International Journal of Engineering

Journal Homepage: www.ije.ir

TECHNICAL NOTE

# Statistical Analysis of the Railway Accidents Causes in Iran

I. Bargegol[a], V. Najafi Moghaddam Gilani*[b], M. Abolfazlzadeh[c]

[a] Department *of Civil Engineering, Faculty of Engineering University of Guilan, Rasht, Iran*
[b] Highway & Transportation Engineering, Faculty of Engineering University of Guilan, Rasht, Iran
[c] Department of Energy Systems Engineering, Islamic Azad University – South Tehran Branch & Pardaraz Consultants Engineering, Tehran, Iran

*PAPER INFO*

*Paper history:*
Received 17 June 2017
Received in revised form 18 August 2017
Accepted 08 September 2017

*Keywords*:
Accident
Train
Railway
Accident Rates

*ABSTRACT*

The occurrences of accidents on the railways are inevitable in today's world and the factors which may cause it, except the atmospheric and accidental ones, are identified and preventable as well. Therefore, these factors can be investigated and useful actions can be performed in order to reduce these accidents. The main impetus of the present research is the statistical analysis of the causes of railway accidents in Iran. Our achievement illustrates that except the train collision accidents with vehicles, all the accidents vary upon a sixth order curve which means the instability and unpredictability of the railway accidents during the last years. According to the performed studies, it is clarified that the railway accidents during the 10 years from 2000 to 2010 have not had a stable flow and have been under fluctuations and each of the kinds and causes of the accidents has its own contribution to the occurrence of these railway related happenings. Based on the analyses, derailment is the major factor of the various railway accidents and it includes about 55% of these accidents. Damage to people and collisions with non-rail vehicles are placed in the second category. Hereupon, efforts must be made by providing the necessary equipment for the simple access of the people beyond the lines such as pedestrian bridges in order to reduce the railway accidents.

***doi**: 10.5829/ije.2017.30.12c.02*

## 1. INTRODUCTION

Railway collisions happen due to several causes such as incorrect lining, absence of the entrance gate to the intersections, malfunction of the warning devices and insufficient sight distance at the intersections. The above cases are the main causes of many railway related accidents [1].

Iran's railway as a member of the international union of railways (UIC), is considered as one of the most important railway networks in the Middle East. Surveys show that the rails and related equipment in this country is placed in an intermediate state and not so high compared to the other countries. However, it is on a low level and faced with shortcomings compared to the rail facilities of developed countries like America, Canada, Russia, China, France and etc.

The occurrence of accidents on the railways is inevitable in today's world and the factors which may cause it, except the atmospheric and accidental ones, are identified and preventable as well. These causes could be analyzed and useful performances done in order to reduce accidents. Therefore, an inclusive, as well as comprehensive immunization, must be performed in the whole Iranian rail network. Exact analysis of accidents and investigating the causes of their occurrence are the basic and significant sections of the immunization actions. The present study aims to achieve notions indicating the current safety status of the railway transportation industry by statistical analysis of various railway accidents and their reasons in Iran.

## 2. RAILWAY ACCIDENTS

Accidents in which a train is involved are called railway accidents. These accidents are classified into two groups

*Corresponding Author's Email: vahid.moghaddam90@gmail.com (V. Najafi Moghaddam Gilani)

as prominent train accidents (with high damage) and other train related accidents. The first group are said to be the collisions in which one or more events such as loss of human lives, human hurts, damage to the railway infrastructure and delay in the rail traffic occurs [2].

Vehicle-train, train-train, pedestrian-train interferences, inappropriate train speed, train staff forgetfulness, poor maintenance of rail equipment and poor maintenance of the line and the intersections are considered as the various causes of railway accidents [3], among which the train-train, train-vehicle collisions and exit from the rail line are the most common causes [4].

## 3. TRAIN ACCIDENT RATES

The overall train accident rate is defined as the total number of independent accidents (usually excluding highway-rail grade crossing accidents) per million total train-miles [5]. Although trends in train accident rate can be useful, they are also potentially misleading if the effects of different variables are averaged together, thus masking the various factors that affect the probability of a train being involved in an accident. As an example, the mainline derailment rate for Class I freight trains, arguably the most important in terms of the risk associated with the transportation of hazardous materials by rail, has shown little variation over the last decade despite the overall increase in accident (FRA, 2003-2004) [6-9].

## 4. RESULTS

In order to analyze the accidents in different years, it is necessary to consider the number of passed trains further to the accidents data in each year and region.

In this regard, several indexes are available, one of which is train-kilometer index in each year. As mentioned earlier, this indicator shows the amount number of traffic of freight and passenger trains in the rail network [10, 11]. The analyses given in the present study are based upon this index. In comparing railway accidents, according to the type of the accident, the number of accidents over million train kilometers is used as an index. In the following, the above mentioned index points out to the accident rate as well as rate of its causes.

The railway accidents data needed for the statistical analysis including the rates of occurrence and causes of various accidents are collected from the raw data of the general directorate of protection and safety of rail travel and the rail and research center of the Islamic Republic of Iran, respectively. This information are related only to the accidents happened in the timeframe 2001-2010; the data associated with the accidents in 2011-2015 were not sufficiently available or were deficient which made them unreliable.

Table 1 lists the rates of various accidents occurrence for million kilometers traveled by train during 2001-2010. Also, the rates of the accidents occurrence in the entire rail network according to the cause are given in Table 2 per million train-kilometers during 2001-2009.

## 5. STATISTICAL ANALYSIS OF VARIOUS ACCIDENTS

The main impetus of the present research is the statistical analysis of accidents and their causes in Iran's railway system. Least squares method is implemented to determine the accident rate growth during the timeframe 2001-2010. In order to specify the positive or negative growth of the accidents, a first-degree curve is plotted showing the dispersion value of various accidents in different years. To determine the relation between the rail accidents and passed years, the best regression relation according to the correlation coefficient ($R^2$) is chosen. This relationship represents the accurate changes process of the above data.

**TABLE 1.** The rates of various accidents occurrence per million Train-kilometers during 2001-2010 [12]

| Accidents \ Year | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rail Collisions** | 1.20 | 1.30 | 1.00 | 0.90 | 1.00 | 1.40 | 0.90 | 1.30 | 0.80 | 1.10 | **9.80** |
| **Derailment** | 8.00 | 4.70 | 7.60 | 8.30 | 10.90 | 7.70 | 6.30 | 6.10 | 5.30 | 6.70 | **64.90** |
| **Non-rail Collision** | 0.80 | 0.90 | 0.90 | 1.20 | 1.10 | 1.50 | 1.50 | 1.90 | 1.70 | 1.70 | **11.50** |
| **Human Injury** | 3.50 | 3.30 | 2.60 | 2.30 | 3.60 | 3.00 | 2.90 | 3.00 | 2.60 | 3.00 | **26.80** |
| **Other Cases** | 0.50 | 0.70 | 0.10 | 0.20 | 1.00 | 0.50 | 0.40 | 0.30 | 0.60 | 0.50 | **4.30** |
| **Total** | 14.00 | 10.90 | 12.20 | 12.90 | 17.60 | 14.10 | 12.00 | 12.60 | 11.00 | 13.00 | **117.30** |

**TABLE 2.** The rates of the accidents occurrence in the entire rail network according to the cause per million train-kilometers during 2001-2009 [13]

| Accidents occurrence \ Year | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| **Human** | 4.10 | 3.30 | 1.50 | 3.40 | 5.50 | 4.80 | 3.30 | 4.00 | 3.10 | **35.00** |
| **Line** | 2.80 | 1.50 | 2.50 | 2.40 | 3.80 | 2.10 | 2.00 | 1.60 | 1.30 | **20.10** |
| **Energy network** | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | **0.00** |
| **Fleet** | 2.00 | 1.30 | 2.20 | 3.00 | 2.70 | 2.10 | 1.60 | 1.30 | 1.50 | **17.80** |
| **Sign** | 0.00 | 0.00 | 0.10 | 0.00 | 0.10 | 0.00 | 0.00 | 0.10 | 0.10 | **0.40** |
| **Needle performance train** | 0.00 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | **0.70** |
| **Electrical equipment** | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | **0.10** |
| **Passenger and cargo** | 0.40 | 0.10 | 0.10 | 0.30 | 0.50 | 0.40 | 0.20 | 0.30 | 0.10 | **2.40** |
| **Natural factors** | 0.20 | 0.30 | 0.20 | 0.20 | 0.20 | 0.30 | 0.30 | 0.30 | 0.30 | **2.30** |
| **Third party** | 4.20 | 4.00 | 3.70 | 3.40 | 4.00 | 4.10 | 4.20 | 4.70 | 4.00 | **36.70** |
| **Other causes** | 0.10 | 0.20 | 0.10 | 0.00 | 0.20 | 0.10 | 0.10 | 0.20 | 0.40 | **1.40** |

The results obtained from the linear and nonlinear regression analyses of the data are given in Table 3. In this table, the best mathematical formula of all the relations is presented in terms of statistical parameters, i.e. Spearman correlation coefficient ($R^2$), F statistic and significance source.

In Table 3, for each of the accident parameters with respect to the year of happening, two equations are given with the obtained values of $R^2$ and P-Value. One of these equations which is a first-degree curve, determines the accident growth rate and the other one illustrates the best regression relation according to the better values of $R^2$ and P-Value. In order to specify the best regression relationship, the relations with P-Value values smaller than 5% and with 95% reliability can be used of all the possible relationships. In the meantime, the equation with the highest value of F statistic is introduced for each accident.

As can be observed, except the collisions between train and non-rail vehicles, all the accidents varies based on six-degree curves which indicates the instability and unpredictability of the railway accidents during the past years. Furthermore, the values of $R^2$ corresponding to the first-degree curves verifies this fact and stand for the railway accidents dispersion.

**TABLE 3.** The relationships among the different types of railway accidents during 2001-2010

| Types of railway accidents | Equation type | Model equation | $R^2$ | F Statistic | P-value | Significant source "*" |
|---|---|---|---|---|---|---|
| **Rail Collisions** | liner | y = -0.0152x + 31.476 | 0.0513 | 7.1 | 2.351 | --- |
| | Best equation | $y = -0.0001x^6 + 1.3382x^5$ - 6715.1x4 + 2E+07x3 - 3E+10x2 + 2E+13x - 7E+15 | 0.4299 | 2.5 | 0.000 | * |
| **Derailment** | liner | y = -0.1467x + 301.3 | 0.0632 | 8.4 | 4.326 | --- |
| | Best equation | y = 0.0007x6 - 8.2802x5 + 41553x4 - 1E+08x3 + 2E+11x2 - 1E+14x + 4E+16 | 0.8634 | 5.7 | 0.000 | * |
| **Non-rail Collision** | liner | y = 0.1212x - 241.77 | 0.8809 | 2.8 | 0.000 | * |
| | Best equation | y = 8E-85e0.0967x | 0.8942 | 17.4 | 0.000 | * |
| **Human Injury** | liner | y = 0.0048x - 6.6436 | 0.0012 | 4.2 | 0.891 | --- |
| | Best equation | y = -0.0015x6 + 18.383x5 - 92167x4 + 2E+08x3 - 4E+11x2 + 3E+14x - 1E+17 | 0.7632 | 1.6 | 0.000 | * |
| **Other Cases** | liner | y = 0.0024x - 4.3818 | 0.008 | 7.7 | 2.834 | --- |
| | Best equation | y = -0.0011x6 + 13.119x5 - 65778x4 + 2E+08x3 - 3E+11x2 + 2E+14x - 7E+16 | 0.7137 | 4.5 | 0.000 | * |

* Significant at 95 percent confidence level

In a collision between train and non-rail vehicles, except the other rail related accidents, the best regression relation is the exponential one and the linear curve which shows the growth rate of this accident, meets a negligible difference with the best regression relation. Both of the linear and exponential relationships have great as well as trustable values of $R^2$. The detailed explanation for each rail accident is given in the following sections.

**5. 1. Rail Collisions** Figure 1 depicts the plots of the railway accidents growth rates. Based on the first-degree cure, the occurrence of the railway accidents in the rail network of the country has been encountered with a descending trend. Since the correlation coefficient is nearly zero, the rate of the mentioned accident is periodic and has a high dispersion from the trend line, making it unpredictable. It can be easily seen from the above figure that the maximum and minimum rate of railway accidents have happened in 2001 and 2009, respectively and this rate has been faced with fluctuations during the other years. Therefore, it can be concluded that the safety status towards the railway accident reduction is not stable. So, attention must be paid to their causes in order to reduce these accidents.

**5. 2. Derailment** Figure 2 exhibits the accident growth rate of the derailment. According to the first-degree curve, the occurrence of derailment accidents in the country's railway network has slightly had a downward trend.

However as would be observed, with respect to the negligible correlation coefficient (0.06), the corresponding occurrence rate has a high dispersion from the trend line, making it unpredictable. Also, it is seen that the occurrence rate reaches its maximum value in 2004, experiences an upward behavior from 2002 to 2006 and a downward one from 2007 to 2009. In 2010, an upward trend is observed once again which hints to the unstable status of the safety.

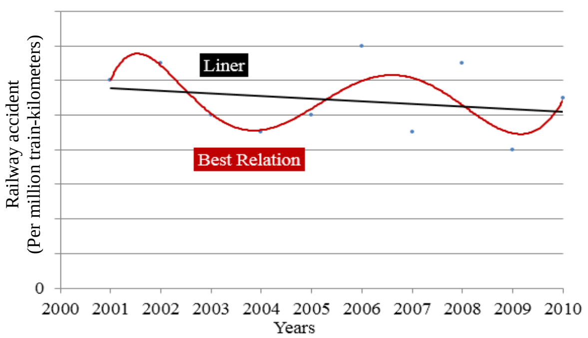


**Figure 1.** Railway accidents rate in the rail fleet

Derailment mainly occurs due to the failure and exhaustion of the lines and fleet, human resources and environmental factors which can be reduced by following the standard maintenance instructions, vehicle repairs and timely line checks with advanced equipment.

**5. 3. Non-rail Collision** The curves associated with non-rail accidents growth rate are plotted in Figure 3. Regarding the first-degree curve and its correlation coefficient value (0.88), the trend line clarifies with a good accuracy that the non-rail accident rate has had a 12% upward growth. The exponential curve with correlation coefficient of 0.89 testifies this. On the other hand, the status of this type of rail accident in the railway network is growing and it is expected to have ever increasing non-rail accidents in each year. These conditions indicate a very bad situation in terms of accidents between railway vehicles, non-railway vehicles and animals. Therefore, the health matter in passageways of vehicles should be highly considered by installing advanced safety systems, conversion to the non-coplanar level crossings as possible, looking for solutions about illegal and unprotected passageways and raising the level of safety culture of people**.**

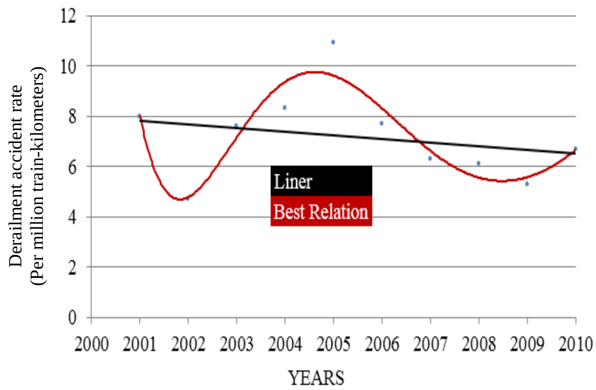


**Figure 2.** Derailment accidents rate in the rail network

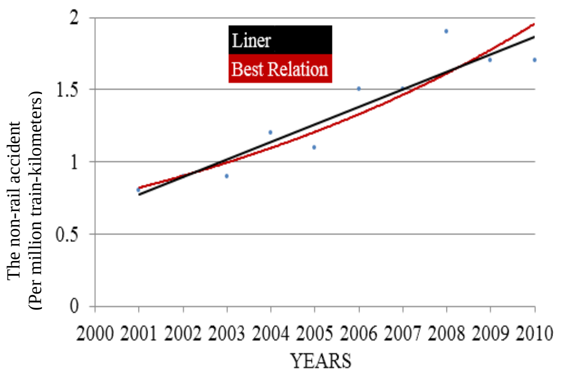


**Figure 3.** The non-rail accidents rate in the rail network

**5. 4. Human Injury** Figure 4 illustrates the accident rate of human injury. Although this rate has been under a slight decay in the railway network of Iran but its rate has dispersion over the trend line which indicates the undesirable condition. From this plot, it can be found that the accident rate of human injury has had a decrement in 2000. However, it has reached its maximum value in 2001, despite having the least amount of train movements in this year. This rate has been in a constant level from 2002 to 2010. Instabilities observed in the accident rate are mainly due to the lack of proper planning toward minimizing the impact to human. In order to reduce human injuries, particular attention must be paid to this important problem in macro-level management and the installation of warning signs and social awareness is necessary.

**5. 5. Other Cases** The accident growth rates associated with other incidents in the railway system are plotted in Figure 5. As can be seen, although the trend line indicates a constant status in the rate of other railway related accidents, this accident rate has

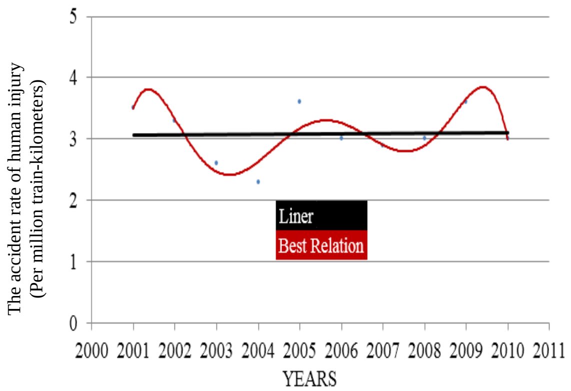


**Figure 4.** The accident rate of human injury in the rail network

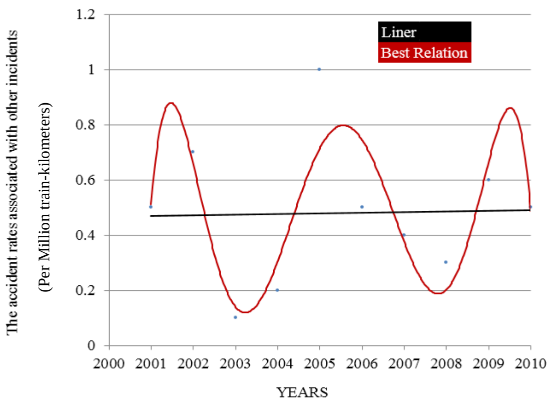


**Figure 5.** The accident rates associated with other incidents in the railway network

dispersion with respect to the trend line due to the nearly zero value of the correlation coefficient which shows undesirable conditions. The above graphical illustrations clarify that the maximum value of other accidents rates occurs in 2001. Although, the rate of such a kind of accident has been under decrement from 2006 to 2008 but again increased in 2009. These kinds of accidents often contain the passenger and cargo wagons fire related to the transportation of flammable materials such as cotton and sulfur.

## 6. THE STATISTICAL ANALYSIS OF ACCIDENT CAUSES

This section aims to present the statistical analysis of accident causes in Iran's railway. The Least Squares approach is applied for identifying the growth rate of accident causes during the timeframe 2001-2009. In this regard, the first-degree curve is plotted to determine the dispersion value of the accident causes in different years. This first-degree illustrates the positive or negative growth rate of accident causes. Furthermore, the best regression relation with respect to the correlation coefficient ($R^2$) is identified in order to determine the relationship between rail accident causes and passed years. This relation indicates the closer varying trend of the above data.

Table 4 gives the results achieved from linear and nonlinear regression analyses of the above data. In this table, the best mathematical relation of all the relations is presented in terms of statistical parameters as Spearman correlation coefficient ($R^2$), F statistic and significance source. For each of the accident cause parameters with respect to the year of occurrence, two relations are given in Table 4 using the obtained values of $R^2$ and P-Value. One of these relations is the first-degree curve for determining the growth rate of accident causes and the other stands for the best regression relationship with respect to the premier values of $R^2$ and P-Value. To identify the best regression relationship of all the possible relationships (linear, logarithmic, exponential, etc.), relations with P-Values smaller than 5%, can be used with 95% trustiness. Then, the relation associated with the maximum F statistics is introduced as the best one of each accident. The notable point is the detection of a nonlinear relation of order six between all the accident causes and the years in which they happened. This is mainly due to the unstable and unsafe conditions of the country's railway network. The $R^2$ values of first-degree curves also verify this claim and indicate the dispersal status of the railway accidents causes. The descriptions of each of the causes of rail accidents are investigated in the following.

**TABLE 4.** The relations between rail accidents causes during 2001-2009.

| Types of railway accidents | Equation type | Model equation | $R^2$ | F Statistic | P-value | Significant source "*" |
|---|---|---|---|---|---|---|
| **Human** | liner | y = 0.0517x - 99.925 | 0.0156 | 4.3 | 3.246 | --- |
| | Best equation | y = -0.0085x6 + 101.92x5 - 510904x4 + 1E+09x3 - 2E+12x2 + 2E+15x - 6E+17 | 0.9994 | 2.3 | 0.000 | * |
| **Line** | liner | y = -0.1167x + 236.14 | 0.1717 | 4.59 | 0.346 | --- |
| | Best equation | y = -0.0008x6 + 9.7984x5 - 49096x4 + 1E+08x3 - 2E+11x2 + 2E+14x - 5E+16 | 0.7616 | 1.43 | 0.000 | * |
| **Fleet** | liner | y = -0.0683x + 138.97 | 0.0959 | 7.57 | 2.414 | * |
| | Best equation | y = 0.0004x6 - 5.0165x5 + 25165x4 - 7E+07x3 + 1E+11x2 - 8E+13x + 3E+16 | 0.993 | 2.62 | 0.000 | * |
| **Passenger and Cargo** | liner | y = -0.005x + 10.292 | 0.0083 | 4.24 | 5.233 | --- |
| | Best equation | y = -0.0007x6 + 8.3535x5 - 41868x4 + 1E+08x3 - 2E+11x2 + 1E+14x - 5E+16 | 0.9845 | 4.9 | 0.000 | * |
| **Third Party** | liner | y = 0.05x - 96.172 | 0.1321 | 9.3 | 0.710 | --- |
| | Best equation | y = -0.002x6 + 24.283x5 - 121717x4 + 3E+08x3 - 5E+11x2 + 4E+14x - 1E+17 | 0.7905 | 8.1 | 0.000 | * |

* Significant at 95 percent confidence level

**6. 1. Human Cause** Figure 6 depicts the growth rate curves of human cause in the railway network. According to this figure, the role of human cause in rail accidents occurrence has been decreased in some years and increased in some others which implies the lack of stable safety in the human factor section of Iran's rail network. Based on the performed investigations, human factor is considered as the most common causes of accidents that cause a variety of rail accidents such as collisions, derailments and etc. [14].

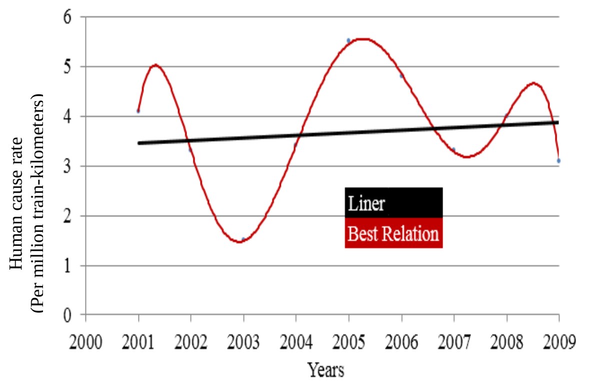


**Figure 6.** The accident rates associated with human factor in the railway network

**6. 2. Line Cause** The growth rate curves associated with the line cause in the railway network of the country are plotted in Figure 7. As would be observed, except in 2005, the line cause related rate has been on a decaying trend which indicates the renovation and relative improvement of lines during the recent years.

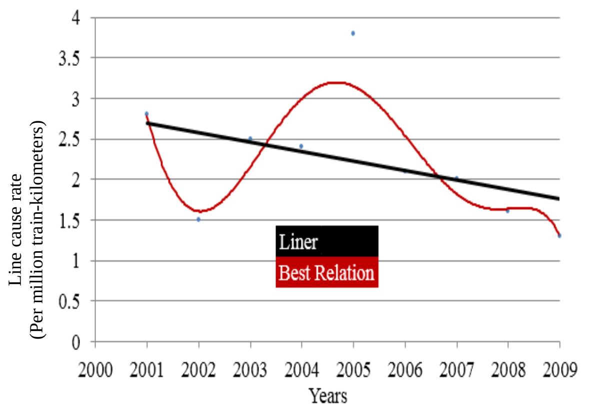


**Figure 7.** The accident rate associated with the line cause in the railway system

**6. 3. Fleet Cause** Figure 8 shows the growth rate curves of the rail accidents due to the fleet in the country's rail network. Based on the above curves, although during 2005-2008 the fleet cause rate has decreased, however, the sporadic distribution of the points indicates the unstable condition in the safety status and correct operation of the rail fleet. This further implies the fleet exhaustion, the lack of efficient management in the maintenance and also disrespect to the correct methods of maintenance, according to manufacturer's instructions.

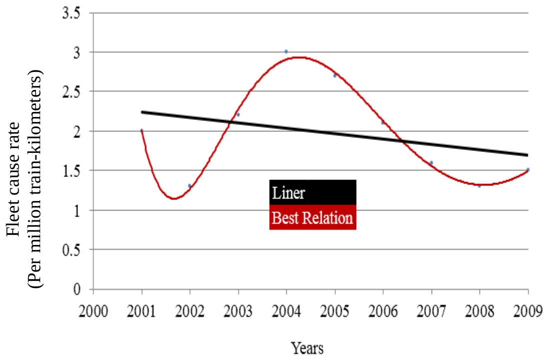


**Figure 8.** The accident rate associated with the fleet cause in the railway system

**6. 4. Passenger and Cargo Causes** Figure 9 illustrates the accident rates due to the passenger and cargo causes. These curves indicate the lack of necessary supervision on the loading and load distribution rules that cause derailment accidents and so on.

**6. 5. Third Party Cause** The curves governing the occurrence rates related to the cause of third party in the railway network are presented in Figure 10. Regarding these curves, it can be concluded that the trend of this cause is ascending and the scattering distribution can be considered as natural since these causes enter from outside into the railway network. Therefore, it is necessary to give enough knowledge and education to the people living on the railway sidelines. Furthermore, facilities must be provided for easy access across the lines by constructing pedestrian bridges.

## 7. RESULTS DISCUSSION

Based on the performed analyses, it is clear that rail accidents has not had a stable trend during the ten years from 2000 to 2010 and have been under constant rise and fall and each of the accident causes has their own contribution to these happenings.

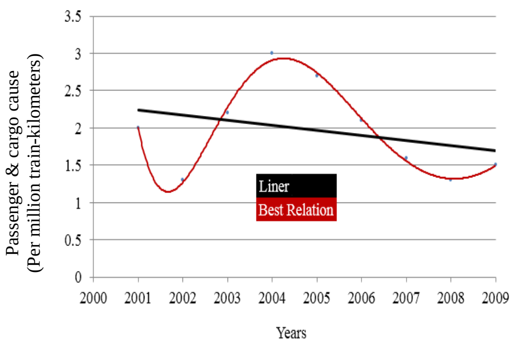


**Figure 9.** The accident rate associated with the passenger and cargo causes in the railway system

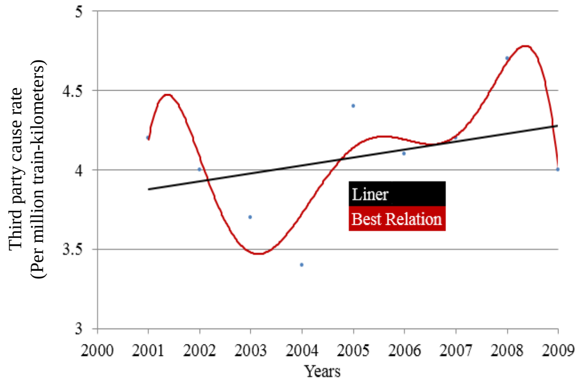


**Figure 10.** The accident rate associated with the passenger and cargo causes in the railway system

Figures 11 and 12 show the contribution of each type and cause of accident, respectively. These plots are determined based upon the average of the accident occurrence and causes rates per million Train-kilometers during 2000-2010.

As can be seen from Figures 11, derailment is the major cause among the rail related accident causes and includes 55% of all the railway accidents. Human damage and non-vehicle collision are in the second and third places, respectively. In addition, as shown in Figures 12, the third party and people who live in the vicinity of railways are counted as the most effective parameter in the occurrence of different rail accidents and include about 42% of the causes of accidents.

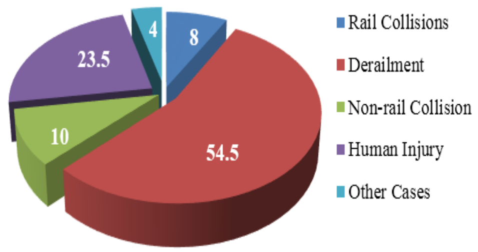


**Figure 11.** The contributions of different rail accidents during 2000-2010

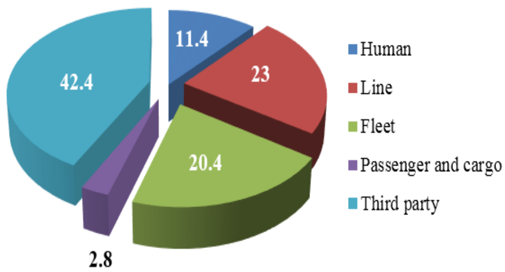


**Figure 12.** The contributions of different causes of accidents during 2000-2010

Hence, facilities must be provided for easy access across the lines by constructing pedestrian bridges in order to decrease railway accidents. The trend and portion of railway accidents causes indicate the importance of design and implementation of a comprehensive safety management system in Iran’s railway system.

Evans in 2011, performed a comparative study for the railway collisions per million people by reviewing the railway accidents of Europe. According to Table 5, comparing the values of railway accidents of Iran with those in European countries shows although having very scanty rail lines, the number of deaths per million people in Iran is too high. In most of the European countries, these values have decreased over the past years,while these figures have increased in Iran.

**TABLE 5.** Fatal train collisions per million people by country

| Country | 2000-2004 | 2005-2009 |
|---|---|---|
| **Iran (IR)** | 7 | 9 |
| **Germany (DE)** | 4 | 0 |
| **France (FR)** | 3 | 1 |
| **UK (UK)** | 3 | 9 |
| **Italy (IT)** | 9 | 9 |
| **Poland (PL)** | 1 | 2 |
| **Spain (ES)** | 5 | 2 |
| **Czech Republic (CZ)** | 4 | 5 |
| **Switzerland (CH)** | 4 | 1 |
| **Austria (AT)** | 4 | 1 |
| **Netherlands (NL)** | 1 | 1 |
| **Sweden (SE)** | 0 | 0 |
| **Romania (RO)** | 1 | 2 |
| **Hungary (HU)** | 1 | 2 |
| **Belgium (BE)** | 3 | 1 |
| **Denmark (DK)** | 2 | 0 |
| **Slovak Republic (SK)** | 1 | 0 |
| **Finland (FI)** | 0 | 0 |
| **Bulgaria (BG)** | 1 | 0 |
| **Portugal (PT)** | 4 | 2 |
| **Norway (NO)** | 1 | 0 |
| **Latvia (LV)** | 0 | 2 |
| **Greece (EL)** | 0 | 2 |

## 8. CONCLUSION

According to the performed analyses, the instability in the safety status is clear and the continuous fluctuations in the accident rates during the ten years indicate the existence of organizational structural problems and lack of coordination in planning of maintenance and repair. Regarding the non-rail collisions, it is saying that these types of accidents show a growing trend with the development of principal lines and increasing the road traffic and crossings which needs considering necessary preparations. Regarding other accidents, due to the unstable status in their occurrence rates and great contribution of human resources in their happenings, the need for maintenance improvement, on-the-job training at all levels, use of new equipment and instruments, electric signs and warning system implementation, control and communication as well as the experiences of developed countries is necessary in order to reduce accidents.

## 9. REFERENCES


1. Zakeri, J., "Iranian railways strategies for reducing risks of accidents in crossings", in CD-proceedings of 8th international Level Crossing Symposium, Sheffield University., (2004).
2. Liu, X., Saat, M. and Barkan, C., "Analysis of causes of major train derailment and their effect on accident rates", ***Transportation Research Record: Journal of the Transportation Research Board***, No. 2289, (2012), 154-163.
3. Yan, X., Richards, S. and Su, X., "Using hierarchical tree-based regression model to predict train–vehicle crashes at passive highway-rail grade crossings", ***Accident Analysis & Prevention***, Vol. 42, No. 1, (2010), 64-74.
4. Anderson, R.T., "Quantitative analysis of factors affecting railroad accident probability and severity", University of Illinois at Urbana-Champaign, (2005),
5. Accident manual for official use only. *West central railway*. 2004.
6. Federal Railroad Administration (FRA), " Office of safety, download data on demand", (2003).
7. Federal Railroad Administration (FRA), "Office of safety, railroad safety statistics annual report & accident/incident bulletin", (2003).
8. Federal Railroad Administration (FRA), "Office of safety, train accident rates", (2003).
9. Federal Railroad Administration (FRA), "Office of safety, query page", (2004).
10. Ayati, E., "Rural road traffic accidents in iran", ***International Journal of Engineering***, Vol. 2, No. 3&488.
11. Ayati, E., "The cost of road accidents in iran", ***International Journal of Engineering***, Vol. 2, No. 3&4, (2006), 98-103.
12. Railway accident raw data, "The department of protection and safety of rail travel of the islamic republic of iran, (2001-2010)".
13. Railway accident raw data, "Railway research center of the islamic republic of iran, (2001-2010).
14. Evans, A.W., "Fatal train accidents on europe's railways: 1980–2009", ***Accident Analysis & Prevention***, Vol. 43, No. 1, (2011), 391-401.

# Statistical Analysis of the Railway Accidents Causes in Iran

**TECHNICAL NOTE**

I. Bargegol[a], V. Najafi Moghaddam Gilani[b], M. Abolfazlzadeh[c]

[a] Department *of Civil Engineering, Faculty of Engineering University of Guilan, Rasht, Iran*
[b] Highway & Transportation Engineering, Faculty of Engineering University of Guilan, Rasht, Iran
[c] Department of Energy Systems Engineering, Islamic Azad University – South Tehran Branch & Pardaraz Consultants Engineering, Tehran, Iran

*PAPER INFO*

*Paper history:*
Received 17 June 2017
Received in revised form 18 August 2017
Accepted 08 September 2017

*Keywords*:
Accident
Train
Railway
Accident Rates

**چکیده**

رخداد حوادث و سوانح در راه آهن در دنیای امروزه اجتناب ناپذیر بوده و عواملی که باعث ایجاد آن می‌گردد جز عوامل جوی و اتفاقی، شناخته شده و قابل پیش‌گیری هستند که در این راستا می‌توان به بررسی آن‌ها پرداخت و در جهت کاهش تعداد سوانح، اقدامات مفید انجام داد. هدف اصلی این پژوهش تحلیل آماری انواع و علل سوانح در راه آهن ایران می‌باشد. نتایج حاصل از تحلیل نشان می‌دهد به جز سوانح برخورد قطار با وسایل غیرریلی، تمامی سوانح دارای منحنی درجه ۶ می‌باشند که این به معنای ناپایدار بودن و غیرقابل پیش‌بینی بودن سوانح ریلی در طی سال‌های مختلف را نشان می‌دهد. با توجه به تحلیل‌های انجام شده مشخص شد که سوانح ریلی درمدت ۱۰ سال ۲۰۰۰–۲۰۱۰ روند پایداری ندارد و مرتباً در حال افت و خیز می‌باشد و هر کدام از انواع و علل سوانح سهم خود را در وقوع این حوادث ریلی دارند. با توجه به تحلیل‌ها، خروج از خط مهم‌ترین عامل سهم انواع سوانح ریلی می‌باشد و نزدیک ۵۵ درصد از کل سوانح ریلی را شامل می‌شود. صدمه به انسان و برخورد با وسایل غیرریلی در رده‌های دیگر قرار دارند. از این‌رو بایستی با فراهم کردن امکانات لازم جهت دسترسی سهل و هموار مردم به آن سوی خطوط با احداث پل‌های عابرپیاده در کاهش حوادث ریلی تلاش نمود.

***doi***: *10.5829/ije.2017.30.12c.02*