and Manpower Planning Issues

5.1 All the vacancies of supervisors and staff in safety category should be filled up in a time bound manner say within 6 months by leveraging IT based recruitment systems. Concerned officer in Railway Board should be given this responsibility along with commensurate empowerment.

5.2 Multi-disciplinary teams of 3 officers, one each from Personal, finance and the concerned department should identify surplus posts at the Divisional, Hd. Qrs. and production unit levels for surrendering to build up a surplus bank. These teams should identify the need for additional posts under safety categories. GMs should ensure that creation of additional posts is rightfully done in the deserving safety categories within 3 months. (Para 2.11.3)

5.3 GMs should be empowered to create additional posts with finance concurrence under Safety categories if no matching surrenders are available. (Para 2.11.3)

5.4 The existing staff yardstick to be looked afresh in a dispassionate fashion and the same should be issued to the zonal railways within 3 months. (Para 2.11.4)

5.5 Railway Board should issue outsourcing policy to get expert service and save cost. (Para 2.11.5)

6.0 Shortage of Critical Safety Spares

6.1 Concerned directorates should issue a defined list of safety items to zonal Railways for uniformity. (Para 2.13.1)

6.2 RDSO should take full responsibility of all those safety items for which drawing, specification, vendor approval, etc., are issued by RDSO. They should enter into long term rate contract with their approved vendors for 3 to 5 years after negotiating rates based on the value of the item which can be best assessed by RDSO. (Para 2.13.3)

6.3 A simple but effective vendor qualification and approval process should be followed for non-RDSO safety items at zonal railway level. (Para 2.13.7)

6.4 A thorough review of the quality system for material procurement process by an external professional agency and revamping of the system should be done as necessary. (Para 2.13.8)

6.5 Conventional method of technical inspection should be replaced with modern Quality Management System for which necessary check sheets should be developed by the respective departments directly associated with safety. These check sheets should be based on present rules, regulations, manuals, instructions, etc., and should form part of the safety manual of the Railway. (Para 2.14)

7.0 External Interference - Encroachment and Sabotage

7.1 Removal of all encroachments in the vicinity of railway track should be addressed at the political level in the interest of safety. (Para 2.15.2)

7.2 PPEA (Public Premises Eviction Act) should be suitably amended so that eviction of encroachers is easily possible with the help of local police/Railway Protection Force. Suitable amendment in the Railway Act should also be made by which encroachers can be severely penalized. (Para 2.15.2)

7.3 Better coordination between Indian Railways and the policing authorities should be established to strengthen the intelligence network to pre-empt sabotage on the Railways. (Para 2.15.3)

7.4 The Railway Act should be suitably amended to impose stringent punishment on persons found guilty of sabotage. (Para 2.15.3)

7.5 Big railway stations should have 'Intelligent Security' largely based on CCTV camera with proper monitoring in the control room. (Para 2.15.4)

7.6 The upper limit set for recruitment of Ex-Servicemen as per stipulated standards against vacant posts in RPF cadre should be removed to expedite filling up of vacancies. (Para 2.15.4)

7.7 Railways should also take up disruptions and vandalism to their assets to the courts for compensation and remedial measures. It should be examined whether suitable provisions can be incorporated in the Railway Act for this purpose. (Para 2.15.5)

7.8 A High Level Task Force involving State Government, ZRUCC and NGOs should be set up to recommend constructive measures which will alleviate or eliminate casualties due to railway infrastructure in the near future. (Para 2.16.2)

8.0 Signaling, Telecommunication and Train Protection

8.1 State of the art signaling and protection system - atleast equivalent to the functionalities of ETCS L-2 should be deployed throughout IR, starting with the busy routes (19000 Kms) immediately. A subgroup of the Committee shall examine some of the critical aspects during visit to some of the European railway system and submit its report. (Para 3.5)

8.2 Diverse and redundant means of Satellite based train position sensing (as used in ACD) should be incorporated and merged in ATP functions. (Para 3.5)

8.3 A dedicated Special Purpose Vehicle (SPV) should be formed having full powers and the mandate to formulate and execute the sanctioned projects of ATP in a time bound manner (5 Years). (Para 3.6)

8.4 A high power standing technical review committee should be set up to guide the SPV on technical issues. This Committee should continue till the implementation of the project of ATP and should have experts from Railways as well as from outside. (Para 3.6)

8.5 Communication Based Train Control (CBTC)" system should be used in Metros and dedicated corridor sections like Mumbai suburban, to meet the requirements of head way less than 1.5 minutes after study of design margins. (Para 3.6)

8.6 A "Task Force" should be set up to study the feasibility of communication back bone for IR, utilizing diverse and redundant technology to ensure highest level of availability of the networks for safety and operational requirements. (Para 3.6)

8.7 RDSO signaling directorate should be augmented with comprehensive research framework in order to include work on forecasting /newer signaling and telecom technologies. (Para 3.6)

9.0 Rolling Stock

9.1 IR should switch over to the manufacture of LHB design coaches in all the coach manufacturing units and manufacture of ICF design coaches should be stopped immediately. (Para 4.2)

9.2 Problem of jerk on LHB design coach should be resolved by adopting a new design of draft gear subject to its satisfactory performance. The existing LHB coaches should also be retrofitted. (Para 4.2)

9.3 Other maintenance related problems faced on LHB coaches such as consequential failure to roller bearings, wheel shelling, etc., should be addressed at the earliest. (Para 4.2)

9.4 Some adaptation should be designed and provided on all the existing ICF design coaches in a Mission mode for facilitating energy absorption and anti-climbing during crash or sudden deceleration. (Para 4.3)

9.5 IR must strategize to utilize only LHB coaches at 110 Kmph and above speeds with 18 and above coach formations on the trunk routes. ICF design coaches should be relegated to lesser speeds with shorter compositions. (Para 4.2)

9.6 A simple low cost device such as bimetallic sensor to open or close a circuit at around 60 to 80 degree Celsius on each axle with a display of red lights and alarm bell should be fitted in coaches that run on services having escorting technicians. (Para 4.3)

9.7 LHB coaches must be grounded at the Maintenance yards and sub-standard M8 Fasteners of speed sensor should be replaced with high tensile bolts of the specified quality of reputed make. (Para 4.3)

9.8 Toilets either with no discharge or with harmless discharge should be introduced in all the 43000 coaches within next five years. (Para 4.5)

9.9 Flame detection system should be provided in coaches which should sound hooter at many places in the coach to warn the passengers. Its interface with ACP system should be considered based on field trials. (Para 4.6)

9.10 A simple ladder or equivalent feature with a permanent fitment or foldable and deployable provision should be available for assisting passengers to get down from coaches in the event of accident. (Para 4.6)

9.11 Existing instructions prohibiting cooking in Pantry Cars should be strictly enforced. License of violating contractors should be cancelled and they should be severely penalized if found cooking. Necessary provisions in this regard should be made in the Railway Act. (Para 4.7)

9.12 Video Camera based data logging, storage and display in monitoring room of Train Examiners Cabin should be introduced. (Para 4.8)

9.13 Hot box detectors, Wheel impact load detector (WILD) and Track side bogie monitoring system should be extensively deployed. (Para 4.4)

9.14 Radio tags on all types of rolling and a communication backbone should be provided along the railway network with last mile connectivity for transfer of condition data form track side to the control centre as well as maintenance depots. (Para 4.4)

9.15 Every train should be checked for formation Leak rate during maintenance in addition to Brake Power Certification. (Para 4.9)

9.16 Weigh-bridges should be installed at all major loading depots and at other places in a way that every loaded wagon is weighed within 50 to 100 kilometers. A uniform operating protocol to deal with overloaded wagon should be prescribed by Railway Board. (Para 4.10.1)

9.17 Wagons with track friendly bogie should be deployed on Indian Railways on priority. (Para 4.10.2)

9.18 Concept of distributed power in freight operations to reduce coupler forces and rail wear should be developed. (4.10.3)

10.0 Track

10.1 A national level expert committee should be constituted to establish the root cause of rail failures and identify the metallurgical and chemical solutions including enhanced quality assurance and control protocols from steel melting to laying of rail on a war footing within the next three months. This expert team should also review Rail Welding technology. (Para 5.2)

10.2 A Senior Administrative Grade officer of high integrity and strong background in Material Science & Chemistry should be posted full time to monitor and control Rail production process at Bhilai Steel Plant. (Para 5.2)

10.3 Production of 52 kg rail should be stopped and 52 kg PSC sleepers should no longer be produced. Only 60 kg/M head hardened rails should be used on curves sharper than 400 meter radius of curvature. (Para 5.2)

10.4 Modern technologically driven vehicle borne ultrasonic testing machine should be introduced for faster and reliable detection of rail and weld flaws. (Para 5.2)

10.5 Rail grinding at required intervals should be mandatory to increase the life of rails and wheels of rolling stock. (Para 5.2)

10.6 A systematic AT welding improvement programme should be introduced conforming to European standards. Procurement of latest and proven raw materials and quality welding procedures must be introduced to eliminate AT welding failure. (Para 5.3)

10.7 Directorate dealing with track formation in RDSO should be strengthened, stretches of weak formation identified and an action plan formulated to treat weak formations in a scientific manner with a view to eliminate such weak spots permanently including improvement to drainage within the next 5 years. (Para 5.7)

11.0 Bridges

11.1 For recording and monitoring the condition of distressed bridges, photographs should be taken using modern hand held electronic cameras and should be posted on MIS/ sent through Internet to all concerned expert engineers having vast experience. (Para 5.5)

11.2 Vulnerable bridges should be fitted with water level gauges and turbine flow meters to measure flow which should be interlocked in a way to warn the driver of the approaching train. (Para 5.5)

11.3 Distressed and vulnerable bridges should be instrumented in terms of deflections/displacements, water level and flow velocity on a continuous basis and data should be communicated to the office of the concerned Chief Bridge Engineer for monitoring. Advanced scientific measurement and inspection for the condition assessment of the under-side of the bridges using mobile and articulating platform is essential. (Para 5.6)

12.0 Level Crossings

12.1 All Level Crossings whether manned (with or without signals) or unmanned should be eliminated in next 5 years. This is gigantic task for which dedicated SPVs should be formed in each of the zonal railway fully empowered and mandated to complete the project in a time frame of 5 years. (Para 5.6)

12.2 Level Crossings having little road traffic should be closed. Merger of nearby LCs by constructing connecting roads at railway's cost even on non-railway land should be taken up. (Para 5.6)

12.3 Construction of limited height sub-ways, Road under Bridge (RUB) and Road over Bridge (ROB) should be taken up in mission mode and traffic blocks should be generously granted. (Para 5.6)

12.4 No LC should be newly introduced under any circumstances on the existing system as well as during gauge conversion, doubling and construction of new railway lines. (Para 5.6)

12.5 No LC gate should henceforth be manned or interlocked. (Para 5.6)

12.6 The present policy of sharing the cost of RUB or ROB with the State Governments should be dispensed with and the full responsibility and entire cost of construction should be taken over by the Railways. For this purpose, the present Railway policy needs to be changed and section 19 of Railway Act needs to be amended. Further, to augment the Road Safety Fund a large share of diesel cess should come to the Railways for which Government of India should be approached. (Para 5.6)

12.7 To expedite the construction of limited height sub-ways, RUBs and ROBs the CRS's role should be taken away and relevant plans and documents should be approved and signed at the level of the concerned Principal Head of the Departments (PHODs) instead of sending them to the Commissioner of Railway Safety (CRS) for sanction unless there is some change in the track/yard layout. (Para 5.6)

12.8 Regular meetings and coordination between Railway and civil administration at the highest to the local levels should be held to expedite the execution.

13.0 Human Resource Development with Emphasis on Education and Training

13.1 A large number of projects of importance to Railways should be regularly awarded to some select engineering academic institutions in which students can participate. Courses, minor stream and major specializations in the area of railway engineering should be introduced in the Indian engineering academic programs. (Para 6.1)

13.2 All officers should be periodically imparted training in safety engineering for building a safety culture. (Para 6.2)

13.3 One training institute at the divisional level should be nominated and upgraded for training to staff on safety environment in the Railways. This institute should have animation films; general equipment, tools and gadgets used on Indian Railways, etc., (Para 6.2)

13.4 Departmental staff should be encouraged and extended resources to upgrade their professional qualifications and skills to be fit for promotion to the higher level. (Para 6.3)

13.5 All the newly recruited Assistant Loco Pilots should be Diploma holders instead of present Matriculate/ ITI holders. All the Maintenance Technicians in all Technical Departments should at least be ITI holders and supervisors should be at-least Diploma holders, preferably, Engineering Graduates. (Para 6.3)

13.6 Cadre of electric and diesel running staff should be separated in the present operating environment having large number of loco variants of both types. (Para 6.4)

13.7 Such running staff who fail in any of the mandatory refresher course should be given only one extra chance to repeat the course and test should be taken at the concerned Branch Officer level. In case the running staff fails again, he should be debarred from running duty and posted on

other non-safety related assignments or given voluntary retirement following the prescribed rules and process. (Para 6.5)

13.8 Some portable cheaper version of loco simulators should be procured and located in drivers' running rooms where running staff can brush up their driving skills at their convenience. (Para 6.7)

13.9 Customized signaling Panels should be introduced at the earliest in Zonal Railway Training Institutes (ZRTIs) for the training of station operating staff. (Para 6.8)

13.10 Separate hand-books should be prepared for the operating staff, such as loco pilots, station masters, etc., which should contain all the necessary instructions to be followed by them while performing their duty. (Para 6.9)

13.11 Each Division should have Grievance Redressal Machinery which should deal with staff grievances in time-bound manner. (Para 6.10)

13.12 Special allowance equivalent to 25% of the salary and grade pay should be given to the staff who work as regular Gatemen as a special incentive during the intervening period till LC gates are closed. (Para 6.11)

14.0 Training Institutes on IR

14.1 All sanctioned capacity enhancement works of CTIs, ZRTIs and STSs should be fully funded and executed within next two years. (Para 6.2)

14.2 Posting as a trainer in Centralised Training Institutions (CTIs) should be based on the recommendation of a committee of which the Head of the institute concerned must be a member. Tenure of deserving officers may be extended on the recommendation of the Head of the CTI even if it involves transfer of elements of posts if such a trainer is due promotion so that he/ she can be promoted in the training institute itself. (Para 6.2)

14.3 Heads of CTIs should be given full powers to invite academicians, industry leaders, technocrats, etc., as visiting faculty within the allocated budget grant. In case of Railway Staff College, where Management training is imparted to officers of all railway disciplines, arrangements should be made to have one or two professional academicians on loan from management institutes of repute for a few years fixed tenure. (Para 6.2)

14.4 Funds for CTIs, Zonal Railway Training Institutes (ZRTIs) and Supervisors Training Schools (STSs) should be allocated separately both under Works as well as Revenue. Incurrence of expenditure under these fund-allocations should be fully under the control of Heads of the institute. Considering the importance and size of CTIs, they should have their own maintenance infrastructure. (Para 6.2)

14.5 Terms of Principals of ZRTIs and STSs should be fixed for at least 3 years. (Para 6.2)

14.6 Teaching allowance of trainers of ZRTIs and STSs should be increased from 15% to 30% to bring it at par with trainers in CTIs. (Para 6.2)

15.0 Research Eco-System on Indian Railways

15.1 An apex body called Railway Research & Development Council (RRDC) should be established. It should be chaired by an eminent technologist / scientist of the country reporting to the Railway Minister. (Para 7.3.1)

15.2 Financial support up to 2 % of yearly revenue of Indian Railways should be available to support the entire research eco-system of railways in India. (Para 7.3)

15.3 Advanced Railway Research Institute (ARRI) should be established which

should be a high-end, research organization focusing on engineering challenges in railway specific areas. (Para 7.3)

15.4 A string of five or so Railway Research Centers should be established which should be co-located on the campuses of Indian technological academic institutions of national importance. Each center should specialize in specific areas like signaling, rolling stock, motive power, track and bridges, operations management, etc., (Para 7.3)

15.5 Present system of only having railway officers on deputation at senior positions in RDSO should be done away with and professionals and scientists from reputed technical institutions should also be inducted at higher levels on the permanent cadre. Their career progression should be on the similar lines as followed in other research institutions of Government of India. (Para 7.3.4)

15.6 Power of DG/RDSO should be enhanced as under:

1. Full autonomy with financial powers to function within the sanctioned budget.
2. To award consultancy contracts of enhanced value upto Rs. 1 Cr. In each case against the present delegation of Rs. 30 lakhs in each case. Powers for awarding MOU/Consultancy Contract should also be extended to benchmarked organizations in India and abroad like AAR, TTCI, UIC, etc.
3. Full powers to award Consultancy Contract once sanctioned by the Board for values more than Rs. 1 Cr. each and there should not be any further need of sending the proposal to the Board. (Para 7.3.4)
4. Full powers for placement of developmental order within lump sum Budget Grant of RDSO irrespective of cost. This will expedite prototype and field validation for which RDSO is presently depending on PUs and Railway Board.

16.0 Safety Architecture on IR

16.1 A Railway Safety Authority (RSA) should be set up as a statutory body independent of Indian Railway Board under the Government. The Authority shall have a separate budget fully funded by the Ministry of Railways and shall be backed by a full-fledged Secretariat. (Para 8.5).

16.2 New post of Member (Safety and Research) in Railway Board should be created who will be the link between Railway Board, Railway Safety Authority (RSA) and Railway Research and Development Council (RRDC) at the apex level. (Para 8.5).

16.3 Existing posts of Chief Safety Officers on zonal railways should be upgraded to Additional General Manager (Safety) as part of the new Safety Architecture. (Para 8.5)

16.4 The Institution of Commissioner of Railway Safety should be merged with Railway Safety Authority and should be strengthened and empowered. There should be CRS for each zonal railway and each CRS should have a Regulatory Inspection Team consisting of HODs of the concerned technical departments. (Para 8.5.3)

16.5 Role of Commissioner of Railway safety should be withdrawn from the routine clearance of proposals from the railways such as changes in Plans, Working Rules, etc., which consume lots of his time. These should be dealt and finalized by the concerned Principal Head of the department who should full responsibility of the changes. (Para 8.5.3)

17.0 Implementation of Recommendations

17.1 A non-fungible non-lapsable safety fund generated through safety cess on passengers of different classes in graded manner should be created to raise funds to the tune of Rs. 5,000 Crores per annum. (Para 9.5)

17.2 Payment of dividend to the tune of Rs. 5,000 Crore per annum should be deferred in view of social service obligation being borne by Railways which is assessed as Rs. 15,000 Crores every year. (Para 9.5)

17.3 An empowered group of officers (including an officer from finance) in Railway Board should pilot the implementation of safety enhancement recommendations and projects as accepted by the Ministry of Railways in a time bound manner with full funding. Other projects should be appropriately pended or slowed down for the time being to accommodate funding of these key projects. (Para 9.8.2).

17.4 Newly constituted Railway Safety Authority under the Govt. of India should also review the implementation of accepted Recommendations at a prescribed periodicity, say, once every 3 months for the next 2 to 3 years (Para 9.8.3).

REVIEW ARTICLE*

MACROECONOMICS IN TIMES OF ECONOMIC CRISIS

M.K.Datar

The 2008 Global or Trans-Atlantic (with China, India, Korea, Indonesia, Australia, Sub- and Saharan Africa suffering only Growth-recessions to various degrees) Financial Crisis (hereafter GFC) has simultaneously resulted in spate of literature describing and analyzing various features thereof; causal factors behind it as also suggesting ways how to avoid its recurrence in future. Even after a decade, the flow of literature, which is quite varied in its nature, is still continuing. While some books have presented the events from a micro-perspective, wherein the writer is focused on her experiences of working in an institution affected by the crisis situations, e.g., McDonald, 2008; Sorkin, 2009. There are memories by the dramatis persona, i.e., policy makers in US administration during crisis period [Paulson, 2010; Geithner, 2014] while several other academics, journalists, etc., have analysed GFC from wider perspectives be it historical, theoretical or policy perspectives to assess and understand nature of GFC (Wolf 2015; King, 2016; Tooze, 2018].

Prof. Nachane's book, a significant addition to this growing literature, has several distinctive features. Firstly, it views GFC mainly from a theoretical perspective though it presents policy discussion and perspectives as well. Basically it seeks to explore whether GFC has any links with the particular manner in which discipline of macroeconomics has evolved since Keynes. The policy discussion has a distinct Emerging Market (EM) perspective with special emphasis on India. The book has two dimensions, viz., (a) Macroeconomic Perspective which offers a critical analysis of macro theoretic developments and (b) economic policy implications from GFC in general and particularly from an India context. This may be the reason why publishers have included this book in its India series. The book will be extremely useful to readers from both these distinct but related perspectives.

Development of New Consensus Macroeconomics (NCM)

The book provides a panoramic view of various strands of theories of Macroeconomics as developed over the last 70/80 years. It would enable a non-academic reader, having of course some background in Macroeconomic theory to integrate its previous, often patchy, encounters with macroeconomics and appreciate an inter related, larger picture of discipline. Keynes is natural starting point of this journey. First four chapters present a broad stroke picture of main currents of Macroeconomics. After describing major concepts introduced by Keynes, its subsequent mathematical refinements the famous IS-LM analysis - are described. The author makes a mention of a remark by Samuelson that perhaps Keynes himself did not understand his own analysis clearly till it was formalized by Hicks, Harrod, Meade, etc., but also goes on to show, based on the class notes taken by a student of Keynes, that it was untrue. Keynes did use a mathematical model in his class room presentation though it was not included in The General Theory [Nachane, Pp. 13-15[1]]. Though investment is seen as a function of interest rate by Keynes and his predecessors, the latter exponents

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M.K. Datar an Economist by training, has worked in IDBI Bank and the Indian Banks Association.

* Nachane, Dilip M., *Critique of the New Consensus Macroeconomics and Implications for India*, Springer, 2018, Pages XXVI+406, Kinale Edition, Price: Rs. 1176.00.

The author wishes to thank an anonymous referee for comments which has resulted in improved clarity in the presentation of the paper. The usual disclaimer apples.

1. All references (page numbers) in the text are to Prof. Nachane's book under review.

saw it as a stable function while inherent instability of private investment is at the heart of Keynesian theory. Nachane's comment that this insight of Keynes often gets lost in formalistion of his theory is quite pertinent. IS-LM type analysis attempts to synthesize Keynes with neoclassical analysis from a short run perspective. Nachane also discusses the similar attempts to synthesize Keynes's analysis from a long run Walrasian equilibrium analysis and opines in favour of the *impossibility* of Keynes-Walras synthesis (p. 22). Joan Robinson, a close witness to writing of General Theory, had developed quite a vocal critique of attempts to synthesize Keynes with neo classicism. Her Ely lectures in 1971 (The Second Crisis of Economic Theory) or posthumously published article "The Theory of Normal Prices and Reconstruction of Economic Theory" brings out her view about futility of the notion of Equilibrium to deal with essential attributes of a capitalist economy, viz., that it exists in historical (as against logical) time. Absence of any mention of her contributions to develop a critique of economic theory which predates NCM (and is still valid) is surprising indeed [Robinson, 1974, Pp. 236-249; Robinson, 1985; Harris D J, 2003].

Monetarism and New Classical Economics

The stagflation in the 1970s set the stage for descent of Keynesian paradigm and resurgence of Neoclassicism. Chapter 3 describes rise of monetarism which basically highlighted importance of monetary policy (control of money supply) in times of inflation *vis-à-vis* Keynesian demand stimulating policies through higher deficit financing during recessions. The reliance on fiscal policy was partly a result of likely inability of monetary policy to stimulate demand when interest rates are already low. The monetarists argued in favour of rule based control of money supply for stability. Collapse of Bretton Woods system added to luster of Friedman's analysis and ushering in flexible exchange rates. Like rise of inflation in the 1970s helped ascendency of monetarism in early 1970s, control of US inflation through hike in interest rates led to its decline. US abandoned monetary targeting. Despite fall of monetarism, the reins of challenging Keynesian perspective - inherent instability of market economy - or Capitalism - was taken over by new perspectives such as New Classical (NC) and Real Business Cycle (RBC) theories. In Chapter 3 the essential elements of these perspectives and their similarities with and differences from monetarism are crisply presented. Importance of Economic Agent' expectations was retained but these were now treated as rational which make full use of all available information unlike Adaptive expectations which merely extrapolate the concerned variable based on the past experience only of that variable, as hypothesized by Monetarists. Providing micro foundations to macroeconomic theories gained importance while existence of complete markets, markets being in continuous equilibrium was assumed as a matter of fact. It's instructive to note that in a world of complete markets inter temporal budget constraints are always satisfied and real world phenomena like illiquidity, willful defaults, insolvency and market freeze are ruled out *à priori* (p. 63). Moreover, with rational expectations of economic agents incorporated in the analysis it was shown that only unanticipated changes in monetary policy will have real effects as anticipated changes in it will be neutralized by agents' behavior. Lucas's critique of economic policy showed that as economic agents' actions depend on their expectation about government policy, their behavior will change as government's policy changes. If government policy does not factor such behavioral changes, the intended effects of the policy will not be realized. As regards fiscal policy, its effect too will be restricted due to crowding out of private investment by higher public investment. Moreover,

even if public investment is funded through government borrowings, if economic agents correctly anticipate required higher taxes in future that would weaken the wealth effect arising from higher bond holding. This effect termed as Ricardian equivalence will weaken effectiveness of fiscal policy.

Emergence of New Consensus Macroeconomics

Chapter 4 describes the responses of Keynesian paradigm to the onslaught of NC & RBC which in essence attempts to provide micro foundations to their propositions, e.g., nominal and real rigidities, hysteresis with Natural rate of unemployment and co-ordination failures which create space for policy intervention. Chapter 4 describes these neo Keynesian attempts as also New Consensus Macroeconomics that emerged from NC, RBC and Neo Keynesian perspectives. As pointed out by Nachane, the schema assumes away many real world problems. However, Milton Friedman had perhaps taught the profession that as long as any model of the economy 'performs' whether underlying assumptions correspond with reality is a non-issue. Period of great moderation experienced by western economies during 1983-2007 facilitated necessary cover for the NCM. Development of GFC, the critique of NCM and the question of reforming the financial system is the subject matter of remainder of the book (12 chapters).

Financial Crisis

Though financial crisis have been occurring periodically, 2007 crisis challenged theoretical perceptions about the way macro economy works as also notions about the conduct and effects of policy. Nachane has analysed various long term and medium term factors behind origination of GFC and its transmission to a large number of other economies in two separate chapters. The manner in which various governments and central banks dealt with the crisis through conventional and non-conventional monetary policy measures and increased budget deficits is discussed with the help of quantitative measures of fiscal and monetary policy in comparable terms. Chapter 5 is focused on the USA where the crisis originated. Two long term factors, viz., the great moderation - steady growth and low inflation - experienced by the West and the imbalance in the world economy where by export surpluses of China & other countries were funding US trade deficit and its under-saving. It has remained a contentious issue whether China is generating (and exporting) excessive saving or the US is consuming (importing) more. China's entry into WTO enabled it to use its low cost man power by selling a range of manufactured goods at competitive prices in world markets which is a major factor that kept price increases at moderate levels. This in turn helped in gaining support for inflation targeting (IT) monetary policy regimes which proliferated to many developed and developing countries. In addition to these structural factors, Nachane also mentions several US specific medium term factors relating to financial structure and policies. The chapter also describes US policy responses encompassing fiscal policies as well as monetary policies. Chapter 6 which deals with transmission of the crisis to the rest of world is centered on response to the crisis in different continents. Tooze [2018] has recently brought out GFC links to European crisis due to overseas operations of European Banks. The quantitative data about various measures of fiscal and monetary stimulus presenting comparative pictures thereof is a notable feature of these twin chapters.

Crisis explained

As the NCM described in chapter 4 focused on deriving grounds for a self correcting macroe-

conomic model, it is hard to even visualize any possibility of economic crisis in such a framework let alone explain it. Through Chapters 7-10 Nachane provides a range of explanations of the economic crisis in terms of competing economic theories some of them old and others of more recent origins.

Austrian school of thought hypothesizes that market economies based on rule of law and property rights are self correcting in absence of government intervention. It proposes a concept of natural rate of interest which equates savings and investment at full employment. If market interest rate is lower than natural interest rate there would arise over investment in investment goods sector. The investment boom in absence of sufficient savings would lead to correction in market interest rate which would lead to lower investment and an equilibrium is regained both in terms of overall investment as also in terms of balance between investment goods and consumption goods sectors. But the intervening period would be marked by investment boom and bust. This original formulation of the Austrian theory faced trenchant criticism from Friedman accusing that it has done the world a great harm by encouraging do nothing policy (Pp. 177-78) Also, the theory, which predicts that during boom there would be greater production of capital goods and a contraction in production of consumer goods and an opposite trend during recession, is contradicted by observed positive correlation between consumption and investment over the business cycle. However, the restated Austrian school introduces concept of malinvestment wherein investment decisions are distanced from underlying fundamentals. Low market interest rates fuel consumption due to wealth effect (p. 181). It also results in financialisation and information cascading leading to herd behavior and asset bubbles due to low interest rates. Inappropriate monetary policies and laxity in financial regulations help perpetration of financial crisis. Further, there is secondary deflation leading to fall in prices of factors of production, i.e., real wages. Based on this view of financial system, the restated Austrian school is able to relate low interest rates and low inflation experienced during period of great moderation. Coupled with lax regulation of financial system it leads to asset price bubbles, herd behavior of investors and undue optimism about future. This view has policy implications in terms of macro prudential regulation, market discipline enhancing disclosures and curtailment of real estate sector (Pp. 187-188)

Chapter 8 is focused on contributions of Hyman Minsky which emphasized inherent tendencies of instability in working of modern corporations. It brings explicitly the financial structure of companies in the analysis. To meet the investment demand, corporates start using debt financing which sows the seeds of instability. At low debt levels, corporates are able to meet their debt servicing obligations in full (hedge finance). At higher leverage they are able to meet only interest obligation and they need periodic refinance of their debt obligations (speculative finance). At still higher debt levels, companies are unable to pay even interest. (Ponzy finance). Nachane raises an issue whether Minsky could be considered as part of the post Keynesian school (p. 193) in view of his emphasis on institutional aspects which is not in line with the striving for generality by modern economics including the post Keynesian school. In contrast to NCM, it is remarkable that Minsky brought in analysis of financial structure of non-financial corporate sector as also financial system, financial products and markets. His analysis also explained that there is no one Minsky moment but that the US developments in terms of rise of shadow banks,

rise of universal banking and development of new products which cumulatively made financial structure more prone to financial instability.

Chapter 9 is devoted to explaining GFC in terms of Post Keynesian theoretical perspectives. Essential features of Post Keynesian thought are primacy of effective demand as the main determinant of macro economy, skepticism about self regulating markets, rejection of Says law, and fallacy of composition. In view of the last mentioned factor and particularly due to Lucas critique, the need to provide micro foundation to macroeconomics becomes unimportant. It brings out several elements in explaining GFC. Firstly, it extends Minsky's analysis, originally focused on corporate sector, to Household sector. Minsky's classification of hedge, speculative and Ponzy finance is dovetailed with different mortgages, i.e., normal, interest alone and adjustable rate mortgages that prevailed in the US. This schema would neatly explain the risk proneness of mortgage finance over the years. Secondly, move towards capital convertibility and varieties of new risks such as currency risk, maturity mismatch risks, contagion risk (also noticed in the 1987 Asian Financial crisis) and spillover effects of US monetary policies in EMEs which have enhanced the rage of financial risks and potential for financial instability arising there from. Herd behavior of investors and endogeneity of money are other important factors contributing to financial instability. Nachnae mentions studies showing that herd behavior may not be always irrational when investment horizon is of a short duration and returns cannot be modeled in terms of probabilities (p. 210). Endogenous money enhances the importance of correct level of policy rates as that determines demand for credit. Income inequality affects the level of effective demand and rising inequality creates an opportunity to support debt based consumption. The policy implication of post Keynesian analysis relates to emphasising the role of fiscal policy, adequate regulation of financial markets; need to keep CAD in limits, stability in share of wages and maintaining real interest rate equal to growth rate in labour productivity so that monetary policy is rendered neutral with respect to distribution of income as well.

Chapter 10 provides a Marxian Perspective on GFC. From Marxian perspective crisis situation is a regular (enduring) feature of capitalism eventually (hopefully) leading to its overthrow! Nachane hints at this in the title itself by use of Russian words Povorot (meaning Turning point) or Perelom? (meaning breaking point). It may be considered a bit surprising to find a small section on Marxian explanations of the crisis as well in an otherwise 'inside' critique of Macroeconomic theory. This critique is termed 'insider' as it considers sustainability and even desirability of capitalist system which is denied by many Marxists critiques. While this move is certainly welcome, the treatment of Marxian analysis-/theories appears quite sketchy. It brings out in a succinct manner the essential features of Marxian theory of crisis drawing mainly on the basis of Marx's own writings. He also makes a reference to more recent analysis mostly is the wake of GFC. This shortcoming is significant in at least two specific contexts. Firstly, Marxian economists have often analysed financialisation of economy particularly in the context of advanced capitalistic economies which goes a long way also in explanation of the 2007-08 crisis. The analysis presented by Paul Sweezy, Paul Baran and others is notable in the context of advanced (US) capitalism. It also provides a framework which is used to analyse centre-periphery relations where advanced capitalist centre is in an unequal relationship with pre capitalist or less or mal developed third world economies. This framework of analysis developed by Samir Amin, Andre Gunder Frank and others traces, from an historical

perspective, the unequal impact of developing capitalism in capitalist centre and pre capitalist peripheries. This framework focuses on different effects of international trade and investment flows largely beneficial to developed countries at the capitalist center and adverse to developing countries on the semi capitalist periphery. This perspective would be quite rich to look at international dimensions of US monetary policy which has become quite important parameter for policy formulation in EM countries.

NCM - Post Crisis View

Chapters 11-15 present a comprehensive look at the post crisis NCM world. Chapter 11 looks at theoretical aspects which were subjected to revision/relook. Chapter 12 looks at policy aspects that were questioned in the wake GFC. Chapter 13 makes an overall assessment of the dint GFC has made into the bastion of NCM. Conceding the point that unlike 1930 Great Depression which led to a Keynesian Revolution in economics, GFC has not led to such epoch making development. Neither NCM is being replaced with another theoretical framework nor did any such grand new formulation appear on the horizon. The author's frustration at such an outcome is quite obvious; the chapter 13 offers an explanation for such a depressing outcome. The persistence of NCM is explained in terms of Lakatosian perspective of Scientific Research Programme (SRP) wherein an SRP such as NCM is characterised by (a) existence of a hard core of propositions which are considered irrefutable or beyond falsification; (b) a set of auxiliary hypothesis that support SRP but are falsifiable which are protective belt or periphery; and (c) a method that is deemed scientific. Three groups among the proponents of NCM are identified: (a) loyalists did not consider any weakness in NCM in the light of GFC and hence no change in NCM frame is warranted. The groups of moderates concede some weaknesses exposed due to GFC but these are not fundamental and can be easily accommodated without giving in anything essential. The third group of insider critiques does accept some flaws that are exposed during GFC but feel that these can be accommodated within the NCM framework to ensure no recurrence of such events in future. Nachane describes in detail the arguments of all the three groups' reactions to GFC. The loyalists don't find anything that happened during GFC that would require revision in EMH or RET. While moderates do agree that things go wrong on occasions but we don't have much to replace efficiently functioning markets housed by rational operators. The insider critics were trenchant in their criticism but they would stop short of a thorough overhaul of NCM framework. They would rather begin with maximization - and - equilibrium as a first cut and combine it with *ad hoc* modification to deal with empirical regularities (p. 289). In the light of the above - as much of hard core is retained with acknowledgement of some changes in assumptions regarding RE & CM, the methodology of DSGE remaining unchanged and need for some modifications recognized only in auxiliary hypotheses it's hardly surprising that GFC and soul searching by a section of the profession arising there from, - it's no surprise that spell of NCM is not significantly affected. Importance of income distribution and institutional aspects of financial system are the two factors hitherto neglected in macroeconomic theorizing are now being recognized as important relevant aspects to be incorporated in theoretical structure. Several lines of explanation are indicated to explain continued dominance of NCM. Power of vested interests, - leading luminaries in profession having close links with financial sector were advocating policy of light touch regulation and non-interference in working of markets. - This is one such hypothesis. Keynes himself has referred to this but felt that power of vested interests is

often exaggerated and ultimately power of ideas would prevail, if gradually. But Nachane feels that the world of 1930s has changed; good ideas are not lacking but their power to challenge vested interests is evaporated. (p. 300). The world has indeed changed. GFC is seen as a crisis of economy but very rarely crisis in economic theory. Nachane refers to a paper by Kirkman [2010] but that paper perhaps is an exception rather than the rule. In contrast, economic crisis in the past was also seen as a crisis in economic theory. Joan Robinson was talking about the Second Crisis in Economic Theory in the 1970s and advocated a lot of "spring cleaning" in the early 1980s. Notwithstanding the high priests in the economics profession not recognizing the need for change one can expect going forward there may not be hegemony of any one school of thought but a republic of several competing perspectives. After all, unlike the lack of significant changes happening in economic theory, the policy perspectives have witnessed several changes in post GFC world.

Policy Implications

Four chapters in the book are written from a policy perspective; two (chapters 5 & 6) of them respectively deal with inception of the crisis in the USA and its spread across the world. Chapter 12 deals with policy implications from the NCM critique as developed in the book. While the developments in US financial sector have been covered quite in detail, particularly the development of shadow banking sector, evolution of originate and distribute model in Mortgages, development of different new products with various risk contents, the crucial development, viz., end of Glass Stiegel Act which broke the wall between commercial and investment banking giving rise to the so called Universal Banks is dealt somewhat summarily. While Nachane does make a mention of abolition of G-S Act (p. 201 & 267) it somewhat understates the deep impact it had on evolution of US financial system in the twenty first century. In retrospect, it appears that this single factor provided the foundation for growth of shadow banks, proliferation of derivative products that supposedly resulted in transfer of risk to other investors without reference to their awareness of different risks or risk bearing capabilities or risk appetites. It's certainly true that the Great Moderation characterized by low inflation, low unemployment and stable growth and steady rise in prices of financial assets led to an euphoria about success of the recommended IT monetary policy regime under NCM. It also provided a justification for light touch financial regulation. The investments made by banks in implementation of Basel II norms were primarily guided by lowering the capital requirements under Advanced Approaches. Admati & Helwig [2013] makes a zealous case for increasing bank capital requirements. Significantly, Basel III represents a shift to simple, if unsophisticated measures, (common equity, leverage ratio) of risk. While GFC has resulted in minor dents on NCM on theoretical grounds its policy implications are quite significant as revealed in Chapter 14 which looks at NCM in terms of policy framework. While the policies pursued since the 1990s came under increased criticism in the wake of GFC, as revealed in the analysis presented, many of the critical insights predate onset of GFC. In short, NCM gives prime role to monetary policy and deemphasizes fiscal policy. It considers fiscal policy is unable to change aggregate demand irrespective of its financing, viz., additional taxation or borrowing through bonds. Crowding out of private investment through higher public investment will neutralize resource raising through tax levies while the effect of Ricardian equivalence would dent the effect of borrowing programme as investors would also weigh in the additional taxation that would be necessary in future to repay the current higher

borrowings. It's the monetary policy which takes the burden of macro management. Due to variable lags in policy effects, rule-based monetary policy is preferred; the rule is specified in terms of inflation target. While the issue of setting appropriate inflation target is discussed in the literature in greater detail, a benign view is adopted towards asset price changes. In view of globalization and rise of a huge pool of liquid capital ready to flow across national boundaries, harmonization of (light touch) regulation of banks gained importance while sophisticated measurement of different risks on banks' portfolios were guided by efficient use of bank capital. Nachane's observations on working of DSGE models are quite harsh. While underling theory may be scientific, the real world problems of crucial significance to policy makers - such as incomplete markets, role of bargaining power, strategic interactions and coordination problems among agents - are sidestepped (Pp. 267-68). Granted that economic policy is hard in the sense of being difficult to develop formally, DSG models adopt Type A approach of providing a formal solution to simplified version of the problem rather than Type B approach which admits non formal solution without simplifying the problem. In view of Solow's testimony before Science and Technology committee of US House of Representatives that DSGE models have nothing useful to say about anti-recession policy, a rethink on use of these models in policy formulation is unavoidable. The alternatives are difficult but perusing (a) Lesser reliance on preselected formal models in favour of exploratory data analysis, (b) robustness across model specifications in policy choices, and (c) ethical responsibility of economic researchers could be the way forward for "re-education" of policy makers. Chapter 14 takes a detailed review of developments in the policy formulation in the wake of GFC. The most significant development is activation of international forum of G20 countries to develop and adopt a coordinated policy approach to tackle the problem. However, the issue of monetary policy focused on Inflation targets; attitude towards asset prices movements (equity, house prices); introduction of macro prudential regulation to supplement hitherto pursued micro prudential regulation and issues of policy coordination at global level are still work in progress. Whether asset prices should be among indicators of monetary policy or they should be target as well; should exchange rate stability be a consideration for monetary policy and the linkages and coordination of other policies with fiscal policy are issues which different countries would deal differently. The detailed and broad discussion in the chapter vividly brings out the practical issues of policy formulation. In view of the large international capital flows and the reserve currency status of the US $, the rate setting moves by Federal Reserve have inevitable impact on several other economies. Would such potential impact in other jurisdictions, in addition to domestic economic consideration ever impact Fed moves is not very clear. Similarly, while policy coordination among policies of different countries in terms of monetary policy, financial regulation, resolution of distressed firms etc. are matters of intense debate, Trump effect is threatening seemingly settled matters of open trade and need for collective global efforts for environmental protection!. Perhaps that makes the policy making interesting (in Chinese sense) and also sets limits for use of economic analysis alone.

An Indian Perspective

India remains a reference point, at times implicit, all through the book. Towards the end a panoramic view of Indian policy developments over the last three decades is presented. While discussing decline and fall of monetarism (in chapter 3), Nachane mentions in a foot note (p.

56) that in India ideas are often imported from the west "long after they have lost their freshness and discarded". As an illustration it's mentioned that India experimented with monetary targeting during 1990-98 while it was abandoned in the US in 1982. The reasons for such routinely delayed response could be an interesting point for further probe not pursued by the author. In view of the crucial role of monetary and financial stability in achieving high and inclusive growth Nachane feels that "it is of paramount importance to have a policy framework in place which will safeguard monetary and financial stability". The Indian perspective is primarily guided by this consideration. Policy developments in the field of monetary policy, fiscal policy and financial regulation are discussed in detail. In a synoptic review of policy developments in these areas with more emphasis on proposals in recent period and the evolving policy steps, the 'live' issues like independence of regulatory institutions, coordination among different regulators and implementations of FSLRC are brought out vividly. In such policy issues where controversies are abounding the readers are normally curious to know the opinion of the author. Nachane fulfills such expectation at times when he opines in favour of Asset Based Reserve Requirements over traditional Liability Based Reserve Requirements or his preference for wider mandate for monetary policy than current target of inflation control alone. But in some instances, viz., recommended move to Principle based supervision or suggested separation of bank regulatory powers of RBI to improve monetary policy formulation he is somewhat ambivalent. However, even in such cases he generally presents both sides of the argument quite vividly which would enable readers to form their independent opinion. If this happens, it would be a sure indicator of the success of the author.

In conclusion, the book presents a bird's eye view of developments in the fields of macroeconomic theory and policy since Keynes. The literature review is very detailed; it gives the reader an option to further pursue the subject in greater details and also provides a route map to undertake this journey. The bibliographical references at the end of each chapter could have been supplemented with name/subject index in the end which would have greatly enhanced the reader surplus. An integrated bibliographical reference list may be more reader friendly. It should be possible for various readers to have suggestions for addition of certain strands of thoughts or pleas for longer treatment of such themes. Such mentions of 'shortcomings' would not however underrate the educative value of the book. It provides a full picture of current Macroeconomic theory. Nachane's own view is perhaps reflected in dedication of the book; which is dedicated to "millions who lost their bread because a few who wanted more cake". Whether the presumed success of those who wanted *more* cake can be attributed to NCM alone is certainly debatable. To presume so is to perhaps overvalue importance of theory in practical matters. There is widespread feeling that unlike Great Depression in 1930 which resulted in Keynesian Revolution, 2007 GFC has not led to any similar upheaval in theory even if policies were redrawn quite swiftly and in a coordinated manner.

If this picture of persistence of NCM, which admittedly is unsatisfactory, leads the professionals to look for possible clues for improvisation (which are also sprinkled in the arguments presented the book) it would be an added effect (perhaps intended by the author). Also as described in Chapter 13, our understanding of rise and fall of ideas has now changed; it perhaps resembles transfer of power though elections rather than capture of power through a coupe

d'état! The recent decadal surveys of Macroeconomic theory appearing in *Journal of Economic Perspectives* [2018] and *Oxford Review of Economic Policy* [2018] provide ample testimony to the new directions in which economists are trying to explain observed reality. We perhaps are witnessing development of multiple perspectives - rather than one paradigm replacing NCM - which is more in tune with democracy and federalism.

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Dr.M.K. Datar passed away at his home in Kharghar, Navi Mumbai on April 29, 2020 following a heart attack. After his post-graduation in Economics from Babasaheb Ambedkar Marathwada University, Aurangabad, Dr. Datar obtained his Ph.D. in Economics from the University of Mumbai. After a brief stint at the Gokhale Institute of Politics and Economics, Pune, between 1983 and 1984, he joined the Research Division of the Industrial Development Bank of India (IDBI) and retired as Chief General Manager of the organisation (now IDBI Bank) in 2016. Since then, he had been an Advisor to the Indian Banks Association, Mumbai. He was a prolific writer on issues relating to money, banking and infrastructural development among other areas of general interest especially in the context of India. His books in Marathi entitled ***'Acche Din: Ek Pratiksha'*** and ***'Maharashtra: Eka Sankalpanecha Magova'*** have been well received. He has contributed to some very analytical and insightful papers to the School's journal. Basically, warm hearted, Dr. Datar and was often seen in Seminars and Conferences offering his comments in the most affable manner. His absence will be missed by many of his friends among whom the Editor of the journal was one.

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National University of Educational Planning and Administration
17-B, Sri Aurobindo Marg, New Delhi 110016 (India)

Phone: 91-11-26544819, 26544800; Fax: 91-11-26853041, 26865180
E-mail: Editorial: *jepa@niepa.ac.in;* Others: niepapublications@niepa.ac.in
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Telephone: 022-28493723; Fax: 091-022-28493724; e-mail: isae@bom7.vsnl.net.in website: www.isaeindia.org