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A study on Supply Chain issues of Indian Railway in Samastipur division using AHP technique

Saurabh Bhardwaj[1], C.S. Jawalkar[2]
[1,2] *Department of Production and Industrial Eng., PEC University of Technology, Chandigarh, India*

Abstract : *This study aimed to focus on some of the important issues associated with the supply chain in Indian Railway (IR). Railways are rapidly losing their market share in case of freight service, if this trend is not reversed; the growth and survival of railway will be under threat as freight service is the major source of income for IR. This paper analyses the attitude of the passengers and stakeholders over the current scenario of IR. The responses were obtained from the respondents by using a developed questionnaire. A decision hierarchy was framed and priorities were assigned; further Analytic Hierarchy Process (AHP) was used as a multi variable decision tool in order to decide the priority of the factors responsible for an efficient supply chain transport. The two most critical factors - punctuality and safety are discussed in the context of Samastipur division of East Central Railway (ECR) zone along with their severity and cause.*
Keywords *- Supply chain, freight, safety, punctuality, Analytic Hierarchy Technique.*

I. INTRODUCTION

Supply chain is a network of firms interacting to deliver product or service to the end customer, linking flow from raw material supply to final delivery [1]. Supply chain involves procurement of raw materials, their storage, loading and shipment to the end user. Thus transportation becomes a vital part in supply chain, transportation networks are amongst the most important building blocks in the economic development of a country. The performance of transportation network reflects the ease of travelling and transferring goods in different parts of a country. Railway, roadway, airway, waterway and pipelines are the different modes of transport used for freight service. The trend of freight mode preference in India from 1950-51 to 2007-08 is shown in Figure1 [2]. From the Figure 1, it is clear that Indian Railway is rapidly losing its freight share to the roadways, which is a threat for the growth and survival of railway in India as two third of the railways income comes from freight service.

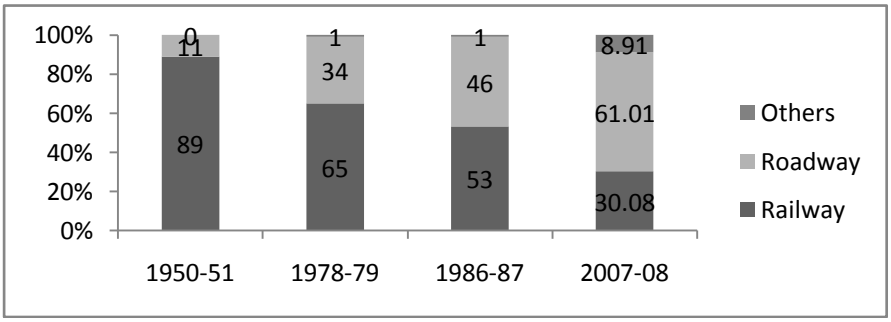

Fig. 1. Freight mode preference in India (1950-2008)

II. CUSTOMER AND STAKEHOLDER PERCEPTION

In order to study the cause of this rapid decline in freight share of IR; 40 people were interviewed in Samastipur division of East Central Railway zone of railway and they were asked to name some probable demerits of railway freight service; based on the demerits suggested by the interviewed people, a questionnaire was further framed which consisted of 14 questions from different areas of freight service. The people were asked to give their opinion using a five point scale, ranging from highly satisfied, satisfied, neutral, dissatisfied and highly dissatisfied. Apart from this the respondents were asked to choose between the two set of variables and assign a priority level to them. The interviewed people consisted of IR staffs and its stake holders. The hierarchy level illustrated in Fig.2 shows the three level of hierarchy in IR supply chain.

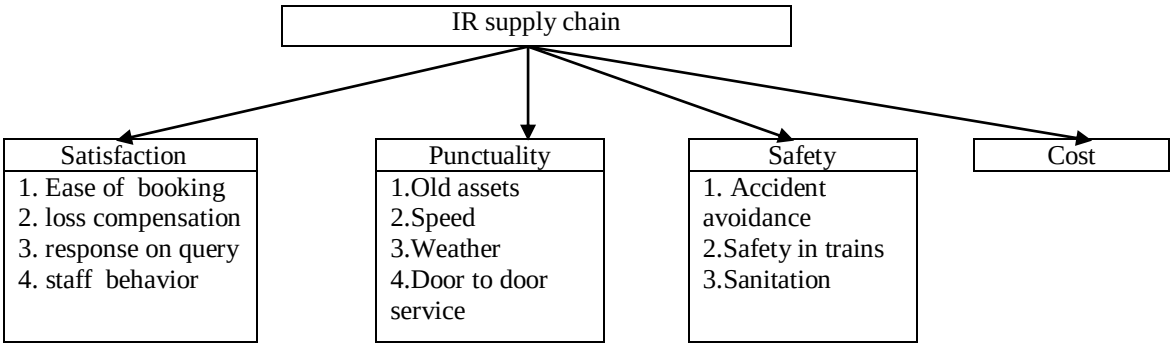

Figure 2: Hierarchy levels in IR supply chain

III. ANALYTIC HIERARCHY PROCESS (AHP)

In AHP technique pair wise comparisons between two set of variables are done using the rule given by Satty in 1980. Variables in the upper triangular matrix are assigned priorities in terms of 1= equal importance, 3= moderate importance, 5=strong importance, 7=very strong importance and 9=extreme importance. The values 2, 4, 6, 8 can also be used to express intermediate importance. To assign less priority we can use 1/3, 1/5, 1/7, and 1/9 for small to least priority. Values in the lower triangular matrix are the reciprocals of the upper triangular matrix [3].The pair wise comparison (values obtained from the questionnaire response) matrix of factors in level 1 hierarchy has been illustrated in Table 1, further all the entries in Table 1 have been divided by the sum of their column to obtain the normalized matrix which is illustrated in Table 2. Overall weight has been calculated by taking the average of each row. Normalized matrix when multiplied to overall weights results in priority values, these values are converted into percentage value and then ranked in order of their percentage value as shown in Table 3 below.

Table 1: Pair wise comparison matrix

	Satisfaction	Safety	Punctuality	Cost
Satisfaction	1	0.33	0.2	3
Safety	3	1	0.33	5
Punctuality	5	3	1	7
Cost	0.33	0.2	0.1428571	1
Sum	9.33	4.53	1.6728571	16

Table 2: Normalized matrix

	Satisfaction	Safety	Punctuality	Cost	Overall weights
Satisfaction	0.107181136	0.07284768	0.1195559	0.1875	0.1217712
Safety	0.321543408	0.22075055	0.1972673	0.3125	0.2630153
Punctuality	0.535905681	0.66225166	0.5977797	0.4375	0.5583593
Cost	0.035369775	0.04415011	0.0853971	0.0625	0.0568542

Table 3: Rank priority matrix

Category	Priority	Rank
Satisfaction	11.8 %	3
Safety	26.2 %	2
punctuality	56.5 %	1
cost	5.5 %	4

3.1 Checking consistency

The next step in AHP is to check consistency, if consistency index CI is sufficiently small; the decision maker's comparison is probably consistent enough to give useful estimates of the weights for his objective function. If CI/RI < 0.10, the degree of consistency is satisfactory, but if CI/RI > 0.10, serious inconsistencies may exist, and AHP may not yield meaningful result.

CI = (Principal eigen value - n)/(n-1) , In this case principle eigen value is 4.117
Now, CI = (4.117-4)/(4-1) = 0.039
RI = 0.9 for a (4*4) matrix [3].
So, CI/RI = 0.039/0.9 = 0.0433
As CI/RI ratio is < 0.10, so this matrix is consistent.
The pair wise comparison (values obtained from the questionnaire response) of 9 factors in level 2 of hierarchy important from the cost effectiveness point of view has been illustrated in table 4. The steps are same as performed in rank and priority calculation of level 1 factors of hierarchy. The result obtained for different factors has been illustrated in Table 5.

Table 4: Pair wise comparison of factors for cost effectiveness

	Ease of booking	Loss compensation	Response on query	Staff behavior	Speed	Door to door service	Accident avoidance	Safety in train	Sanitation
Ease of booking	1	0.33	3	3	0.2	0.14	0.33	0.20	1
Loss compensation	3	1	3	3	1	0.33	0.20	0.33	3
Response on query	0.33	0.33	1	1	0.2	0.2	0.14	0.33	3
Staff behavior	0.33	0.33	1	1	0.2	0.33	0.20	0.14	3
Speed	5	1	5	5	1	1	0.33	0.33	5
Door to door service	7	3	5	3	1	1	0.20	1	5
Accident avoidance	3	5	7	5	3	5	1	1	7
Safety in train	5	3	3	7	3	1	1	1	7
Sanitation	1	0.33	0.33	0.33	0.2	0.2	0.14	0.14	1

Table 5: Rank priority matrix for cost effectiveness

Category		Priority	Rank
1	Ease of booking	5.0 %	6
2	Loss compensation	8.3 %	5
3	Response on query	3.6 %	7
4	Staff behavior	3.6 %	8
5	speed	12.6 %	4
6	Door to door service	15.6 %	3
7	Accident avoidance	28.2 %	1
8	Safety in train	20.6 %	2
9	sanitation	2.5 %	9

IV. ANALYSIS OF THE RESULT

The AHP calculation indicates that punctuality and safety are the two most critical factors in level -1 hierarchy; while from the cost effective point of view accident avoidance and safety in train are the dominant factors followed by door to door service, speed and other remaining factors as shown in table 5. In this era of severe competition it is important for a service or product to ensure and reach its end users, at the most economical cost, at the promised time and in good condition. This is why punctuality and safety becomes vital

feature in the supply chain management. To illustrate the above key features of supply chain; East Central Railway zone of IR has been taken as the area of study. ECR comprises of five division; Mughalsarai, Dhanbad, Samastipur, Danapur and Siwan. The area under ECR zone along with location of some important junctions has been illustrated in Fig. 3.

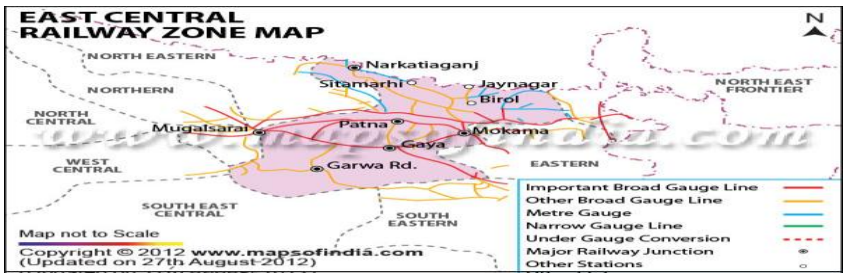

Fig.3. ECR zone map

4.1 Punctuality

The punctuality factor is a measure of trains running performance, it gives an idea whether the train is running according to its time table or not. It is a key performance indicator in supply chain which is affected by several factors [4]. It is a critical issue in railways as the reliable arrival time most often, out ways the provision of faster journey with less certain arrival times [5]. The punctuality is an associated deviation, majorly negative from the defined timetable. The table 6 shows the punctuality data for trains in ECR zone of IR for the consecutive years 2012-13 and 2013-14.

Table 6: Punctuality of trains (2012-2014) [6]

	Mail/Express		Passenger		Overall	
	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
April	64.77	69.07	43.88	36.09	53.72	51.82
May	58.61	61.76	40.34	34.81	48.93	47.6
June	52.5	64.82	35.73	35.28	43.67	49.17
July	49.59	71.28	32.42	99.35	40.6	54.24
August	64.17	68.7	37.98	51.45	50.51	60.07
September	67.15	72.91	37.56	38.74	51.74	54.82
October	65.71	65.88	36.77	36.44	50.55	50.05
November	62.46	68.4	34.64	36.02	47.66	50.86
December	50.69	61.03	32.51	35.11	41.14	47.3
January	56.98	54.28	36.93	34.02	46.51	43.56
February	68.68	60.76	39.09	35.11	53.4	47.29
March	70.43	68.23	39.11	37.57	54.17	51.94

The table 6 clearly indicates that there is a huge scope of improvement in punctuality in Indian railways. The average punctuality of mail/express trains were 60.97 % in 2012-13 whereas it increased to 65.59 % in 2013-14. In case of passenger trains it increased from 37.24 % in 2012-13 to 42.49 % in 2013-14. Overall values from questionnaire response average punctuality increased from 48.55 % in 2012-13 to 50.72 % in 2013-14. The

Fig. 4 shows the average trend of punctuality in ECR zone of IR in the two consecutive years 2012-13 and 2013-14.

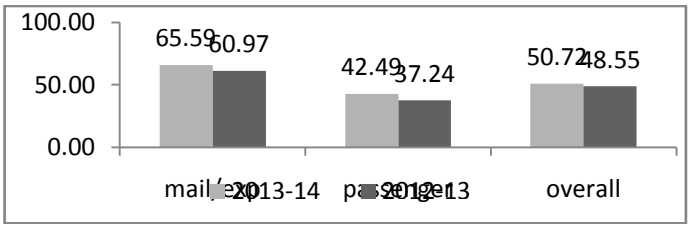

Fig 4: Average trend of punctuality in ECR zone

There are many factors which can affect the timely running of passenger and freight services, some of these are – (a) Condition of railway track, (b) Weather disturbances like fog and heavy rain, (c) Absence of dedicated freight corridor till now in India, (d) Poor average speed of goods and passenger trains, (e) Use of old locomotives and wagons. The Table 7 shows the average speed of Mail/Express, ordinary passenger and EMU trains on broad gauge for the last 15 years.

Table 7: Average speed of trains in 2003-2013(in km/hr) [7]

Year	Mail/Express	Ordinary/Passenger	EMU
2003-04	46.8	35.6	39.5
2004-05	46.8	36.1	39.7
2005-06	46.9	37.8	40.6
2006-07	47.9	38.3	41.1
2007-08	48.2	37.8	41.4
2008-09	49.9	38.0	42.0
2009-10	50.0	36.8	40.2
2010-11	50.1	36.7	40.4
2011-12	50.3	36.2	40.5
2012-13	50.4	36.1	40.7

There has not been any improvement in the average speed of trains for the last 15 years in India. Though we have achieved a maximum speed of 160 km/hr but average speed remains an alarming area which needs some actions viz. increasing no. of tracks on busy routes, dedicated routes for freight and local trains, less no. of stoppages, replacement of old tracks and locomotives etc.If we compare punctuality of IR with Japanese railway we lag far behind. The average delay on the Tokaido Shinkansen in year 2012 was only 0.6 minutes, in case a train gets delayed by 5 minutes the railway company may provide a "delay certificate" as no one would expect a train to be this late [8].

4.2 Safety

Safety is the utmost factor to be taken care either in freight or passenger service. The accident not only causes loss of life and wealth (in terms of compensation) but also degrades the reputation of any organization. Frequent accidents cause sense of insecurity in the mass. Fig. 5 shows the no. of accident cases from 2006-07 to 2012-13. The Fig. 6 shows the types of accidents via different modes like derailment, level crossing, fire, collision and other miscellaneous types [9],[10].

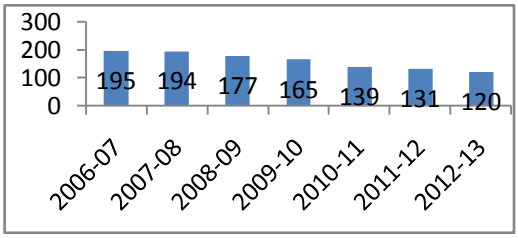

Fig.5. No. of accidents (2006-2013)

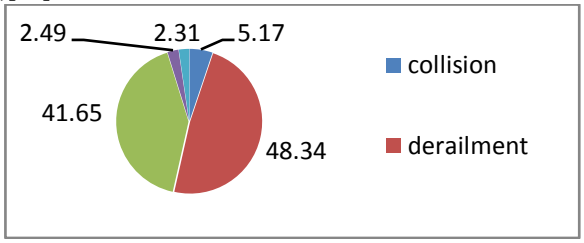

Fig.6.Types of accident

Table 8: Cause of train accidents in India (2006-2011) [7]

Year	Failure of Railway staff	Failure of other	Failure of Equipment					Sabotage	Combination of Factor	Incidental	Could Not Established	Under Inestigation	Total
			Rolling Stock	Track	Electrical	S&T	Total						
2006-07	85	84	4	5	-	-	9	8	1	6	-	1	194
2007-08	84	81	4	3	-	1	1	7	-	8	1	3	193
2008-09	*76	75	-	-	-	-	1	13	*4	*5	4	*-	177
2009-10	63	75	3	3	-	-	-	14	1	4	2	-	165
2010-11	58	58	-	2	-	-	-	16	2	3	-	-	139
Legend :- * : Revised.													

It is clear from the above table that human factor is the major cause of rail accidents in India. Incidental Causes Include acts of Nature like falling of boulders, water logging on track due to heavy rain or flood, cattle getting run over, etc.

V. CONCLUSION

The Supply chain of any organization cannot be efficient if its transport facility within and outside the organization is not efficient. IR is the largest government owned railway in the world and it serves as a prominent supply chain partner to many service and manufacturing organizations in India. From the conducted study it can be concluded from this study that roadways are giving a tough competition to IR in freight and passenger services. Punctuality and safety are the key areas which a customer or passenger keeps in mind while selecting a mode of transport from the study on Samastipur division using a questionnaire and AHP technique. The technological advancement for avoiding derailment is required along with the elimination of unmanned level crossings; further human factor is a critical cause of accidents. In India the railway is currently lagging in punctuality and safety feature, the likely reasons and difficulties are discussed in the study.

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