

# Analysis of Road Accidents in Cities of India

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## INTRODUCTION

**” Roads and Highways are the backbone of connectivity in an economy “**

Road accidents in India takes away more than 90,000 lives a year. It is a major concern for developing countries like India. So a case study is made to analyse the pattern of road accidents in the cities of India. This type of case study will help Ministry of Road Transport and Highways and other government agencies to monitor the situation and take necessary steps.

Versions: Rstudio(2021.9.2.382) , R version 4.1.2(2021-11-01)

libraries used: *ggplot2,dplyr,superml,psych*

## Importing the libraries

```
library(ggplot2)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
## 
##     filter, lag
```

```
## The following objects are masked from 'package:base':
## 
##     intersect, setdiff, setequal, union
```

```
library(superml)
```

```
## Loading required package: R6
```

```
library(psych)
```

```
##  
## Attaching package: 'psych'
```

```
## The following objects are masked from 'package:ggplot2':  
##  
##     %+%, alpha
```

## Loading the dataset

```
train <- read.csv("Road_Accident.csv", header = TRUE)
```

## Printing sample data of 5 rows

```
sample_n(train, 5)
```

```

##      Name.of.City Total.number.of.Fatal.Accidents...2011 All.Accidents...2011
## 1 Tiruchirapalli                               NA                               NA
## 2 Lucknow                                     493                             1270
## 3 Coimbatore                                  253                             1126
## 4 Agra                                       336                             1299
## 5 Delhi                                      2007                            7281
## Persons.Killed...2011 Persons.Injured...2011
## 1                                         NA                               NA
## 2                                         517                             741
## 3                                         259                           1058
## 4                                         632                           1046
## 5                                         2065                          7226
## Total.number.of.Fatal.Accidents...2012 All.Accidents...2012
## 1                                         139                             778
## 2                                         474                           1202
## 3                                         263                           1128
## 4                                         381                           922
## 5                                         1822                          6937
## Persons.Killed...2012 Persons.Injured...2012 Fatal.Accidents...2013
## 1                                         142                             864                           121
## 2                                         497                             762                           458
## 3                                         270                           1004                          245
## 4                                         427                             675                           436
## 5                                         1866                          6633                          1778
## Total.Accidents...2013 Killed...2013 Injured...2013 Severity...2013
## 1                                         641                             129                           701                         20.1
## 2                                         1254                            473                           762                         37.7
## 3                                         1300                            248                           1138                         19.1
## 4                                         1008                            502                           750                         49.8
## 5                                         7566                          1820                          7098                         24.1
## Fatal.Accidents...2014 Greviously.Injured.Accidents...2014
## 1                                         168                               4
## 2                                         515                           413
## 3                                         272                           404
## 4                                         405                           432
## 5                                         1629                          352
## Minor.Accidents...2014 Non.Injurey.Accidents...2014 Total.Accidents...2014
## 1                                         515                               24                           711
## 2                                         302                               126                          1356
## 3                                         790                               128                          1594
## 4                                         127                               31                           995
## 5                                         6433                            209                         8623
## Killed...2014 Injured...2014 Severity...2014 Fatal.Accidents...2015
## 1                                         180                             766                           25.3                         156
## 2                                         537                             838                           39.6                         483
## 3                                         282                           1465                           17.7                         238
## 4                                         503                             747                           50.6                         498
## 5                                         1671                          8283                           19.4                        1582
## Greviously.Injured.Accidents...2015 Minor.Accidents...2015
## 1                                         7                               597
## 2                                         379                           353
## 3                                         483                           664

```

```
## 4                      369                      260
## 5                      372                      5971
## Non.Injurey.Accidents...2015 Total.Accidents...2015 Killed...2015
## 1                      68                       828                      161
## 2                     156                      1371                      526
## 3                     128                      1513                      245
## 4                      16                      1143                      474
## 5                     160                      8085                     1622
## Injured...2015 Severity...2015
## 1                     873                     19.4
## 2                     820                     38.4
## 3                    1393                     16.2
## 4                     650                     41.5
## 5                    8258                     20.1
```

## To know the datatypes of variables of the dataset

```
str(train)
```

```

## 'data.frame': 52 obs. of 30 variables:
## $ Name.of.City : chr "Agra" "Ahmedabad" "Asansol-Durgapur" "Aurangabad" ...
## $ Total.number.of.Fatal.Accidents...2011: int 336 222 229 161 689 275 253 2007 74 229 ...
## $ All.Accidents...2011 : int 1299 2020 368 719 6031 3459 1126 7281 138 803 ...
## $ Persons.Killed...2011 : int 632 227 230 173 720 299 259 2065 82 249 ...
## $ Persons.Injured...2011 : int 1046 2036 185 744 4952 2970 1058 7226 106 595 ...
## $ Total.number.of.Fatal.Accidents...2012: int 381 245 199 178 707 278 263 1822 49 227 ...
## $ All.Accidents...2012 : int 922 1850 380 715 5508 3623 1128 6937 144 711 ...
## $ Persons.Killed...2012 : int 427 251 224 192 725 301 270 1866 54 247 ...
## $ Persons.Injured...2012 : int 675 1845 315 649 4527 3076 1004 6633 191 537 ...
## $ Fatal.Accidents...2013 : int 436 227 200 150 733 242 245 1778 223 205 ...
## $ Total.Accidents...2013 : int 1008 1888 433 565 5215 3294 1300 7566 484 713 ...
## $ Killed...2013 : int 502 230 218 160 752 257 248 1820 248 215 ...
## $ Injured...2013 : int 750 1855 404 547 4334 2615 1138 7098 551 507 ...
## $ Severity...2013 : num 49.8 12.2 50.3 28.3 14.4 7.8 19.1 24.1 51.2 30.2 ...
## $ Fatal.Accidents...2014 : int 405 256 195 161 703 199 272 1629 60 253 ...
## $ Previously.Injured.Accidents...2014 : int 432 263 167 254 1385 127 404 352 32 127 ...
## $ Minor.Accidents...2014 : int 127 1123 70 99 1934 2328 790 6433 11 302 ...
## $ Non.Injury.Accidents...2014 : int 31 0 11 46 982 805 128 209 3 37 ...
## $ Total.Accidents...2014 : int 995 1642 443 560 5004 3459 1594 8623 106 719 ...
## $ Killed...2014 : int 503 262 210 170 729 236 282 1671 63 259 ...
## $ Injured...2014 : int 747 1597 284 578 4098 2601 1465 8283 77 466 ...
## $ Severity...2014 : num 50.6 16 47.4 30.4 14.6 6.8 17.7 19.4 59.4 36 ...
## $ Fatal.Accidents...2015 : int 498 318 210 153 708 222 238 1582 42 199 ...
## $ Previously.Injured.Accidents...2015 : int 369 351 160 297 1331 207 483 372 48 92 ...
## $ Minor.Accidents...2015 : int 260 1168 60 147 1899 2351 664 5971 19 374 ...
## $ Non.Injury.Accidents...2015 : int 16 0 16 57 896 841 128 160 5 4 ...
## $ Total.Accidents...2015 : int 1143 1837 446 654 4834 3621 1513 8085 114 669 ...
## $ Killed...2015 : int 474 328 210 170 713 235 245 1622 48 206 ...
## $ Injured...2015 : int 650 1722 220 670 4057 2779 1393 8258 137 539 ...
## $ Severity...2015 : num 41.5 17.9 47.1 26 14.7 6.5 16.2 20.1 42.1 30.8 ...

```

## To find missing values in the dataset

```
lapply(train, function(x){length(which(is.na(x)))})
```

```
## $Name.of.City
## [1] 0
##
## $Total.number.of.Fatal.Accidents...2011
## [1] 13
##
## $All.Accidents...2011
## [1] 12
##
## $Persons.Killed...2011
## [1] 12
##
## $Persons.Injured...2011
## [1] 12
##
## $Total.number.of.Fatal.Accidents...2012
## [1] 1
##
## $All.Accidents...2012
## [1] 1
##
## $Persons.Killed...2012
## [1] 1
##
## $Persons.Injured...2012
## [1] 1
##
## $Fatal.Accidents...2013
## [1] 1
##
## $Total.Accidents...2013
## [1] 1
##
## $Killed...2013
## [1] 1
##
## $Injured...2013
## [1] 1
##
## $Severity...2013
## [1] 1
##
## $Fatal.Accidents...2014
## [1] 1
##
## $Previously.Injured.Accidents...2014
## [1] 1
##
## $Minor.Accidents...2014
## [1] 1
##
## $Non.Injurey.Accidents...2014
```

```
## [1] 1
##
## $Total.Accidents...2014
## [1] 1
##
## $Killed...2014
## [1] 1
##
## $Injured...2014
## [1] 1
##
## $Severity...2014
## [1] 1
##
## $Fatal.Accidents...2015
## [1] 1
##
## $Previously.Injured.Accidents...2015
## [1] 1
##
## $Minor.Accidents...2015
## [1] 1
##
## $Non.Injury.Accidents...2015
## [1] 1
##
## $Total.Accidents...2015
## [1] 1
##
## $Killed...2015
## [1] 1
##
## $Injured...2015
## [1] 1
##
## $Severity...2015
## [1] 1
```

## Eliminating the last row from the dataset

```
train <- train[-c(52),]
```

## To have a summary of the dataset

```
print(summary(train))
```

```

##  Name.of.City      Total.number.of.Fatal.Accidents...2011 All.Accidents...2011
##  Length:51          Min.   : 52.0                      Min.   : 138.0
##  Class  :character  1st Qu.: 165.8                    1st Qu.: 650.5
##  Mode   :character  Median : 237.5                   Median : 1231.0
##                  Mean   : 316.4                   Mean   : 2284.3
##                  3rd Qu.: 393.8                   3rd Qu.: 2025.0
##                  Max.   :2007.0                   Max.   :25471.0
##                  NA's   :13                     NA's   :12
## Persons.Killed...2011 Persons.Injured...2011
##  Min.   : 55.0        Min.   : 69.0
##  1st Qu.: 172.5       1st Qu.: 625.5
##  Median : 249.0       Median :1042.0
##  Mean   : 333.9       Mean   :1595.3
##  3rd Qu.: 416.0       3rd Qu.:2022.0
##  Max.   :2065.0       Max.   :7226.0
##  NA's   :12           NA's   :12
## Total.number.of.Fatal.Accidents...2012 All.Accidents...2012
##  Min.   : 49.0         Min.   : 144.0
##  1st Qu.: 158.0        1st Qu.: 730.8
##  Median : 250.5        Median :1190.5
##  Mean   : 323.8        Mean   : 2208.8
##  3rd Qu.: 386.2        3rd Qu.: 1963.8
##  Max.   :1822.0        Max.   :24592.0
##  NA's   :1             NA's   :1
## Persons.Killed...2012 Persons.Injured...2012 Fatal.Accidents...2013
##  Min.   : 54.0         Min.   : 71.0        Min.   : 55.0
##  1st Qu.: 168.0        1st Qu.: 592.0      1st Qu.: 155.5
##  Median : 266.0        Median : 977.5      Median : 246.0
##  Mean   : 339.1        Mean   :1619.3      Mean   : 321.7
##  3rd Qu.: 407.8        3rd Qu.:1893.0      3rd Qu.: 386.8
##  Max.   :1866.0        Max.   :8628.0       Max.   :1778.0
##  NA's   :1             NA's   :1           NA's   :1
## Total.Accidents...2013 Killed...2013    Injured...2013  Severity...2013
##  Min.   : 135.0        Min.   : 58.0        Min.   : 76.0  Min.   : 2.1
##  1st Qu.: 697.8        1st Qu.: 165.5      1st Qu.: 628.8 1st Qu.:12.8
##  Median : 1234.0       Median : 261.0       Median : 987.0 Median :20.5
##  Mean   : 2203.8       Mean   : 340.1       Mean   :1607.6  Mean   :25.7
##  3rd Qu.: 1983.5       3rd Qu.: 409.8      3rd Qu.:1806.0 3rd Qu.:39.5
##  Max.   :23512.0       Max.   :1820.0       Max.   :8700.0  Max.   :72.6
##  NA's   :1             NA's   :1           NA's   :1     NA's   :1
## Fatal.Accidents...2014 Previously.Injured.Accidents...2014
##  Min.   : 51.0         Min.   :  1.0
##  1st Qu.: 162.0        1st Qu.: 129.0
##  Median : 254.5        Median : 366.5
##  Mean   : 313.3        Mean   : 513.6
##  3rd Qu.: 408.0        3rd Qu.: 494.8
##  Max.   :1629.0        Max.   :2748.0
##  NA's   :1             NA's   :1
## Minor.Accidents...2014 Non.Injurey.Accidents...2014 Total.Accidents...2014
##  Min.   : 11.0         Min.   :  0.0        Min.   : 106
##  1st Qu.: 176.0        1st Qu.:  33.0      1st Qu.: 713
##  Median : 302.0        Median :  80.0      Median : 1185

```

```

## Mean     : 821.4      Mean    : 570.8      Mean    : 2219
## 3rd Qu.: 842.5      3rd Qu.: 235.5      3rd Qu.: 1995
## Max.    :6433.0      Max.    :18733.0      Max.    :22570
## NA's    :1           NA's    :1           NA's    :1
## Killed...2014       Injured...2014     Severity...2014 Fatal.Accidents...2015
## Min.    : 58.0       Min.    : 77.0       Min.    : 2.40   Min.    : 42.0
## 1st Qu.: 170.5       1st Qu.: 644.0      1st Qu.:13.50  1st Qu.: 159.0
## Median  : 264.5       Median : 965.5      Median :19.80   Median : 250.0
## Mean    : 332.2       Mean    :1660.0      Mean    :25.66   Mean    : 316.0
## 3rd Qu.: 426.8       3rd Qu.:1749.2     3rd Qu.:38.27  3rd Qu.: 410.5
## Max.    :1671.0       Max.    :9355.0      Max.    :66.90   Max.    :1582.0
## NA's    :1           NA's    :1           NA's    :1           NA's    :1
## Previously.Injured.Accidents...2015 Minor.Accidents...2015
## Min.    : 1.0          Min.    : 16.0
## 1st Qu.: 140.5        1st Qu.: 179.5
## Median  : 360.0        Median : 350.0
## Mean    : 538.9        Mean    : 780.2
## 3rd Qu.: 562.2        3rd Qu.: 829.5
## Max.    :2949.0        Max.    :5971.0
## NA's    :1           NA's    :1
## Non.Injurey.Accidents...2015 Total.Accidents...2015 Killed...2015
## Min.    : 0.00         Min.    : 114.0      Min.    : 48.0
## 1st Qu.: 27.75         1st Qu.: 694.8      1st Qu.: 168.5
## Median  : 88.00         Median : 1336.0     Median : 260.5
## Mean    : 585.40         Mean    : 2220.5     Mean    : 330.3
## 3rd Qu.: 270.25         3rd Qu.: 2176.8     3rd Qu.: 424.2
## Max.    :19635.00        Max.    :23468.0     Max.    :1622.0
## NA's    :1           NA's    :1           NA's    :1
## Injured...2015       Severity...2015
## Min.    : 89.0          Min.    : 2.60
## 1st Qu.: 672.2          1st Qu.:12.80
## Median  :1049.0          Median :20.30
## Mean    :1644.4          Mean    :24.79
## 3rd Qu.:1717.2          3rd Qu.:39.00
## Max.    :8258.0          Max.    :66.00
## NA's    :1           NA's    :1

```

## Filling the missing values using median values of each variable column

```

for (i in 2:30) { x=median(train[,i],na.rm = TRUE)
  train[,i][is.na(train[,i])] <- x
}

```

## Encoding the first variable of the dataset

```
label <- LabelEncoder$new()
train$Name.of.City <- label$fit_transform(train$Name.of.City)
```

## Decoding the first variable

```
decode_names <- label$inverse_transform(train$Name.of.City)
decode_names
```

## [1] "Agra"	"Ahmedabad"	"Asansol-Durgapur"	"Aurangabad"
## [5] "Bengaluru"	"Bhopal"	"Coimbatore"	"Delhi"
## [9] "Dhanbad"	"Faridabad"	"Ghaziabad"	"Gwalior"
## [13] "Hyderabad"	"Indore"	"Jaipur"	"Jabalpur"
## [17] "Jamshedpur"	"Jodhpur"	"Kochi"	"Kolkata"
## [21] "Kollam"	"Kota"	"Kannur"	"Lucknow"
## [25] "Ludhiana"	"Madurai"	"Mallapuram"	"Mumbai"
## [29] "Meerut"	"Nagpur"	"Patna"	"Pune"
## [33] "Rajkot"	"Surat"	"Srinagar"	"Thrissur"
## [37] "Vadodra"	"Varanasi"	"Visakhapatnam"	"Allahabad"
## [41] "Amritsar"	"Chandigarh"	"Chennai"	"Kanpur"
## [45] "Khozikode"	"Nashik"	"Raipur"	"Thiruvanthapuram"
## [49] "Tiruchirapalli"	"Vijaywada City"	"Vizaq"	

## Adding new variables to the dataset

```
train$total_fatal_accidents <- train$Total.number.of.Fatal.Accidents...2011 +
  train$Total.number.of.Fatal.Accidents...2012 +
  train$Fatal.Accidents...2013+ train$Fatal.Accidents...2014+
  train$Fatal.Accidents...2015

train$total_accidents <- train$All.Accidents...2011 + train$All.Accidents...2012+
  train$Total.Accidents...2013 + train$Total.Accidents...2014 +train$Total.Accidents...2015

train$total_person_killed <- train$Persons.Killed...2011 +train$Persons.Killed...2012+
  train$Killed...2013 + train$Killed...2014 + train$Killed...2015

train$total_person_injured <- train$Persons.Injured...2011 + train$Persons.Injured...2012
  + train$Injured...2013 + train$Injured...2014 + train$Injured...2015
```

## Classifying total\_person\_killed into groups("High", "Moderate", "Low")

## Calculating percentile of total\_person\_killed

```

Percentile_00 = min(train$total_person_killed)
Percentile_33 = quantile(train$total_person_killed, 0.33333)
Percentile_67 = quantile(train$total_person_killed, 0.66667)
Percentile_100 = max(train$total_person_killed)

RB = rbind(Percentile_00, Percentile_33, Percentile_67, Percentile_100)

dimnames(RB)[[2]] = "Value"

RB

```

```

##           Value
## Percentile_00 318.000
## Percentile_33 964.663
## Percentile_67 1737.672
## Percentile_100 9044.000

```

## Creating a column classifying persons\_killed

```

train$total_person_killed_class[train$total_person_killed >= Percentile_00 & train$total_person_killed < Percentile_33] = "Low"
train$total_person_killed_class[train$total_person_killed >= Percentile_33 & train$total_person_killed < Percentile_67] = "Moderate"
train$total_person_killed_class[train$total_person_killed >= Percentile_67 & train$total_person_killed <= Percentile_100] = "High"

```

## Classifying total\_person\_injured into groups("High", "Moderate", "Low")

## Calculating percentile of total\_person\_injured

```

Percentile_00 = min(train$total_person_injured)
Percentile_33 = quantile(train$total_person_injured, 0.33333)
Percentile_67 = quantile(train$total_person_injured, 0.66667)
Percentile_100 = max(train$total_person_injured)

RB = rbind(Percentile_00, Percentile_33, Percentile_67, Percentile_100)

dimnames(RB)[[2]] = "Value"

RB

```

```
##           Value
## Percentile_00    229.000
## Percentile_33   1521.997
## Percentile_67   2654.360
## Percentile_100 13859.000
```

## Creating a column classifying persons\_injured

```
train$total_person_injured_class[train$total_person_injured >= Percentile_00 & train$total_person_injured < Percentile_33] = "Low"
train$total_person_injured_class[train$total_person_injured >= Percentile_33 & train$total_person_injured < Percentile_67] = "Moderate"
train$total_person_injured_class[train$total_person_injured >= Percentile_67 & train$total_person_injured <= Percentile_100] = "High"
```

## Classifying total\_fatal\_accidents into groups("High", "Moderate", "Low")

## Calculating percentile of total\_fatal\_accidents

```
Percentile_00 = min(train$total_fatal_accidents)
Percentile_33 = quantile(train$total_fatal_accidents, 0.33333)
Percentile_67 = quantile(train$total_fatal_accidents, 0.66667)
Percentile_100 = max(train$total_fatal_accidents)

RB = rbind(Percentile_00, Percentile_33, Percentile_67, Percentile_100)

dimnames(RB)[[2]] = "Value"

RB
```

```
##           Value
## Percentile_00    318.0000
## Percentile_33   914.9992
## Percentile_67  1644.1712
## Percentile_100 8818.0000
```

## Creating a column classifying persons\_injured

```
train$total_fatal_accidents_class[train$total_fatal_accidents >= Percentile_00 & train$total_fatal_accidents < Percentile_33] = "Low"  
train$total_fatal_accidents_class[train$total_fatal_accidents >= Percentile_33 & train$total_fatal_accidents < Percentile_67] = "Moderate"  
train$total_fatal_accidents_class[train$total_fatal_accidents >= Percentile_67 & train$total_fatal_accidents <= Percentile_100] = "High"
```

## Printing most important columns of the dataset for analysis

```
select(train,31:37)
```

	total_fatal_accidents	total_accidents	total_person_killed
## 1	2056.0	5367.0	2538
## 2	1268.0	9237.0	1298
## 3	1033.0	2070.0	1092
## 4	803.0	3213.0	865
## 5	3540.0	26592.0	3639
## 6	1216.0	17456.0	1328
## 7	1271.0	6661.0	1304
## 8	8818.0	38492.0	9044
## 9	448.0	986.0	495
## 10	1113.0	3615.0	1176
## 11	1902.0	4556.0	2037
## 12	1127.0	10037.0	1212
## 13	2177.0	13488.0	2234
## 14	2045.0	27601.0	2177
## 15	2002.0	9402.0	2104
## 16	1441.0	15262.0	1544
## 17	751.0	1838.0	798
## 18	1254.0	2812.0	1429
## 19	747.0	11332.0	781
## 20	2130.0	20415.0	2225
## 21	1050.0	8272.0	1121
## 22	530.0	3436.0	567
## 23	318.0	2962.0	335
## 24	2423.0	6453.0	2550
## 25	1400.0	2357.0	1469
## 26	692.0	3947.0	713
## 27	1567.0	13659.0	1727
## 28	2589.0	119613.0	2698
## 29	1765.0	4701.0	1966
## 30	1315.0	5982.0	1367
## 31	2267.0	5482.0	2284
## 32	1635.0	6587.0	1707
## 33	679.0	4366.0	742
## 34	1175.0	5217.0	1228
## 35	466.5	2285.0	318
## 36	586.0	6570.0	618
## 37	912.0	6034.0	972
## 38	908.0	1772.0	940
## 39	1411.0	6493.5	1466
## 40	1985.5	5409.0	2099
## 41	607.5	1833.0	635
## 42	729.5	2845.0	762
## 43	4761.5	37537.0	4901
## 44	2386.5	6504.0	2632
## 45	876.5	6316.0	923
## 46	880.5	5752.0	944
## 47	1799.5	9981.0	1895
## 48	916.5	9370.0	950
## 49	821.5	4189.0	861
## 50	1598.5	7640.0	1678
## 51	1662.5	7420.0	1759

	total_person_injured	total_person_killed	total_person_injured_class	total_person_killed_class
## 1	1721.0		High	Moderate
## 2	3881.0		Moderate	High
## 3	500.0		Moderate	Low
## 4	1393.0		Low	Low
## 5	9479.0		High	High
## 6	6046.0		Moderate	High
## 7	2062.0		Moderate	Moderate
## 8	13859.0		High	High
## 9	297.0		Low	Low
## 10	1132.0		Moderate	Low
## 11	1527.0		High	Moderate
## 12	3060.0		Moderate	High
## 13	4999.0		High	High
## 14	8472.0		High	High
## 15	3551.0		High	High
## 16	5535.0		Moderate	High
## 17	626.0		Low	Low
## 18	961.0		Moderate	Low
## 19	4439.0		Low	High
## 20	5636.0		High	High
## 21	3720.0		Moderate	High
## 22	1397.0		Low	Low
## 23	1647.0		Low	Moderate
## 24	1503.0		High	Low
## 25	439.0		Moderate	Low
## 26	1491.0		Low	Low
## 27	7138.0		Moderate	High
## 28	9602.0		High	High
## 29	1512.0		High	Low
## 30	2116.0		Moderate	Moderate
## 31	1132.0		High	Low
## 32	1605.0		Moderate	Moderate
## 33	2025.0		Low	Moderate
## 34	1708.0		Moderate	Moderate
## 35	1050.0		Low	Low
## 36	2763.0		Low	High
## 37	1979.0		Moderate	Moderate
## 38	229.0		Low	Low
## 39	2263.5		Moderate	Moderate
## 40	1615.0		High	Moderate
## 41	1113.0		Low	Low
## 42	1389.0		Low	Low
## 43	9670.0		High	High
## 44	2000.0		High	Moderate
## 45	2493.0		Low	Moderate
## 46	1503.0		Low	Low
## 47	2600.0		High	Moderate
## 48	3286.0		Low	High
## 49	1906.0		Low	Moderate
## 50	2488.0		Moderate	Moderate
## 51	2105.0		High	Moderate

```
##      total_fatal_accidents_class
## 1                  High
## 2          Moderate
## 3          Moderate
## 4             Low
## 5             High
## 6          Moderate
## 7          Moderate
## 8             High
## 9             Low
## 10         Moderate
## 11             High
## 12         Moderate
## 13             High
## 14             High
## 15             High
## 16         Moderate
## 17             Low
## 18         Moderate
## 19             Low
## 20             High
## 21         Moderate
## 22             Low
## 23             Low
## 24             High
## 25         Moderate
## 26             Low
## 27         Moderate
## 28             High
## 29             High
## 30         Moderate
## 31             High
## 32         Moderate
## 33             Low
## 34         Moderate
## 35             Low
## 36             Low
## 37             Low
## 38             Low
## 39         Moderate
## 40             High
## 41             Low
## 42             Low
## 43             High
## 44             High
## 45             Low
## 46             Low
## 47             High
## 48         Moderate
## 49             Low
## 50         Moderate
## 51             High
```

# Printing data according to the year

```
select(train,contains("2011"))
```

```

##      Total.number.of.Fatal.Accidents...2011 All.Accidents...2011
## 1                      336.0                 1299
## 2                      222.0                 2020
## 3                      229.0                  368
## 4                      161.0                  719
## 5                      689.0                 6031
## 6                      275.0                 3459
## 7                      253.0                 1126
## 8                     2007.0                7281
## 9                      74.0                  138
## 10                     229.0                 803
## 11                     495.0                1109
## 12                     233.0                2030
## 13                     428.0                2651
## 14                     407.0                4995
## 15                     387.0                2002
## 16                     239.0                2906
## 17                     189.0                  447
## 18                     236.0                  526
## 19                     171.0                1986
## 20                     396.0                3133
## 21                     209.0                1668
## 22                     102.0                  616
## 23                      52.0                  557
## 24                     493.0                1270
## 25                     260.0                  444
## 26                     123.0                  685
## 27                     290.0                2694
## 28                     539.0                25471
## 29                     321.0                  886
## 30                     227.0                1231
## 31                     507.0                1225
## 32                      62.0                  261
## 33                     163.0                1039
## 34                     240.0                1223
## 35                     237.5                  492
## 36                     134.0                1262
## 37                     164.0                1343
## 38                      73.0                  142
## 39                     410.0                1548
## 40                     237.5                1231
## 41                     237.5                1231
## 42                     237.5                1231
## 43                     237.5                1231
## 44                     237.5                1231
## 45                     237.5                1231
## 46                     237.5                1231
## 47                     237.5                1231
## 48                     237.5                1231
## 49                     237.5                1231
## 50                     237.5                1231
## 51                     237.5                1231

```

	Persons.Killed...2011	Persons.Injured...2011
## 1	632	1046
## 2	227	2036
## 3	230	185
## 4	173	744
## 5	720	4952
## 6	299	2970
## 7	259	1058
## 8	2065	7226
## 9	82	106
## 10	249	595
## 11	535	817
## 12	248	1626
## 13	441	2528
## 14	425	4053
## 15	406	1915
## 16	260	2990
## 17	207	292
## 18	264	525
## 19	182	2008
## 20	418	2420
## 21	222	1811
## 22	113	688
## 23	55	833
## 24	517	741
## 25	294	189
## 26	125	656
## 27	324	3534
## 28	563	5059
## 29	384	679
## 30	236	1144
## 31	507	576
## 32	64	213
## 33	172	1042
## 34	248	841
## 35	75	511
## 36	141	1343
## 37	172	908
## 38	73	69
## 39	414	1286
## 40	249	1042
## 41	249	1042
## 42	249	1042
## 43	249	1042
## 44	249	1042
## 45	249	1042
## 46	249	1042
## 47	249	1042
## 48	249	1042
## 49	249	1042
## 50	249	1042
## 51	249	1042

```
select(train,contains("2012"))
```

```

##      Total.number.of.Fatal.Accidents...2012 All.Accidents...2012
## 1                      381.0                 922.0
## 2                      245.0                1850.0
## 3                      199.0                 380.0
## 4                      178.0                 715.0
## 5                      707.0                5508.0
## 6                      278.0                3623.0
## 7                      263.0                1128.0
## 8                     1822.0                6937.0
## 9                      49.0                  144.0
## 10                     227.0                711.0
## 11                     358.0                850.0
## 12                     213.0                1974.0
## 13                     433.0                2577.0
## 14                     419.0                5433.0
## 15                     374.0                1792.0
## 16                     251.0                2919.0
## 17                     173.0                424.0
## 18                     313.0                533.0
## 19                     136.0                2280.0
## 20                     471.0                3937.0
## 21                     197.0                1763.0
## 22                     108.0                601.0
## 23                      74.0                618.0
## 24                     474.0                1202.0
## 25                     250.0                430.0
## 26                     121.0                839.0
## 27                     295.0                2711.0
## 28                     471.0                24592.0
## 29                     431.0                964.0
## 30                     273.0                1083.0
## 31                     509.0                1185.0
## 32                     388.0                1624.0
## 33                     125.0                981.0
## 34                     225.0                1146.0
## 35                      60.0                511.0
## 36                     119.0                1288.0
## 37                     156.0                1196.0
## 38                     216.0                379.0
## 39                     250.5                1190.5
## 40                     396.0                933.0
## 41                      95.0                152.0
## 42                     130.0                419.0
## 43                    1367.0                9663.0
## 44                     522.0                1257.0
## 45                     166.0                1270.0
## 46                     145.0                1023.0
## 47                     348.0                2222.0
## 48                     164.0                1933.0
## 49                     139.0                778.0
## 50                     365.0                1600.0
## 51                     371.0                1439.0

```

	Persons.Killed...2012	Persons.Injured...2012
## 1	427	675.0
## 2	251	1845.0
## 3	224	315.0
## 4	192	649.0
## 5	725	4527.0
## 6	301	3076.0
## 7	270	1004.0
## 8	1866	6633.0
## 9	54	191.0
## 10	247	537.0
## 11	378	710.0
## 12	232	1434.0
## 13	464	2471.0
## 14	447	4419.0
## 15	391	1636.0
## 16	275	2545.0
## 17	189	334.0
## 18	313	436.0
## 19	144	2431.0
## 20	498	3216.0
## 21	213	1909.0
## 22	112	709.0
## 23	78	814.0
## 24	497	762.0
## 25	262	250.0
## 26	127	835.0
## 27	325	3604.0
## 28	488	4543.0
## 29	447	833.0
## 30	280	972.0
## 31	509	556.0
## 32	407	1392.0
## 33	151	983.0
## 34	229	867.0
## 35	64	539.0
## 36	127	1420.0
## 37	171	1071.0
## 38	216	160.0
## 39	266	977.5
## 40	408	573.0
## 41	95	71.0
## 42	136	347.0
## 43	1401	8628.0
## 44	564	958.0
## 45	174	1451.0
## 46	155	461.0
## 47	362	1558.0
## 48	167	2244.0
## 49	142	864.0
## 50	376	1446.0
## 51	384	1063.0

```
select(train,contains("2013"))
```

	Fatal.Accidents...2013	Total.Accidents...2013	Killed...2013	Injured...2013
## 1	436	1008	502	750
## 2	227	1888	230	1855
## 3	200	433	218	404
## 4	150	565	160	547
## 5	733	5215	752	4334
## 6	242	3294	257	2615
## 7	245	1300	248	1138
## 8	1778	7566	1820	7098
## 9	223	484	248	551
## 10	205	713	215	507
## 11	363	874	406	667
## 12	232	1934	247	1470
## 13	482	2591	493	2237
## 14	388	5516	422	4407
## 15	379	1794	399	1525
## 16	301	2939	327	2639
## 17	147	382	153	384
## 18	261	522	298	536
## 19	147	2248	151	2219
## 20	420	4437	437	3577
## 21	247	1577	265	1659
## 22	98	706	109	784
## 23	55	593	58	737
## 24	458	1254	473	762
## 25	312	519	324	291
## 26	140	695	145	668
## 27	314	2653	354	3249
## 28	481	23512	502	4250
## 29	304	842	352	774
## 30	298	1265	310	1237
## 31	514	1214	514	567
## 32	388	1687	399	1503
## 33	115	796	119	761
## 34	213	971	227	740
## 35	59	473	58	477
## 36	127	1297	133	1400
## 37	175	1170	183	1051
## 38	217	416	217	199
## 39	246	1234	261	987
## 40	443	1125	482	813
## 41	92	135	98	76
## 42	114	410	117	335
## 43	1215	9705	1247	8700
## 44	472	1269	554	923
## 45	172	1151	182	1298
## 46	108	1127	134	616
## 47	383	2242	394	1315
## 48	191	2000	195	2341
## 49	121	641	129	701
## 50	320	1496	339	1464
## 51	382	1548	411	1229

```
## Severity...2013
## 1          49.8
## 2          12.2
## 3          50.3
## 4          28.3
## 5          14.4
## 6           7.8
## 7          19.1
## 8          24.1
## 9          51.2
## 10         30.2
## 11         46.5
## 12         12.8
## 13         19.0
## 14          7.7
## 15         22.2
## 16         11.1
## 17         40.1
## 18         57.1
## 19          6.7
## 20          9.8
## 21         16.8
## 22         15.4
## 23          9.8
## 24         37.7
## 25         62.4
## 26         20.9
## 27         13.3
## 28          2.1
## 29         41.8
## 30         24.5
## 31         42.3
## 32         23.7
## 33         14.9
## 34         23.4
## 35         12.3
## 36         10.3
## 37         15.6
## 38         52.2
## 39         20.5
## 40         42.8
## 41         72.6
## 42         28.5
## 43         12.8
## 44         43.7
## 45         15.8
## 46         11.9
## 47         17.6
## 48         10.3
## 49         20.1
## 50         22.7
## 51         26.6
```

```
select(train,contains("2014"))
```

	Fatal.Accidents...2014	Previously.Injured.Accidents...2014
## 1	405.0	432.0
## 2	256.0	263.0
## 3	195.0	167.0
## 4	161.0	254.0
## 5	703.0	1385.0
## 6	199.0	127.0
## 7	272.0	404.0
## 8	1629.0	352.0
## 9	60.0	32.0
## 10	253.0	127.0
## 11	370.0	421.0
## 12	200.0	135.0
## 13	409.0	252.0
## 14	410.0	311.0
## 15	410.0	751.0
## 16	305.0	367.0
## 17	91.0	85.0
## 18	187.0	61.0
## 19	134.0	1381.0
## 20	431.0	1591.0
## 21	206.0	1276.0
## 22	117.0	180.0
## 23	72.0	201.0
## 24	515.0	413.0
## 25	318.0	112.0
## 26	100.0	27.0
## 27	336.0	1761.0
## 28	512.0	1719.0
## 29	337.0	494.0
## 30	263.0	409.0
## 31	493.0	407.0
## 32	378.0	495.0
## 33	140.0	104.0
## 34	246.0	404.0
## 35	51.0	1.0
## 36	103.0	830.0
## 37	201.0	366.0
## 38	202.0	191.0
## 39	254.5	366.5
## 40	454.0	459.0
## 41	89.0	55.0
## 42	124.0	9.0
## 43	1083.0	2748.0
## 44	530.0	434.0
## 45	151.0	760.0
## 46	165.0	280.0
## 47	425.0	76.0
## 48	165.0	1469.0
## 49	168.0	4.0
## 50	314.0	379.0
## 51	329.0	720.0

	Minor.Accidents...2014	Non.Injurey.Accidents...2014	Total.Accidents...2014
## 1	127	31	995
## 2	1123	0	1642
## 3	70	11	443
## 4	99	46	560
## 5	1934	982	5004
## 6	2328	805	3459
## 7	790	128	1594
## 8	6433	209	8623
## 9	11	3	106
## 10	302	37	719
## 11	98	8	897
## 12	1403	221	1959
## 13	2007	240	2908
## 14	4100	963	5784
## 15	479	280	1920
## 16	2090	362	3124
## 17	41	21	238
## 18	252	53	553
## 19	490	252	2257
## 20	1353	1186	4561
## 21	171	50	1703
## 22	401	70	768
## 23	261	36	570
## 24	302	126	1356
## 25	31	14	475
## 26	519	45	691
## 27	401	221	2719
## 28	1606	18733	22570
## 29	179	37	1047
## 30	445	32	1149
## 31	154	139	1193
## 32	580	119	1572
## 33	455	71	770
## 34	215	109	974
## 35	280	42	374
## 36	291	93	1317
## 37	372	222	1161
## 38	17	1	411
## 39	302	80	1185
## 40	168	20	1101
## 41	19	2	165
## 42	199	37	369
## 43	4966	813	9610
## 44	266	21	1251
## 45	185	81	1177
## 46	175	450	1070
## 47	983	613	2097
## 48	294	79	2007
## 49	515	24	711
## 50	860	116	1669
## 51	228	288	1565

	Killed...2014	Injured...2014	Severity...2014
## 1	503.0	747.0	50.6
## 2	262.0	1597.0	16.0
## 3	210.0	284.0	47.4
## 4	170.0	578.0	30.4
## 5	729.0	4098.0	14.6
## 6	236.0	2601.0	6.8
## 7	282.0	1465.0	17.7
## 8	1671.0	8283.0	19.4
## 9	63.0	77.0	59.4
## 10	259.0	466.0	36.0
## 11	387.0	647.0	43.1
## 12	220.0	1630.0	11.2
## 13	411.0	2561.0	14.1
## 14	439.0	4848.0	7.6
## 15	432.0	1693.0	22.5
## 16	317.0	3074.0	10.1
## 17	92.0	163.0	38.7
## 18	257.0	505.0	46.5
## 19	136.0	2264.0	6.0
## 20	450.0	3604.0	9.9
## 21	217.0	1768.0	12.7
## 22	125.0	771.0	16.3
## 23	77.0	909.0	13.5
## 24	537.0	838.0	39.6
## 25	318.0	271.0	66.9
## 26	101.0	643.0	14.6
## 27	357.0	3305.0	13.1
## 28	534.0	3938.0	2.4
## 29	387.0	916.0	37.0
## 30	281.0	1091.0	24.5
## 31	493.0	682.0	41.3
## 32	399.0	1402.0	25.4
## 33	150.0	690.0	19.5
## 34	267.0	817.0	27.4
## 35	58.0	393.0	15.5
## 36	107.0	1417.0	8.1
## 37	217.0	990.0	18.7
## 38	231.0	190.0	56.2
## 39	264.5	965.5	19.8
## 40	481.0	758.0	43.7
## 41	94.0	125.0	57.0
## 42	131.0	335.0	35.5
## 43	1118.0	9355.0	11.6
## 44	600.0	941.0	48.0
## 45	159.0	1253.0	13.5
## 46	172.0	494.0	16.1
## 47	442.0	1452.0	21.1
## 48	175.0	2371.0	8.7
## 49	180.0	766.0	25.3
## 50	335.0	1578.0	20.1
## 51	342.0	1356.0	21.9

```
select(train,contains("2015"))
```

	Fatal.Accidents...2015	Previously.Injured.Accidents...2015
## 1	498	369
## 2	318	351
## 3	210	160
## 4	153	297
## 5	708	1331
## 6	222	207
## 7	238	483
## 8	1582	372
## 9	42	48
## 10	199	92
## 11	316	430
## 12	249	118
## 13	425	484
## 14	421	322
## 15	452	758
## 16	345	370
## 17	151	133
## 18	257	70
## 19	159	1555
## 20	412	1357
## 21	191	1233
## 22	105	180
## 23	65	262
## 24	483	379
## 25	260	133
## 26	208	15
## 27	332	1923
## 28	586	2034
## 29	372	545
## 30	254	497
## 31	244	270
## 32	419	568
## 33	136	134
## 34	251	386
## 35	59	1
## 36	103	870
## 37	216	387
## 38	200	171
## 39	250	360
## 40	455	389
## 41	94	37
## 42	124	7
## 43	859	2949
## 44	625	185
## 45	150	931
## 46	225	309
## 47	406	106
## 48	159	1626
## 49	156	7
## 50	362	335
## 51	343	771

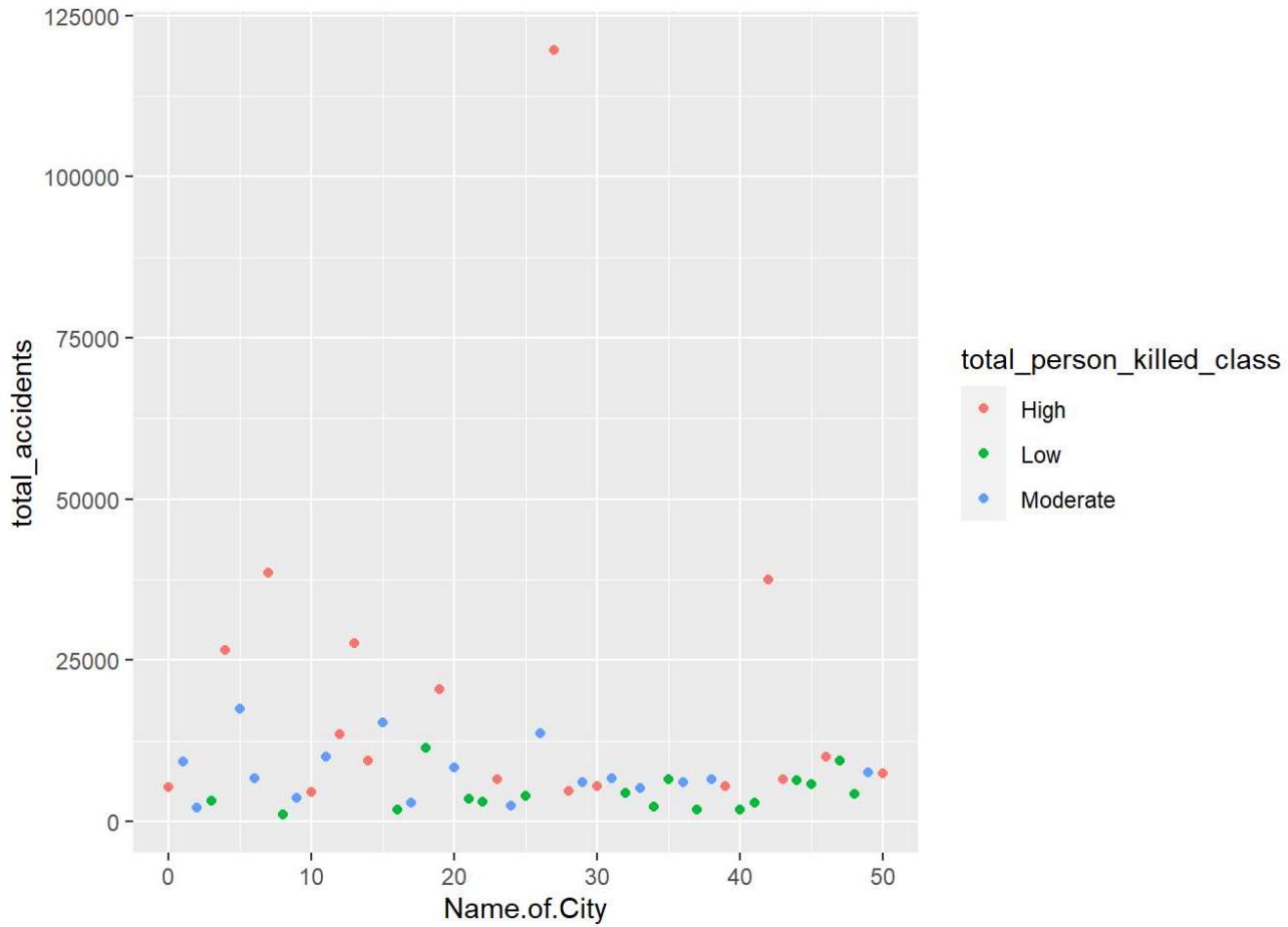
	Minor.Accidents...2015	Non.Injurey.Accidents...2015	Total.Accidents...2015
## 1	260	16	1143
## 2	1168	0	1837
## 3	60	16	446
## 4	147	57	654
## 5	1899	896	4834
## 6	2351	841	3621
## 7	664	128	1513
## 8	5971	160	8085
## 9	19	5	114
## 10	374	4	669
## 11	70	10	826
## 12	1498	275	2140
## 13	1635	217	2761
## 14	4057	1073	5873
## 15	428	256	1894
## 16	2287	372	3374
## 17	38	25	347
## 18	308	43	678
## 19	560	287	2561
## 20	1404	1174	4347
## 21	101	36	1561
## 22	391	69	745
## 23	259	38	624
## 24	353	156	1371
## 25	80	16	489
## 26	768	46	1037
## 27	347	280	2882
## 28	1213	19635	23468
## 29	45	0	962
## 30	460	43	1254
## 31	59	92	665
## 32	367	89	1443
## 33	432	78	780
## 34	179	87	903
## 35	336	39	435
## 36	319	114	1406
## 37	332	229	1164
## 38	51	2	424
## 39	350	88	1336
## 40	159	16	1019
## 41	16	3	150
## 42	236	49	416
## 43	3196	324	7328
## 44	686	0	1496
## 45	247	159	1487
## 46	181	586	1301
## 47	1048	629	2189
## 48	316	98	2199
## 49	597	68	828
## 50	850	97	1644
## 51	186	337	1637

	Killed...2015	Injured...2015	Severity...2015
## 1	474.0	650	41.5
## 2	328.0	1722	17.9
## 3	210.0	220	47.1
## 4	170.0	670	26.0
## 5	713.0	4057	14.7
## 6	235.0	2779	6.5
## 7	245.0	1393	16.2
## 8	1622.0	8258	20.1
## 9	48.0	137	42.1
## 10	206.0	539	30.8
## 11	331.0	668	40.1
## 12	265.0	1703	12.4
## 13	425.0	2382	15.4
## 14	444.0	4685	7.6
## 15	476.0	1661	25.1
## 16	365.0	3216	10.8
## 17	157.0	329	45.2
## 18	297.0	700	43.8
## 19	168.0	2721	6.6
## 20	422.0	3329	9.7
## 21	204.0	1601	13.1
## 22	108.0	713	14.5
## 23	67.0	796	10.7
## 24	526.0	820	38.4
## 25	271.0	324	55.4
## 26	215.0	1021	20.7
## 27	367.0	3264	12.7
## 28	611.0	4029	2.6
## 29	396.0	721	41.2
## 30	260.0	1233	20.7
## 31	261.0	390	39.2
## 32	438.0	1205	30.4
## 33	150.0	716	19.2
## 34	257.0	773	28.5
## 35	63.0	462	14.5
## 36	110.0	1538	7.8
## 37	229.0	984	19.7
## 38	203.0	225	47.9
## 39	260.5	1049	20.3
## 40	479.0	698	47.0
## 41	99.0	89	66.0
## 42	129.0	331	31.0
## 43	886.0	7320	12.1
## 44	665.0	1077	44.5
## 45	159.0	1567	10.7
## 46	234.0	679	18.0
## 47	448.0	1431	20.5
## 48	164.0	2660	7.5
## 49	161.0	873	19.4
## 50	379.0	1548	23.1
## 51	373.0	1313	22.8

# Making visualisation of dataset

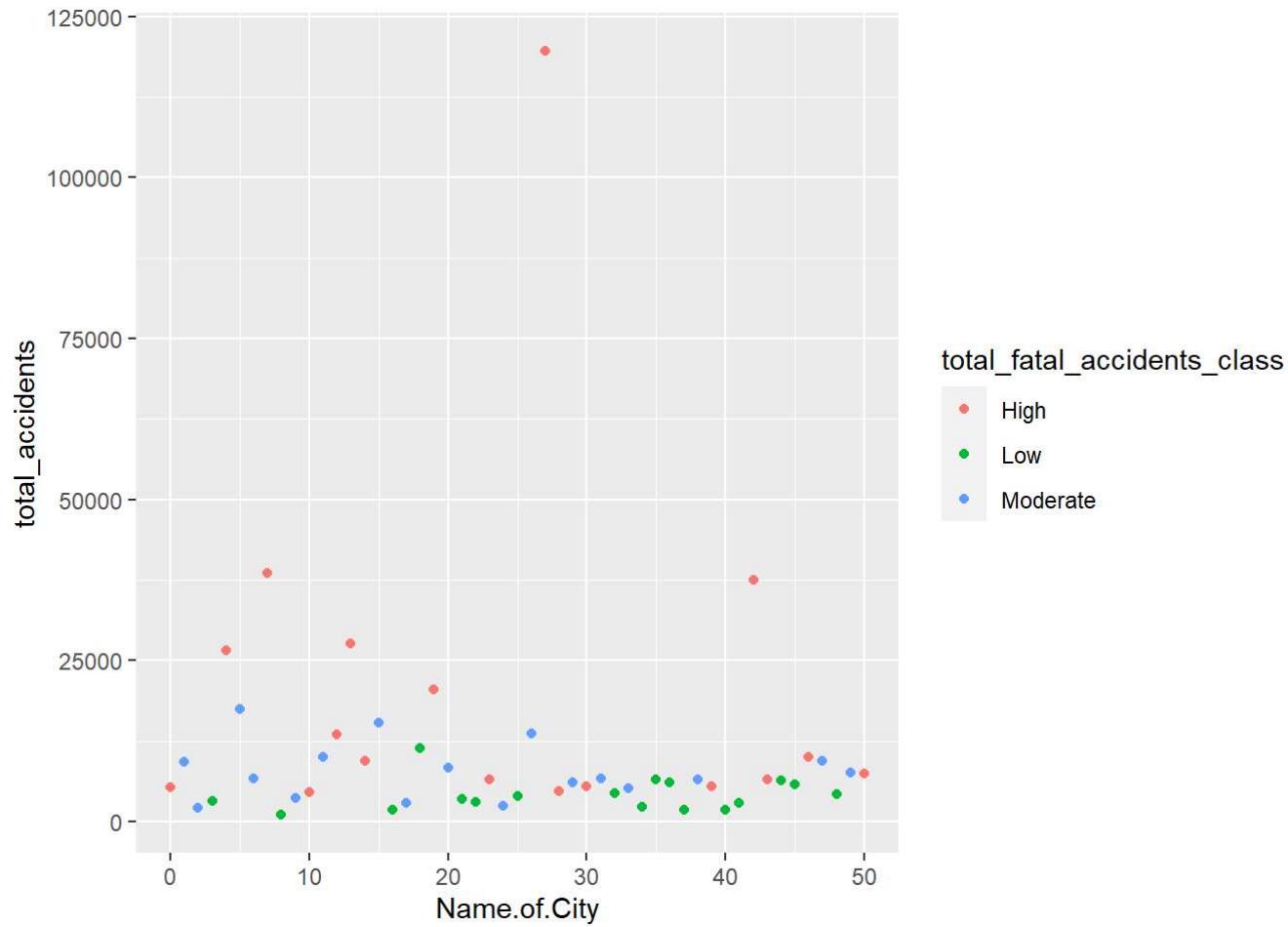
## Making visualisation of total\_accidents along with total\_person\_killed\_class

```
ggplot(data = train) +
  geom_point(mapping = aes(x = Name.of.City, y = total_accidents, color = total_person_killed_class))
```



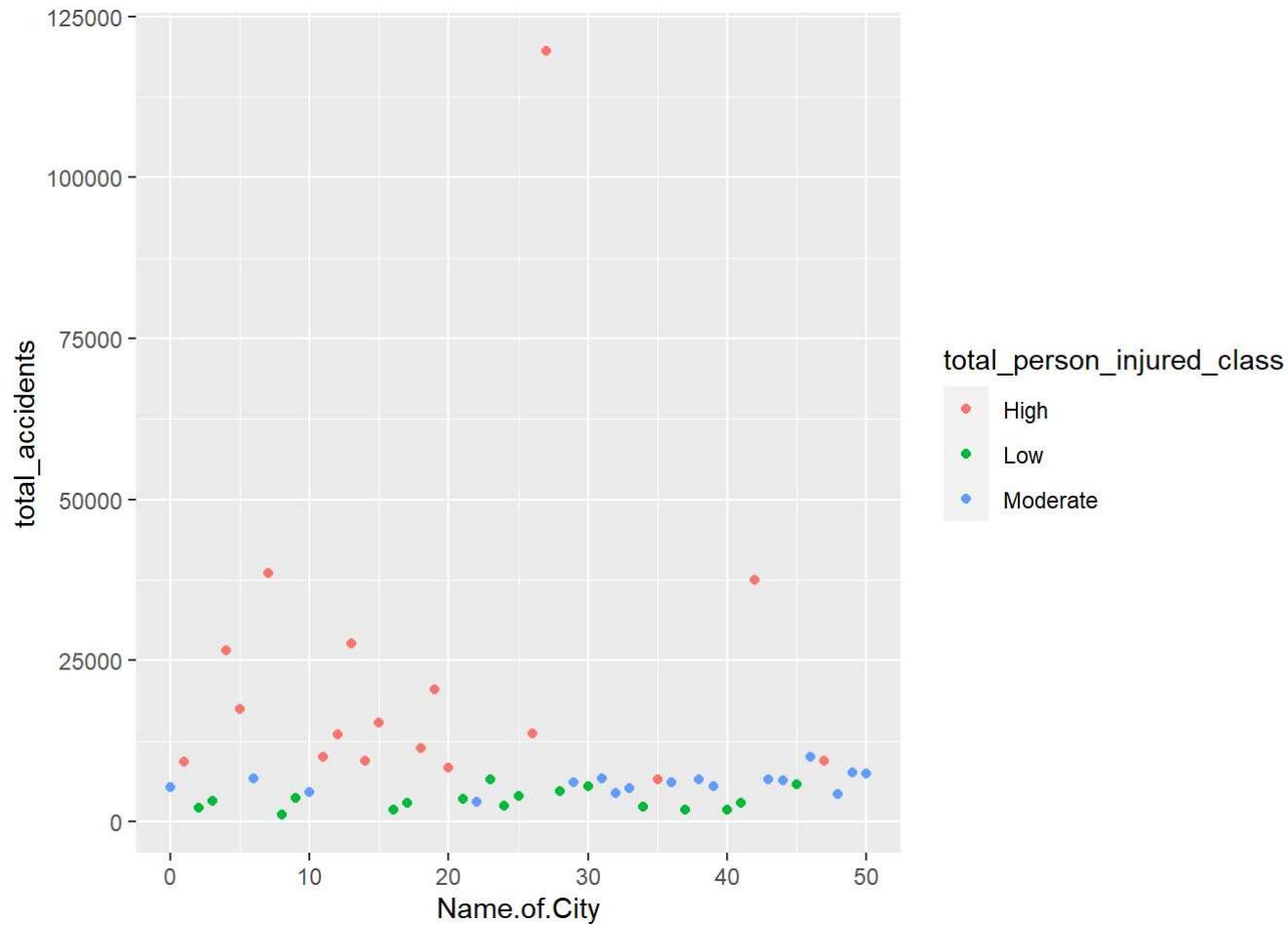
## Making visualisation of total\_accidents along with total\_fatal\_accidents\_class

```
ggplot(data = train) +
  geom_point(mapping = aes(x = Name.of.City, y = total_accidents, color = total_fatal_accidents_class))
```



## Making visualisation of total\_accidents along with total\_person\_injured\_class

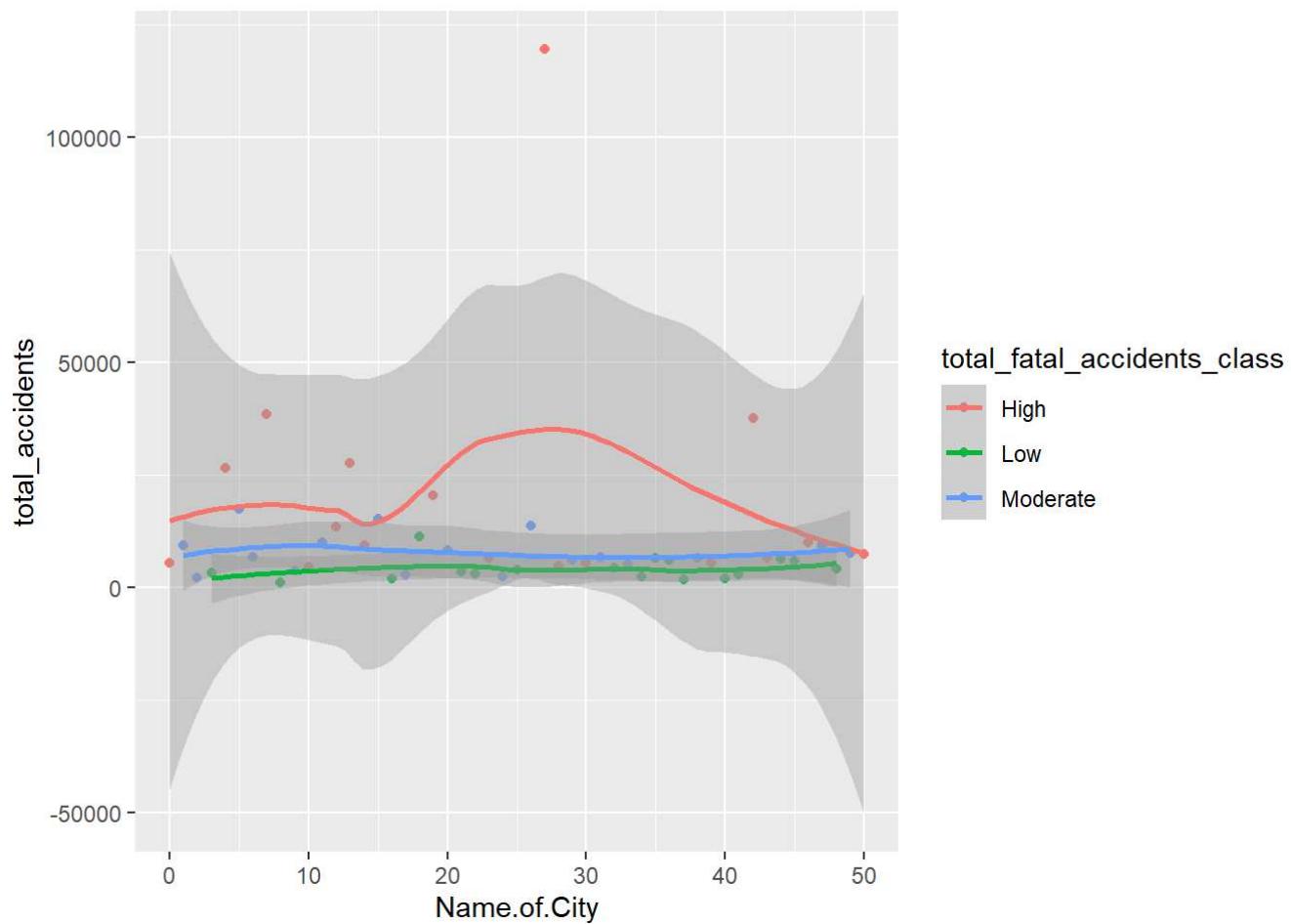
```
ggplot(data = train) +  
  geom_point(mapping = aes(x = Name.of.City, y = total_accidents, color = total_person_injured_c  
lass))
```



## Making visualisation with more details

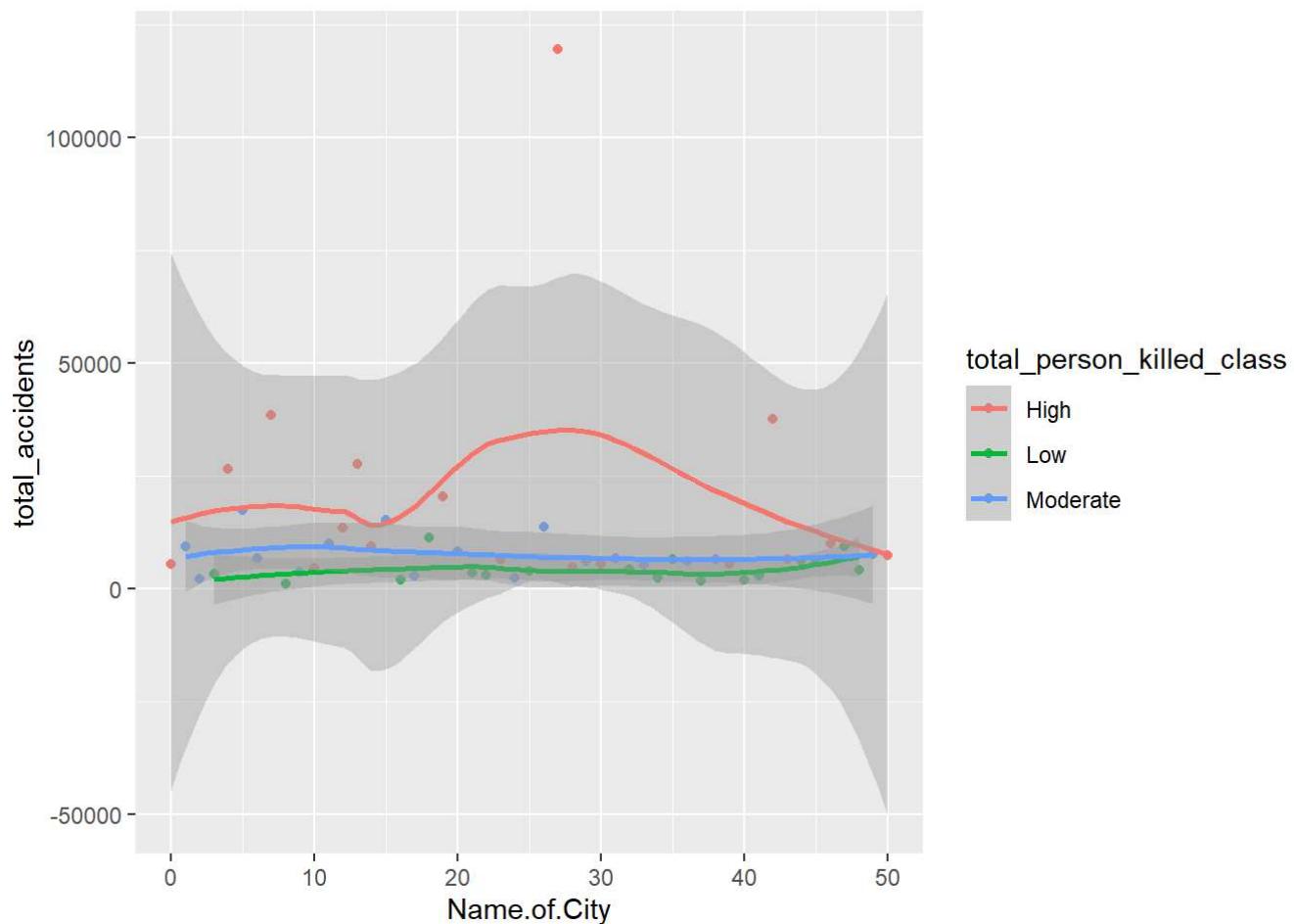
```
ggplot(data = train) +
  geom_point(mapping = aes(x = Name.of.City, y = total_accidents,color = total_fatal_accidents_class)) +
  geom_smooth(mapping = aes(x = Name.of.City, y = total_accidents,color = total_fatal_accidents_class))
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```



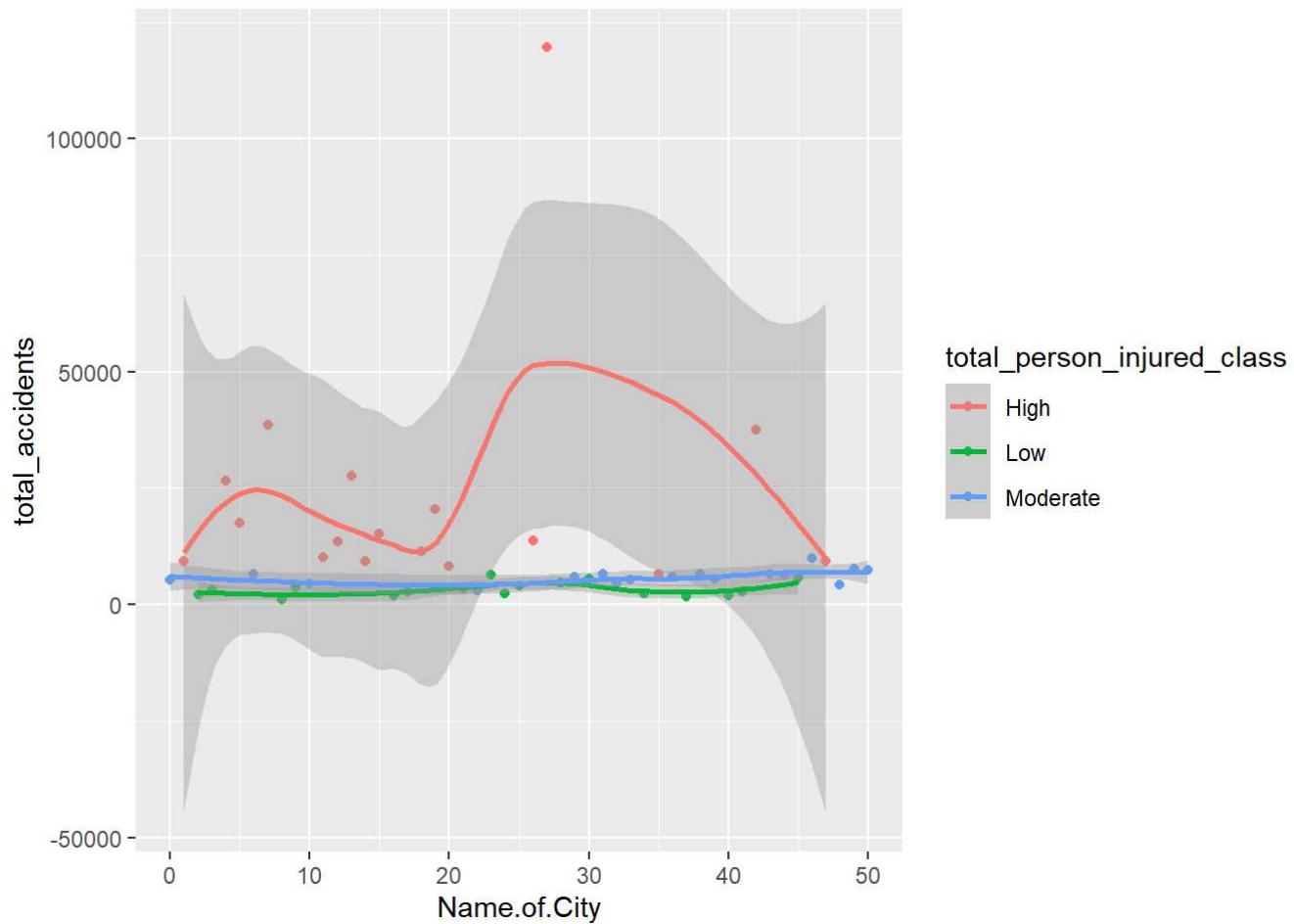
```
ggplot(data = train) +
  geom_point(mapping = aes(x = Name.of.City, y = total_accidents,color = total_person_killed_classes)) +
  geom_smooth(mapping = aes(x = Name.of.City, y = total_accidents,color = total_person_killed_classes))
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```



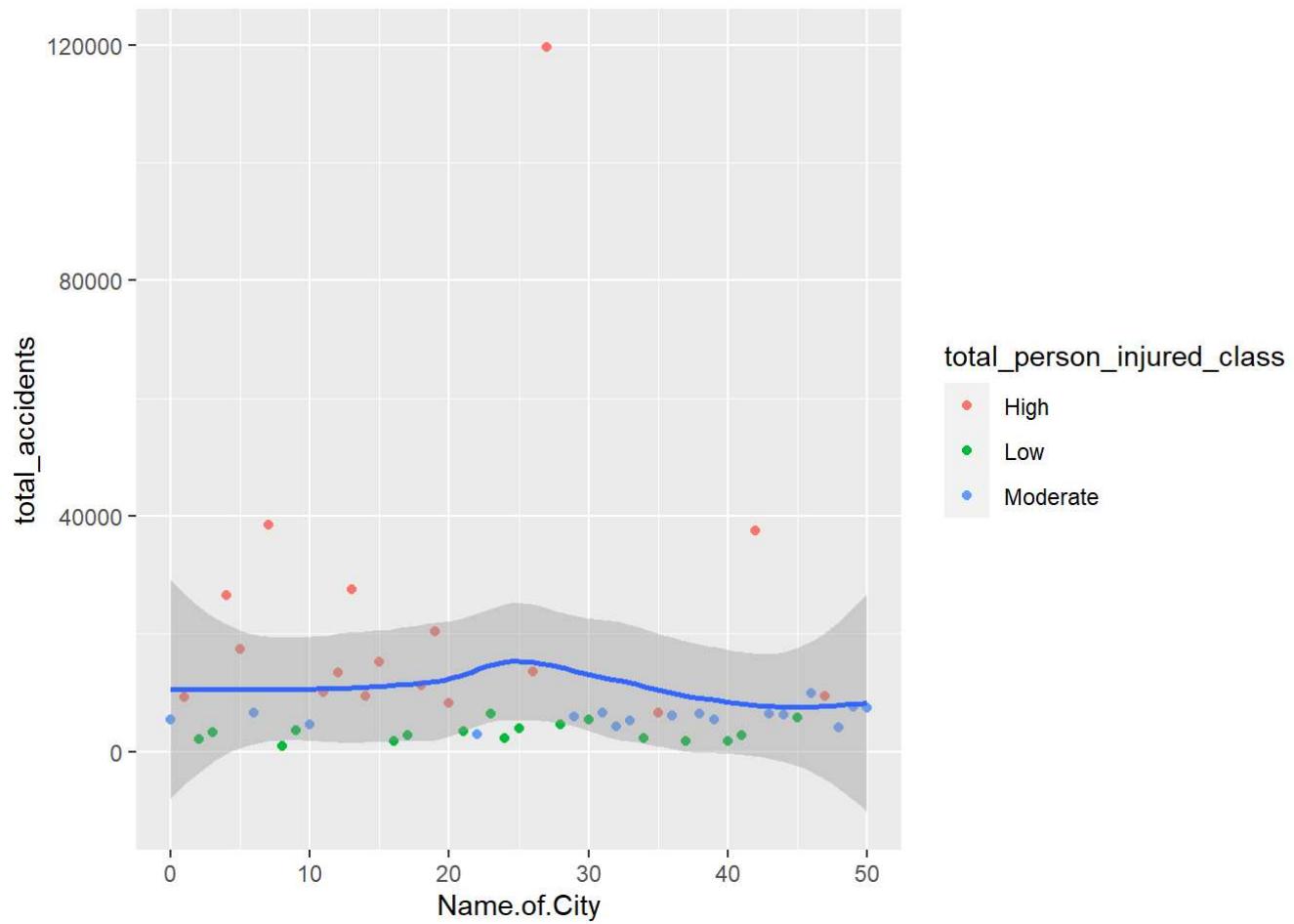
```
ggplot(data = train) +
  geom_point(mapping = aes(x = Name.of.City, y = total_accidents,color = total_person_injured_class)) +
  geom_smooth(mapping = aes(x = Name.of.City, y = total_accidents,color = total_person_injured_class))
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```



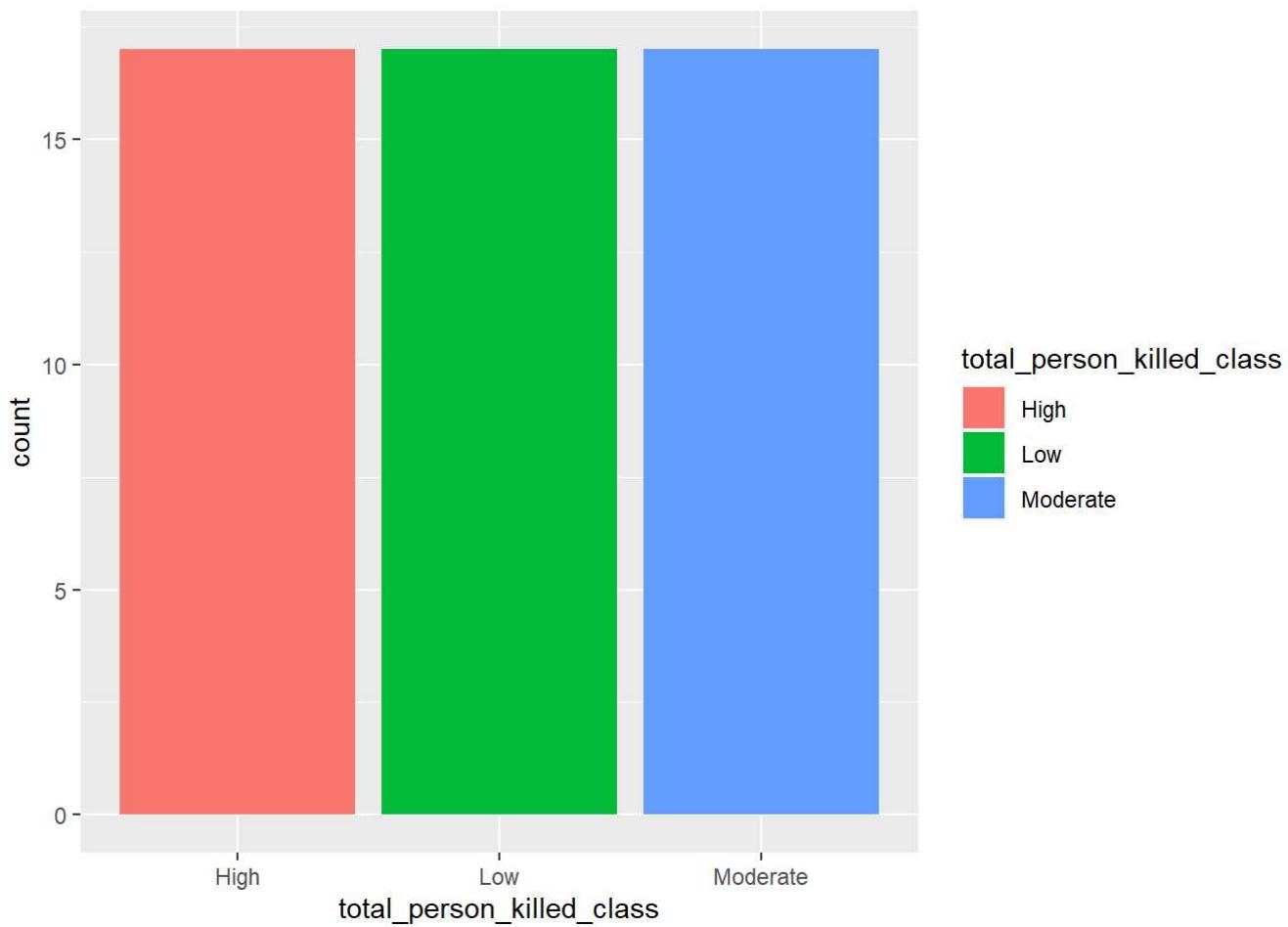
```
ggplot(data = train, mapping = aes(x = Name.of.City, y = total_accidents)) +
  geom_point(mapping = aes(color = total_person_injured_class)) +
  geom_smooth()
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

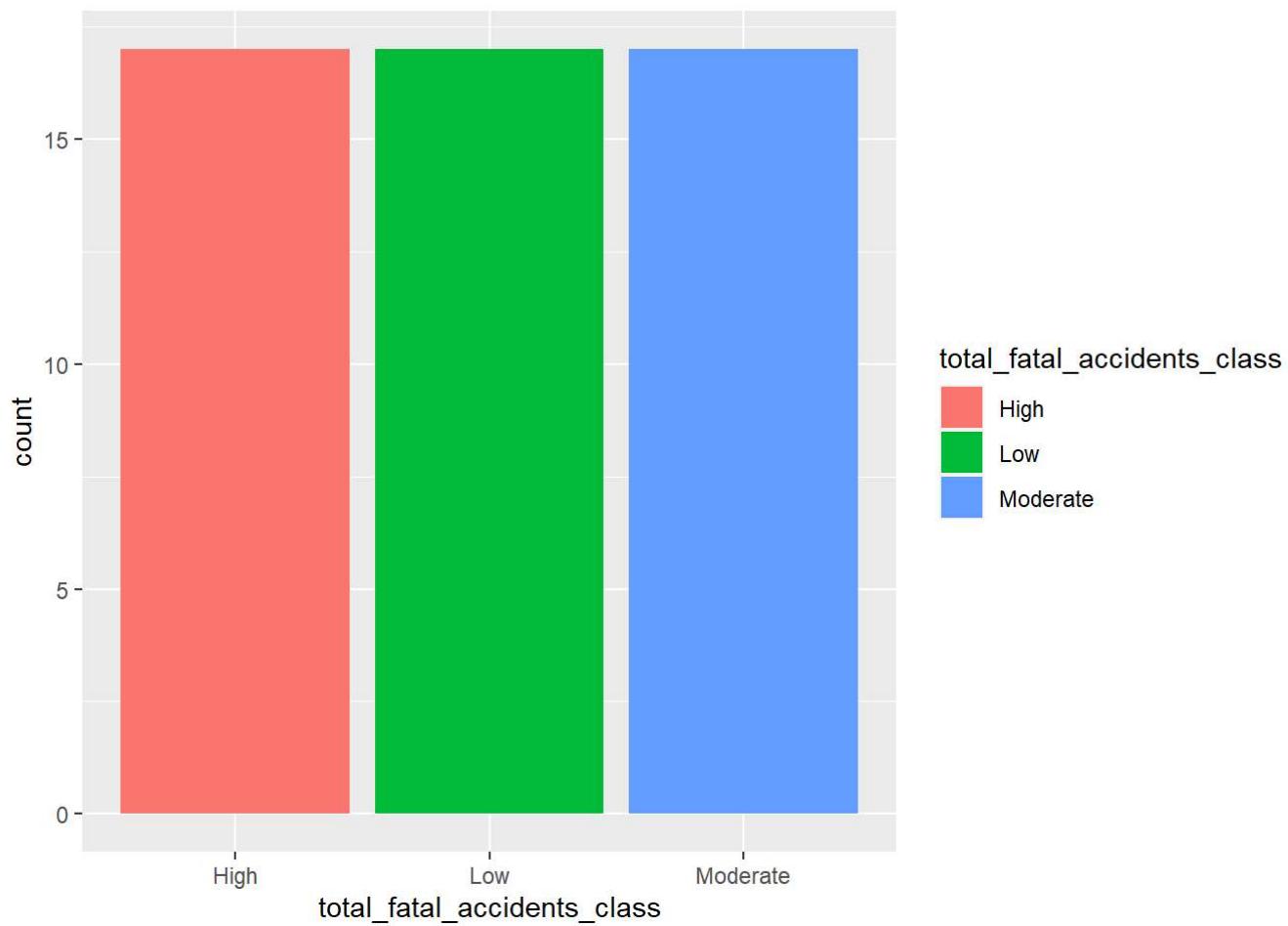


## Making bar\_charts of the dataset

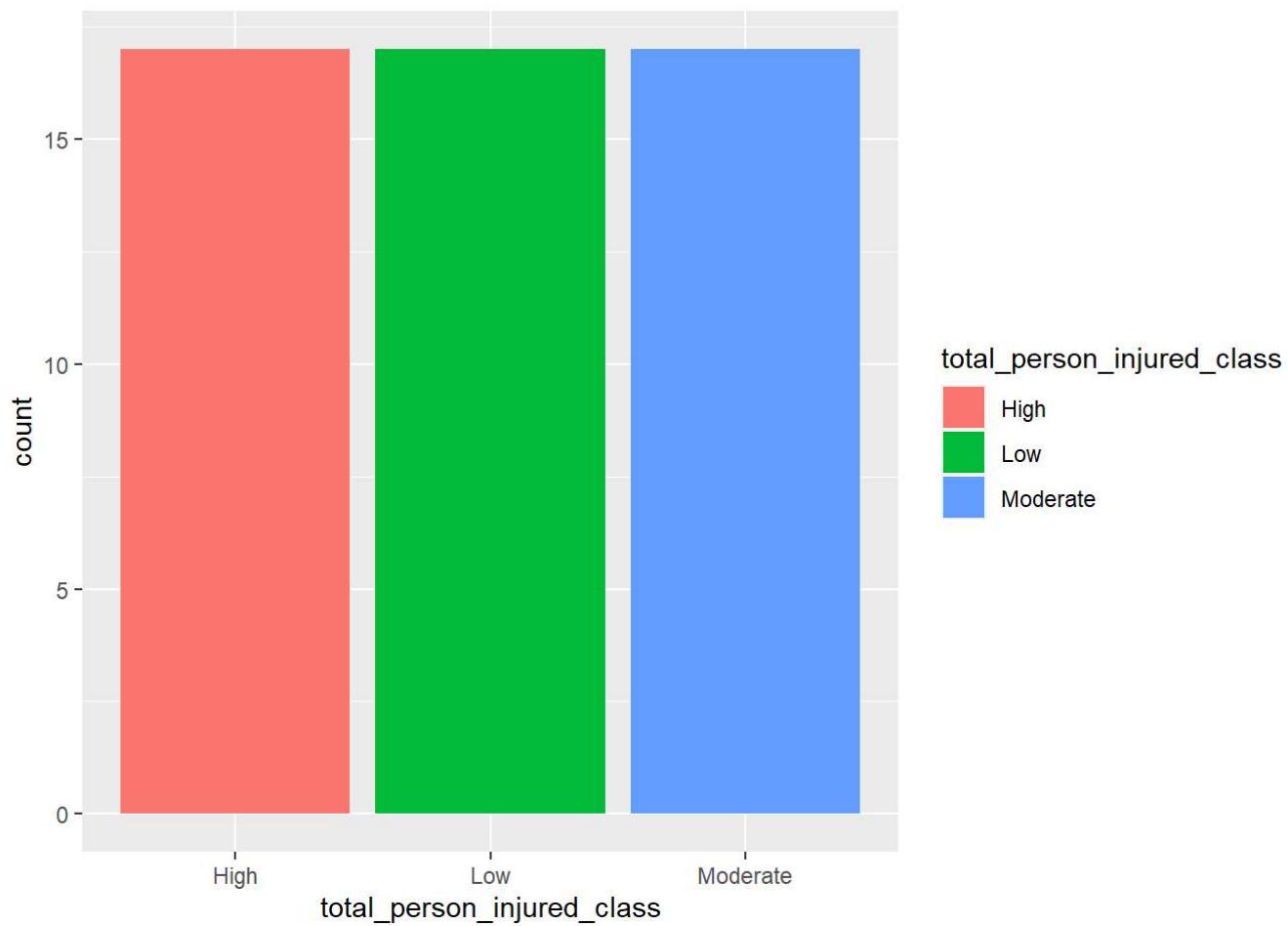
```
ggplot(data = train) +  
  geom_bar(mapping = aes(x = total_person_killed_class, fill = total_person_killed_class))
```



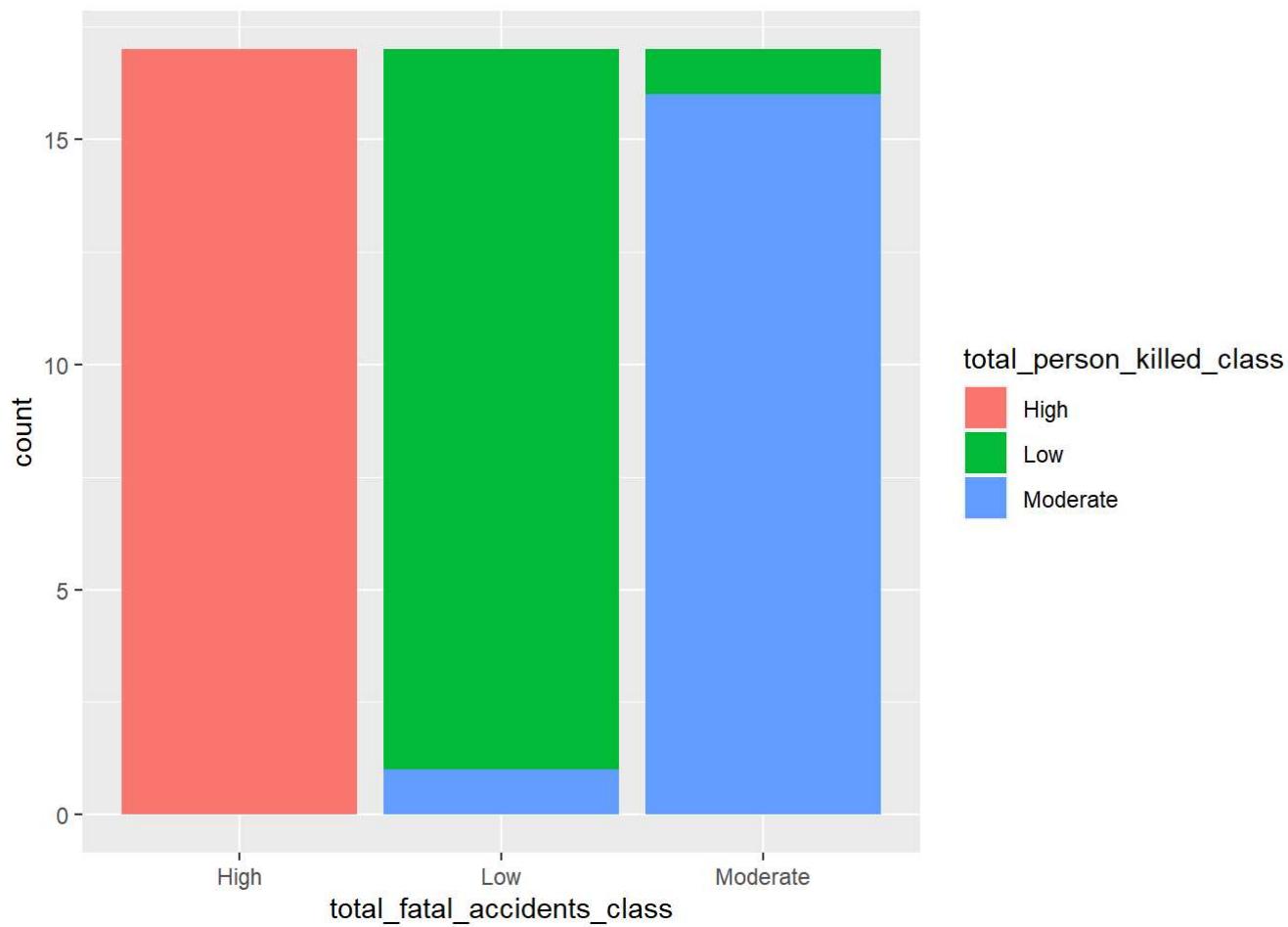
```
ggplot(data = train) +  
  geom_bar(mapping = aes(x = total_fatal_accidents_class, fill = total_fatal_accidents_class))
```



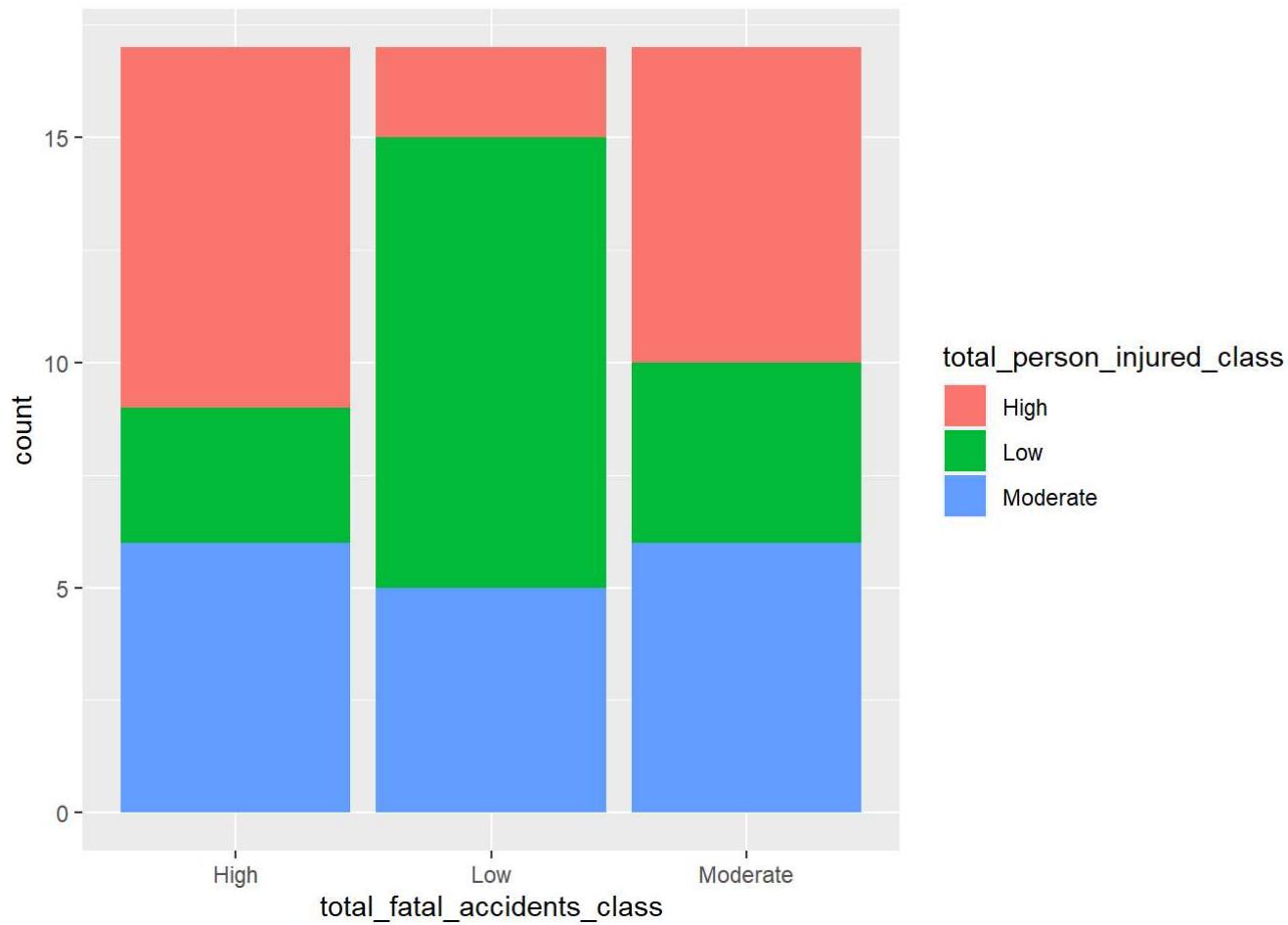
```
ggplot(data = train) +  
  geom_bar(mapping = aes(x = total_person_injured_class, fill = total_person_injured_class))
```



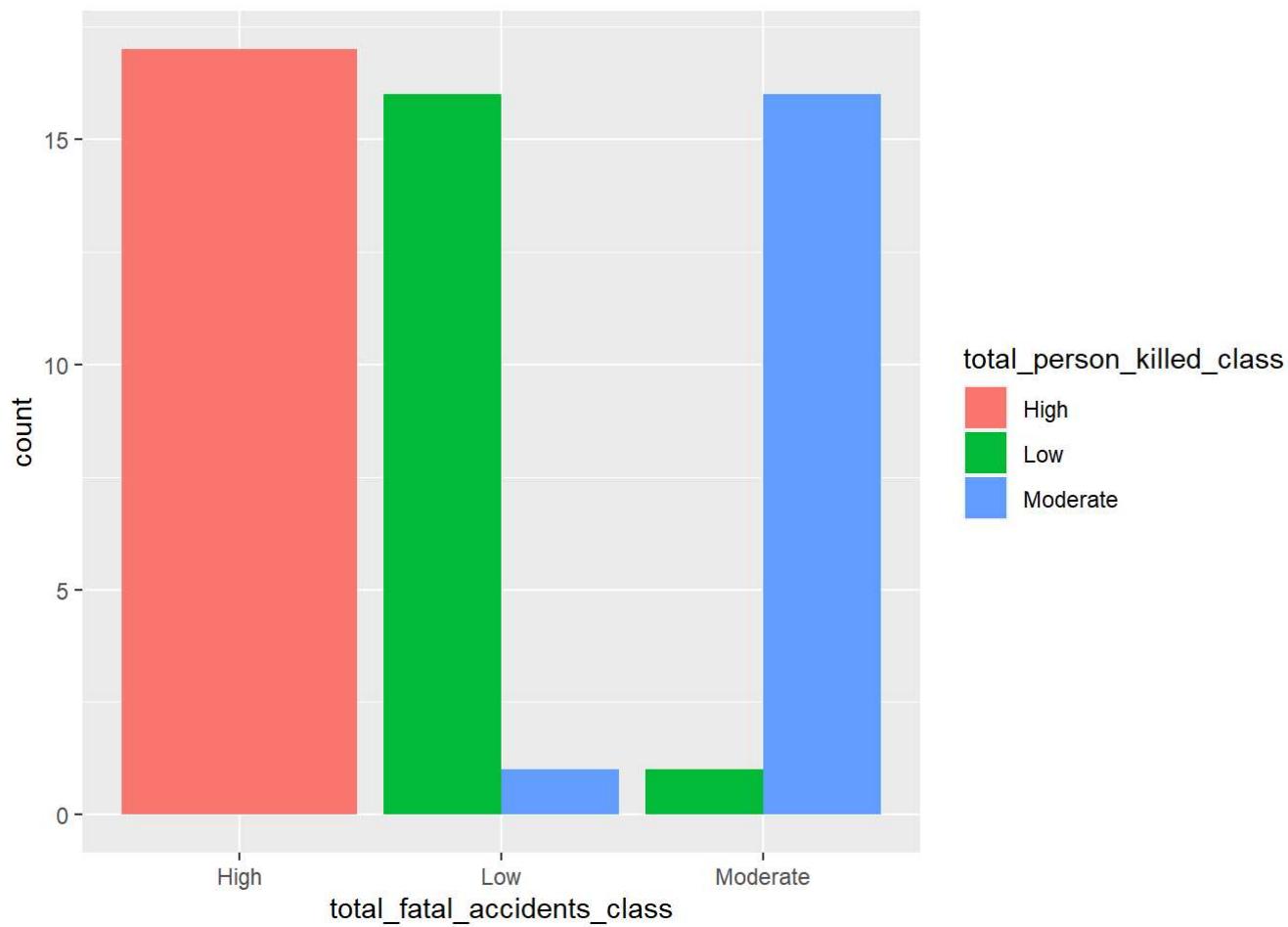
```
ggplot(data = train) +  
  geom_bar(mapping = aes(x = total_fatal_accidents_class, fill = total_person_killed_class))
```



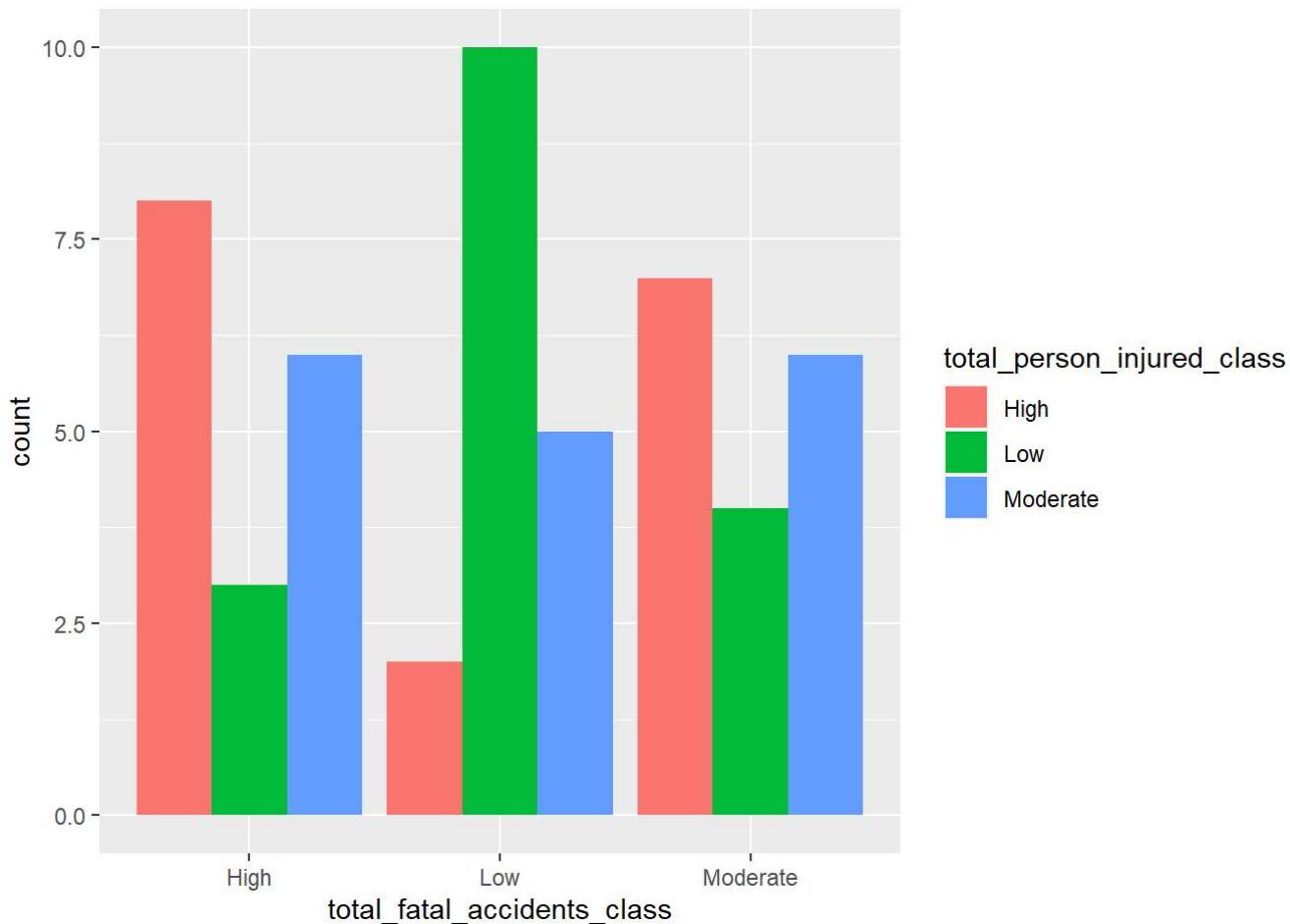
```
ggplot(data = train) +  
  geom_bar(mapping = aes(x = total_fatal_accidents_class, fill = total_person_injured_class))
```



```
ggplot(data = train) +  
  geom_bar(mapping = aes(x = total_fatal_accidents_class, fill = total_person_killed_class), po  
sition = "dodge")
```



```
ggplot(data = train) +  
  geom_bar(mapping = aes(x = total_fatal_accidents_class, fill = total_person_injured_class), p  
osition = "dodge")
```



## Results and Discussions

It is observed that cities like **Delhi, Bengaluru, Indore, Mumbai, Chennai** has highest accident rate along with high fatal accidents rate and high person killed rate. On the other hand cities like **Dhanbad, Jamshedpur, Srinagar, Varanasi, Amritsar** has lowest accident rate.

From the above observation it is clear that **metropoliton** cities has highest accident rate.

From the results obtained we found some cities like **Agra, Ghaziabad, Lucknow, Patna, Meerut, Allahabad** and **Kapur** inspite of having low accident rate those cities has high fatal accident rate as well as high person killed rate.

So it can be said that those cities might be less populated and accidents occuring is very severe. The transportation system in this cities may be very bad or hospital facilities in this cities are bad due to which person killed rate is high.

From the visualisation it is seen that total fatal accidents is directly proportional to total person killed.

## Conclusion

We know that transportation through roads and highways is very important as it helps our economy grow. Also we should ensure safety measures while traveling through this roads. The government and other agencies should look after this matter as it involves life of people and take necessary actions.

# Reference

Data source link,<https://data.gov.in/node/1895961/download> (<https://data.gov.in/node/1895961/download>)

Classification of Indian Cities, [https://en.wikipedia.org/wiki/Classification\\_of\\_Indian\\_cities](https://en.wikipedia.org/wiki/Classification_of_Indian_cities)  
([https://en.wikipedia.org/wiki/Classification\\_of\\_Indian\\_cities](https://en.wikipedia.org/wiki/Classification_of_Indian_cities))