Bachelor's Thesis Project

Fire Risk Assessment for Different Type of Buildings in Delhi

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Submitted to:

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Acknowledgement

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals. Firstly, I would like to express sincere gratitude towards my supervisor, Professor K. Ramachandra Rao, for his continuous support through the project, for his guidance, patience, motivation and enthusiasm. I couldn't have imagined better supervisor and mentor for my project.

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Table of Contents

Introduction

Fire risk assessment is the assessment of the risks to the people and property as a result of unwanted fires. In a simple risk assessment, the probability of a certain unwanted fire scenario are explored. In a comprehensive risk assessment, all probable unwanted fire scenarios and their consequences are considered.
A fire scenario involves the projection of a set of fire events, all of which are linked together by whether the fire protection measures succeed or fail. The probability of fire scenario is dependent on the individual probabilities of success or failure of fire protection measures. *A fire event* is an occurrence that is related to fire initiation, or fire growth, or smoke spread, or occupant evacuation, or fire department response.

A set of fire scenarios can be constructed based on well-known event tree concept.

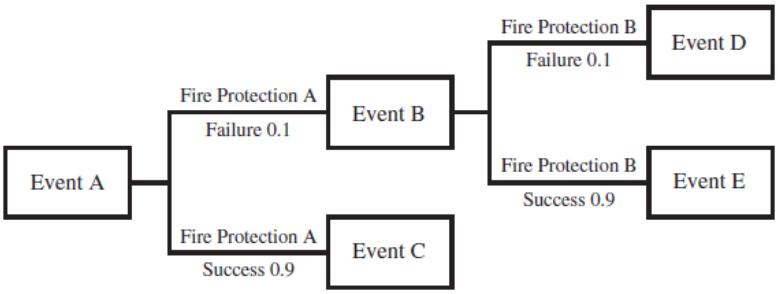

Fig.1

A set of all possible combinations of the linked events forms a complete set of all possible fire scenarios. For example, the combinations of A–C, A–B–D and A–B–E form a complete set of three fire scenarios.

A fire protection measure is a measure that can be a fire protection system such as sprinklers and alarms; or a fire protection action such as occupant evacuation training and drills.

For fire risk assessment in building, the event tree can be constructed based on these five major fire events: Fire ignition, fire growth, smoke spread, failure of occupants to evacuate, failure of fire department to response. Each of the five hazardous events, however can only happen if the fire protection measure for that event fails to prevent the event from happening. There can be five major barriers between a fire and the people. The more effective the barriers are, the lower the probabilities of those fire scenarios that can lead to harm.

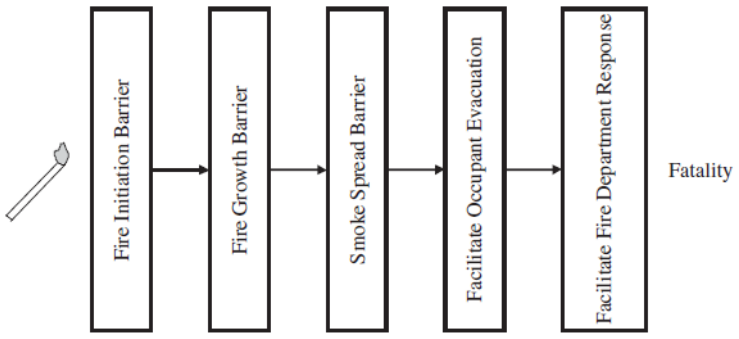

Fig.2

Problem Statement

Fire risk assessment can be performed based on past fire experience. Such fire risk assessment, however, are only valid if the situation in the past and that to be assessed at the present are the same. One of the thing that past disaster have in common is that they all are different, They are in different building types, with different causes and contributory factors, so it seems whatever is done to prevent the last disaster from happening again, the next disaster is likely to be almost completely different. Fire risk assessment provides the opportunity to address the potential risk from all foreseeable potential future disasters, not just the last one.

Risk assessment for different type of building and occupancy based on past fire experience is necessary to prevent the possible fire hazards in future and major regulations can be adopted by fire authorities. Generally, categorization of building and occupancy is done as follows; Residential, Assembly, Educational, Industrial, Institutional, Mercantile, Businesses, Storage etc. Which can be further divided by high- and low-rise type buildings.

To consider the future potential fire risks of a specific building under design, full quantitative fire risk assessment might be necessary. The approach combines the probabilistic information from fire report data with prediction of the physical consequences of fire events.

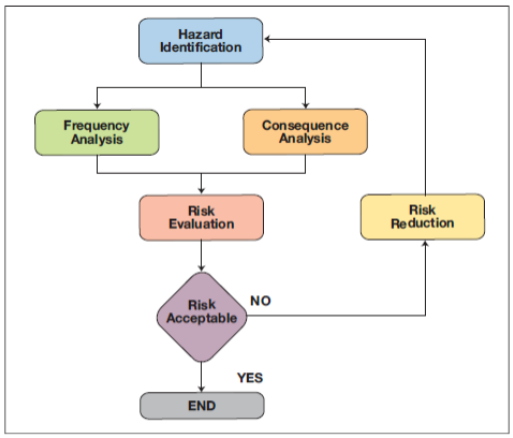

Fig. 3

One of the major challenges to quantifying future fire risk for a specific building design is that the events of greatest concern are very rare, and in many cases may not have happened yet and are not recorded in fire report data. Therefore, there is a need to break the fire event process down into many sub-events (for which there is data) so that they can be reconstructed to predict the probable frequency of fire events that have not happened yet.

In our project we decided to perform statistical analysis of fire reports data for different type of buildings and adopted quantitative fire risk assessment for different type of buildings in Delhi.

Methodology

We extracted data of fire reports from publicly available fire report database of Delhi Fire Department. Delhi Fire Department stores fire reports data for all the fire stations separately, there are total 64 fire station reported in Delhi Fire Department in which some of them are in under construction. There fire stations are further divided by Zones, There are total 4 zones defined by Delhi fire department; New Delhi, south, south west and west zone.
We extracted fire calls data for total 50 fire stations and performed statistical analysis for the data. These files were in JSON file format, we converted into CSV format. These are the attributes of the csv file

• • •

```
Index(['Approximate Distance From Fire Station:',
       'Building Details in Case of Others:', 'Category of Fire:',
       'Date of Leaving From Fire Scene:', 'Date of Receipt of Call :',
       'Details of Affected Area:', 'Fire Report Number  :',
       'Full Address of Incident Place:', 'Information Received From:',
       'Name of The Caller :', 'Nature of Call',
       'Occupancy Details in Case of Others:',
       'Operational Jurisdiction of Fire Station :',
       'Phone No. of the Caller :', 'Time of Arrival at Fire Scene:',
       'Time of Departure From Fire Station:',
       'Time of Leaving From Fire Scene:', 'Time of Receipt of Call \t :',
       'Type of Building:', 'Type of Occupancy:'],
      dtype='object')
```

Total 232945 fire calls files are extracted in which many of the files are not related to fire incident so we filtered the files based on “Nature of Call” attribute. This attribute contains two values “fire call” and “other”, we selected “Nature of Call” as Fire call only. Now we had around 157000 fire reports files only.

These files does not contain information of physical consequences such as number of deaths and injuries in separate attribute in numerical form, the information is included in an attribute “Details of Affected Area” which is in string format ,so there is a sentence which includes the information of injuries and deaths for ex.

“*Fire was in a hut resulting five persons sustained burn injuries and removed to LNJP Hospital by public before the arrival of DFS.*”

Since the number of files are too large, therefore extracting the numbers of deaths and injuries manually is very laborious, Since the format of sentences are almost same so we choose some keywords such as ‘sustained’, “removed”, “resulting” and programmed a code in python to extract this information automatically.

Apart from this other data preprocessing and cleaning is done using python. We calculated operation time of fire department based on given information of departure and arrival of fire fighting trucks at the incident location.

Operation Time = Time of Leaving from fire scene – Time of arrival at fire scene

We observed that there are some files in which operation time is too large. For example

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	operation_time	Category of Fire:
152664	1660 days 08:55:00	Medium
72423	1249 days 00:53:00	Small
128647	583 days 06:05:00	Small
188649	563 days 00:15:00	Small
134712	467 days 01:58:00	Small
12410	449 days 02:50:00	Small
208051	381 days 01:25:00	Small
108512	366 days 00:28:00	Small
176611	365 days 00:34:00	Small
29385	340 days 00:20:00	Small
106300	312 days 00:15:00	Small
208267	309 days 02:12:00	Small
173446	308 days 00:40:00	Small
1307	298 days 00:35:00	Small
100083	298 days 00:30:00	Small
226866	298 days 00:20:00	Small
161987	284 days 01:10:00	Small
26215	281 days 03:57:00	Small

Fig. 4

First column shows fire report number, as we see that for small category of fire, operation time is more than 2-3 years which is not possible there for we preprocessed the data and excluded these fire calls files from statistical analysis, yet we were careful about not losing any important information. We choose only those fire calls files to exclude which has faulty operation time and also no physical consequences information. Since our main focus is on physical consequences due to fire incident therefor, we cannot exclude the important information because of faulty entry in database. We also choose not to exclude all these faulty operation file while we are performing statistical analysis on different attributes because this faulty information does not affect other attributes such as types of occupancy and buildings where fire occurred, and physical consequences.

We performed quantitative fire risk analysis. We calculated probability of occurrence for any area or location as $P = \frac{Number\ of\ fire\ calls\ in\ that\ area}{Number\ of\ years}$ for example, in Geeta colony total number of fire occurrence was 5613 from year 2006 to 2020 therefor P = 5613/14 = 400.92 fires/ year.

We calculated other measures of fire risks which are

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$$Consequence\ to\ injuries = \frac{Total\ number\ of\ injuries}{total\ occurrence\ of\ fire\ cases}$$ (injuries /fire)

$$Consequence\ to\ deaths = \frac{Total\ number\ of\ deaths}{total\ occurrence\ of\ fire\ cases}$$ (deaths / fire)

$$Fire\ risk\ to\ injuries = consequence\ to\ injuries \times probability\ of\ occurrence$$
(injuries/year)

$$Fire\ risk\ to\ deaths = consequence\ to\ deaths \times probability\ of\ occurrence$$
(deaths/year)

These values of probabilities and risks can be used in event tree analysis of quantitative fire risk assessment.

Observation and Statistical Analysis

Fire calls

Figure below shows a heatmap of numbers of call in Delhi. Darker the color, more fire calls received in that area. We see that most affected area in context of receiving fire calls is Rohini sector-5, Janakpuri and Roop Nagar. Less affected areas are Delhi Sectt., Bawana Bhor garh, jwalaheri etc.

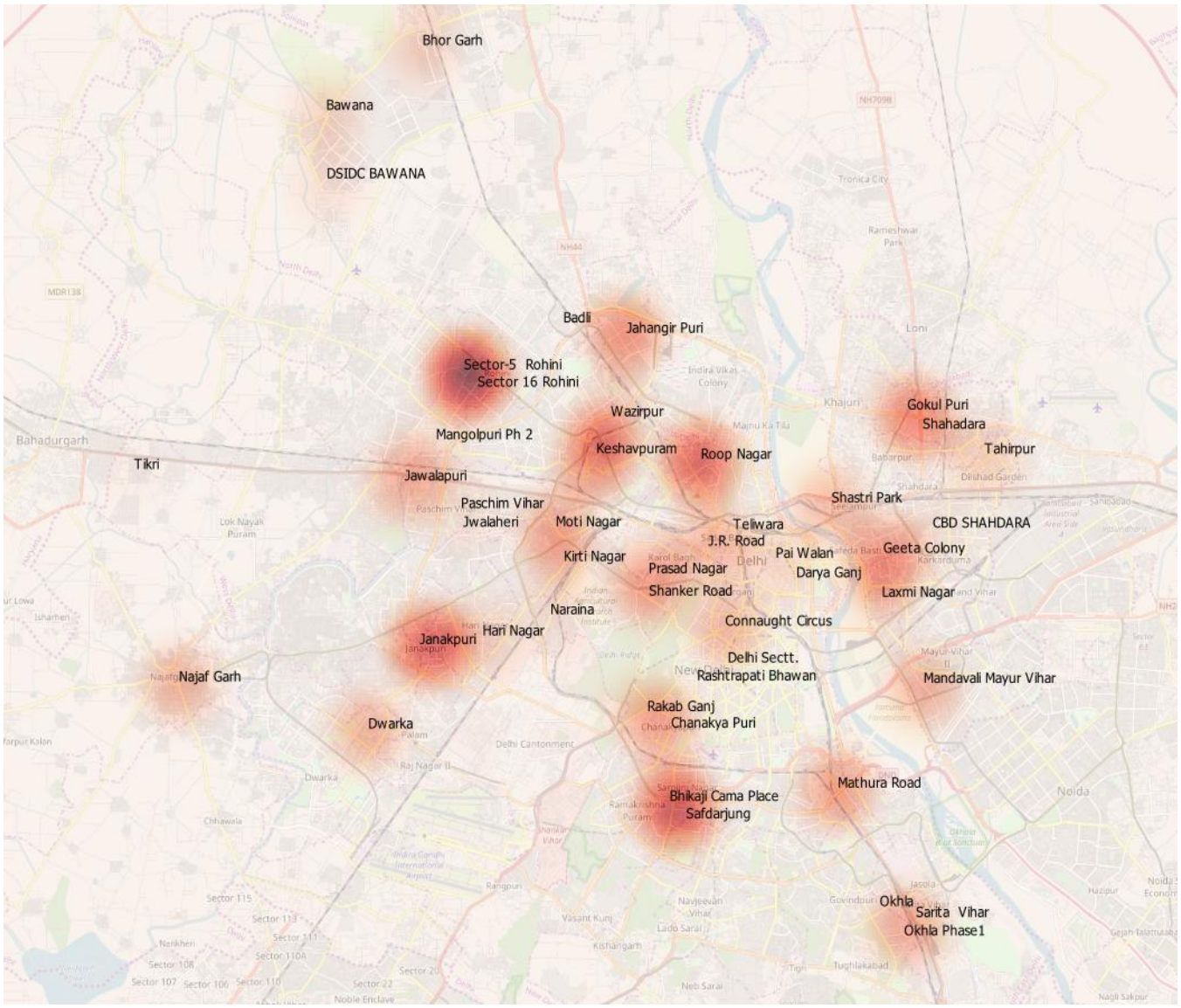

Bhor Garh
Bawana
DSIDC BAWANA
Badli
Jahangir Puri
Sector-5 Rohini
Sector 16 Rohini
Wazirpur
Mangolpuri Ph 2
Keshavpuram
Roop Nagar
Gokul Puri
Shahadara
Tahirpur
Tikri
Jawalapuri
Paschim Vihar
Jwalaheri
Moti Nagar
Shastri Park
CBD SHAHDARA
Teliwara
J.R. Road
Pai Walan
Geeta Colony
Kirti Nagar
Prasad Nagar
Darya Ganj
Shanker Road
Laxmi Nagar
Naraina
Connaught Circus
Janakpuri
Hari Nagar
Delhi Sectt.
Najaf Garh
Rashtrapati Bhawan
Mandavali Mayur Vihar
Rakab Ganj
Dwarka
Chanakya Puri
Mathura Road
Bhikaji Cama Place
Safdarjung
Okhla
Sarita Vihar
Okhla Phase1

Fig. 5

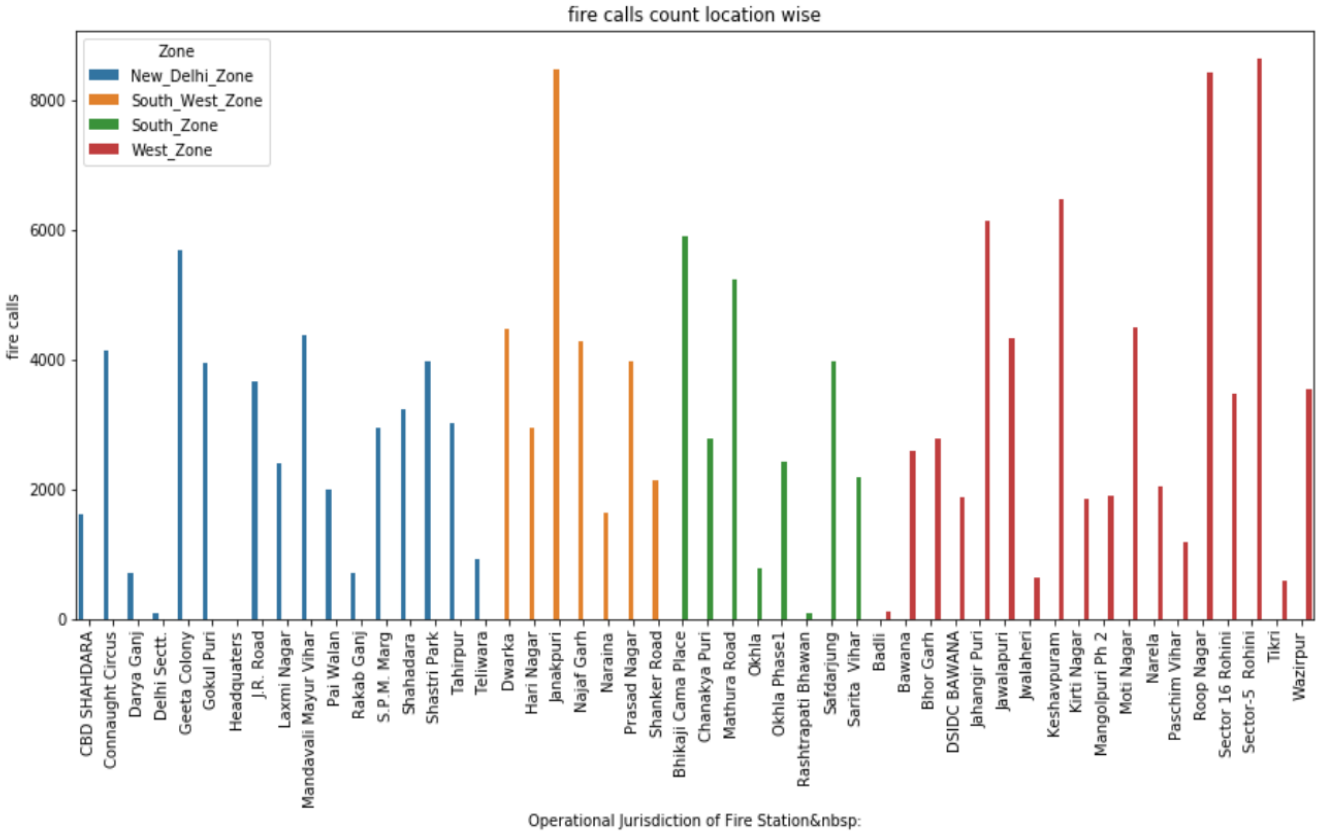


Fig. 6

We also looked at fire calls frequency variation based on hours of the day and month of year(avg by month from year 2006-2020)

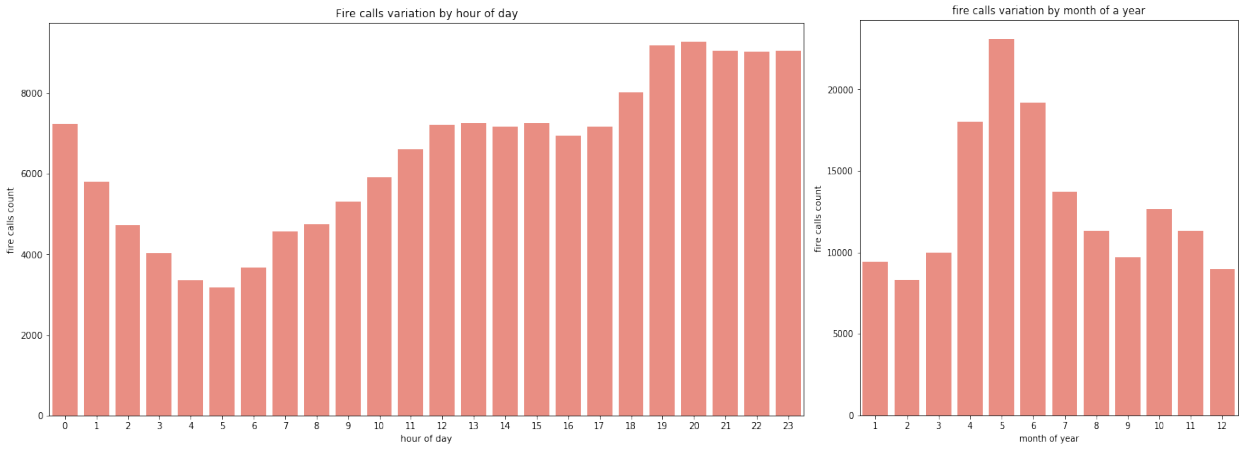
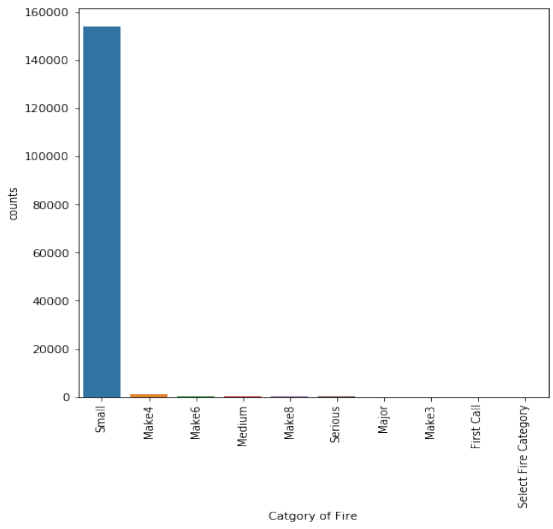


Fig. 7

We see that the peak time for fires in Delhi based on fire reports data is in between 8-12 p.m. and the lowest time period for fires is from 4-7 am
May and June has more fires than any other month while January-March and December has the lowest number of fire reported.

If we look at types of fire, we see that small fires has major share of total fire incident, number of serious and major types of fire are very low.

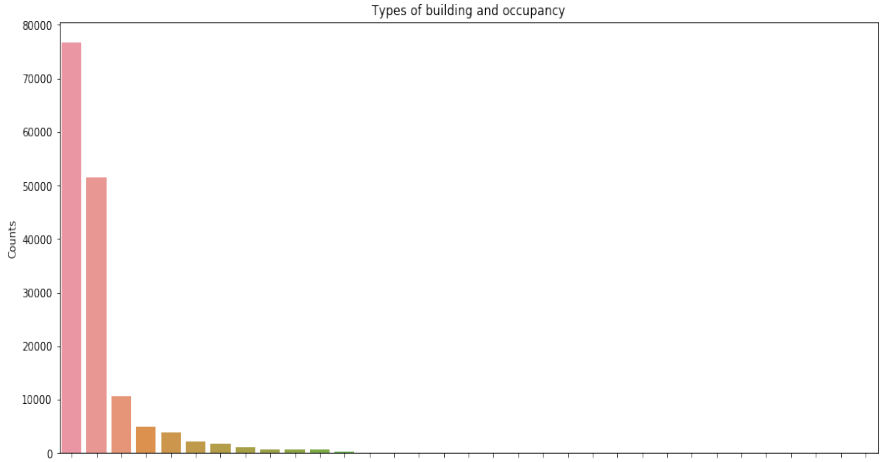


Small	154060
Make4	1010
Make6	359
Medium	191
Make8	107
Serious	37
Major	15
Make3	8
First Call	4

Fig. 8

Fire calls from different type of building

We see that high rise buildings are more fire resistant than low rise buildings, Top 7 buildings in figure where fire case are more are low rise buildings, low rise residential buildings has more fire cases than any other building and much more fire cases than in high rise residential buildings. We can also observe that Mercantile buildings are more fire resistant if it is high rise, since low rise mercantile buildings has more fire case .



Others Others	76736
Low Rise Residential	51608
Low Rise Mercantile	10741
Low Rise Industrial	5039
Low Rise Business	3945
Low Rise JJ Cluster	2157
Low Rise Storage	1737
Low Rise Educational	1037
High Rise Business	657
Low Rise Institutional	617
Low Rise Assembly	601
Low Rise Tents/Pandals	340
High Rise Residential	153
High Rise Institutional	107
Low Rise Others	88
Low Rise Hazardous	69
Others JJ Cluster	27
Others Business	19
High Rise Mercantile	17
Others Mercantile	16
Others Residential	14
High Rise Educational	13
High Rise Industrial	12
High Rise Assembly	9
Others Storage	8
High Rise Others	5
Others Institutional	5
Others Industrial	4
High Rise Storage	4
Others Educational	3
Others Hazardous	2
Select building Select Occupancy	1

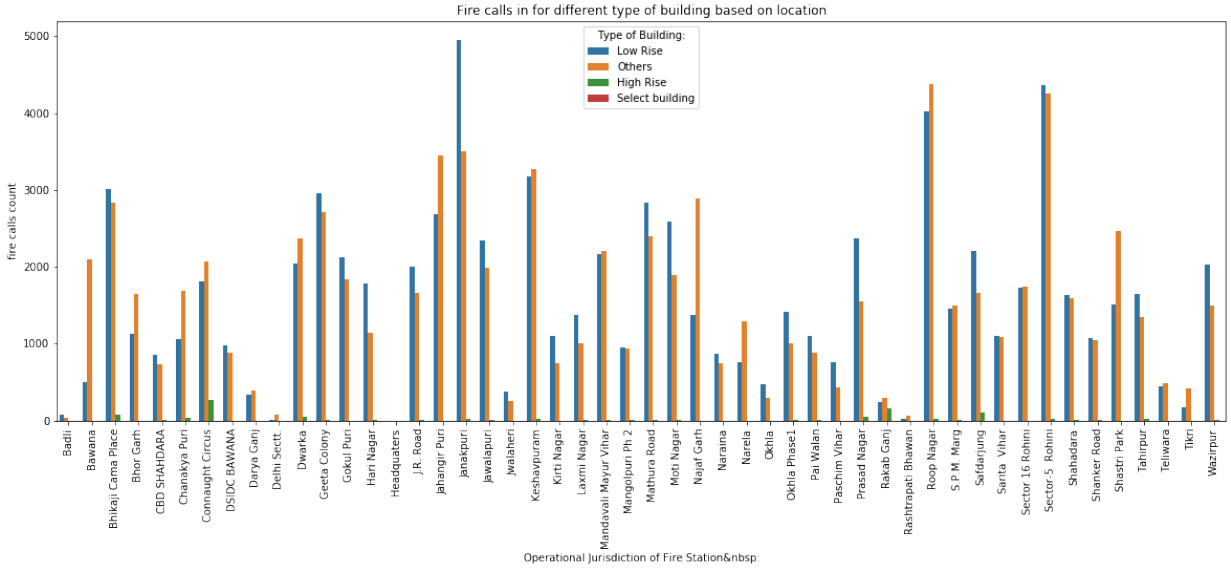


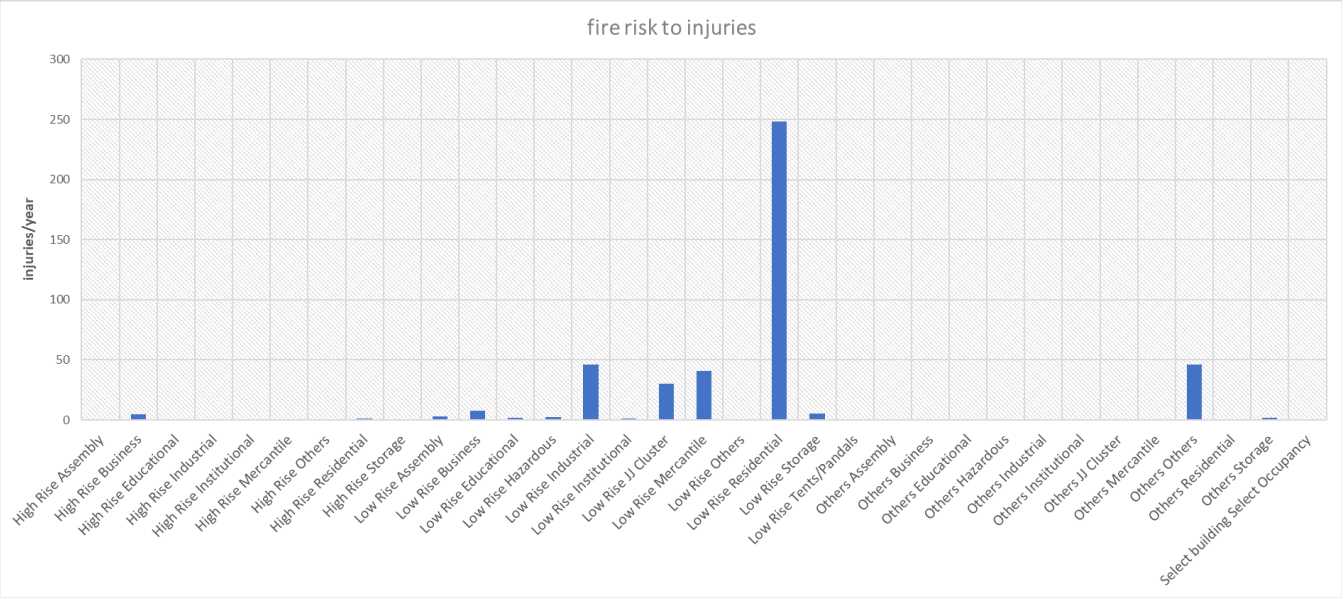
Fig.9

Fire Risk

We calculated fire risk to injuries and deaths based on different type of buildings and different zones

Fire risk values by different type of buildings

types_of_building_occupancy	deaths	injuries	occurence	count_of_years	probability of occurence	consequence to injuries	consequence to deaths	fire risk to injuries	fire risk to deaths
High Rise Assembly	0	6	9	8	1.125	0.666666667	0	0.75	0
High Rise Business	2	63	648	14	46.28571429	0.097222222	0.00308642	4.5	0.142857143
High Rise Educational	0	0	13	14	0.928571429	0	0	0	0
High Rise Industrial	1	9	12	13	0.923076923	0.75	0.083333333	0.692307692	0.076923077
High Rise Institutional	0	6	106	14	7.571428571	0.056603774	0	0.428571429	0
High Rise Mercantile	0	5	17	12	1.416666667	0.294117647	0	0.416666667	0
High Rise Others	0	0	5	8	0.625	0	0	0	0
High Rise Residential	1	19	150	14	10.71428571	0.126666667	0.006666667	1.357142857	0.071428571
High Rise Storage	0	0	4	7	0.571428571	0	0	0	0
Low Rise Assembly	17	43	595	14	42.5	0.072268908	0.028571429	3.071428571	1.214285714
Low Rise Business	18	111	3903	14	278.7857143	0.028439662	0.004611837	7.928571429	1.285714286
Low Rise Educational	1	21	1030	14	73.57142857	0.02038835	0.000970874	1.5	0.071428571
Low Rise Hazardous	1	36	65	14	4.642857143	0.553846154	0.015384615	2.571428571	0.071428571
Low Rise Industrial	148	644	4967	14	354.7857143	0.129655728	0.029796658	46	10.57142857
Low Rise Institutional	3	19	613	14	43.78571429	0.030995106	0.004893964	1.357142857	0.214285714
Low Rise JJ Cluster	69	420	2126	14	151.8571429	0.197554092	0.032455315	30	4.928571429
Low Rise Mercantile	63	575	10591	14	756.5	0.054291379	0.005948447	41.07142857	4.5
Low Rise Others	0	0	87	14	6.214285714	0	0	0	0
Low Rise Residential	397	3479	51029	14	3644.928571	0.068176919	0.00777989	248.5	28.35714286
Low Rise Storage	32	76	1699	14	121.3571429	0.044732195	0.018834609	5.428571429	2.285714286
Low Rise Tents/Pandals	4	9	336	14	24	0.026785714	0.011904762	0.642857143	0.285714286
Others Assembly	0	0	1	1	1	0	0	0	0
Others Business	0	0	19	12	1.583333333	0	0	0	0
Others Educational	0	0	3	4	0.75	0	0	0	0
Others Hazardous	0	0	2	5	0.4	0	0	0	0
Others Industrial	0	0	4	1	4	0	0	0	0
Others Institutional	0	0	5	9	0.555555556	0	0	0	0
Others JJ Cluster	0	2	27	9	3	0.074074074	0	0.222222222	0
Others Mercantile	0	0	16	2	8	0	0	0	0
Others Others	82	648	75809	14	5414.928571	0.008547798	0.001081666	46.28571429	5.857142857
Others Residential	0	0	14	14	1	0	0	0	0
Others Storage	0	2	8	1	8	0.25	0	2	0
Select building Select Occupancy	0	0	1	1	1	0	0	0	0



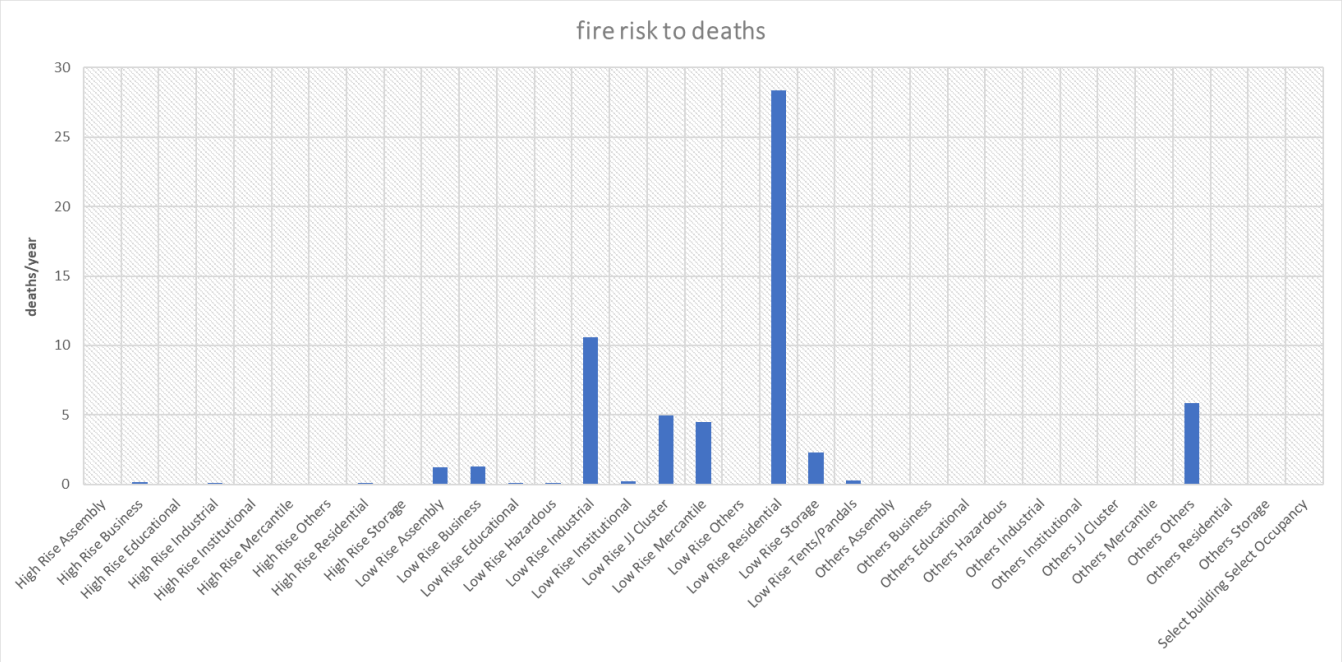


Fig. 10

As we see that Low rise residential has highest risk to deaths followed by low rise industrial, fire risk to injuries is highest in low rise residential buildings and low rise mercantile. If we compare between high rise and low rise buildings in context of fire risk in deaths and injuries, in high rise buildings risk is much lower than in low rise buildings.

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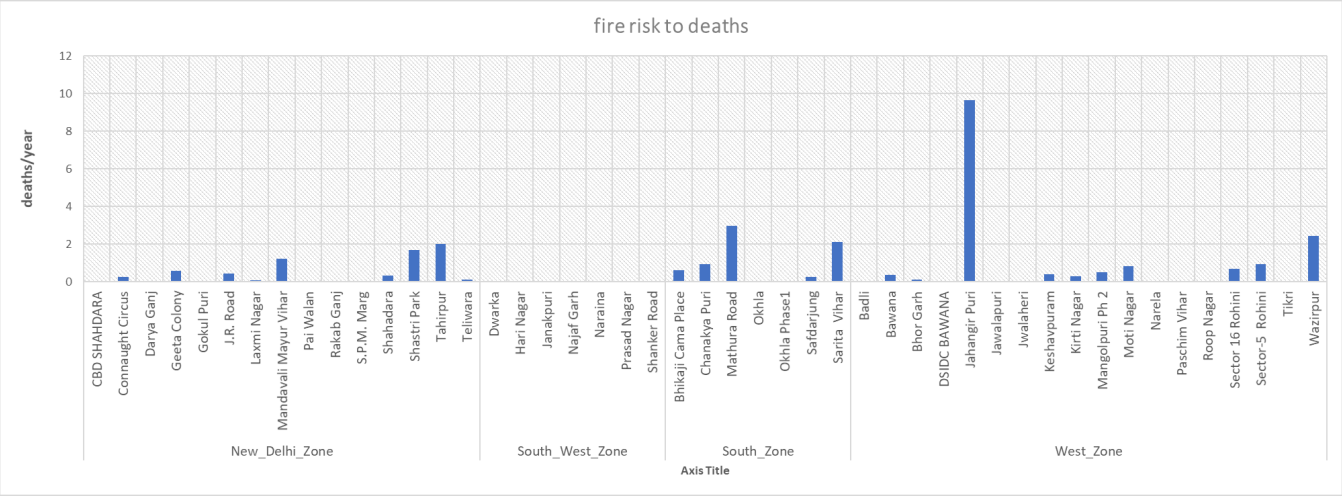
We also calculated risk in different zones and fire station area of Delhi, Values are given below

Fire risk values by fire station area

Zone	Operational Jurisdiction of Fir	deaths	injuries	occurence	count_of_years	probability of occ	consequence to injuries	consequence to deaths	fire risk to injuries	fire risk to deaths
New_Delhi_Zone	CBD SHAHDARA	7	59	1590	10	159	0.037106918	0.004402516	5.9	0.7
New_Delhi_Zone	Connaught Circus	11	156	4098	14	292.7142857	0.03806735	0.002684236	11.14285714	0.785714286
New_Delhi_Zone	Darya Ganj	1	12	713	14	50.92857143	0.016830295	0.001402525	0.857142857	0.071428571
New_Delhi_Zone	Delhi Sectt.	0	2	88	10	8.8	0.022727273	0	0.2	0
New_Delhi_Zone	Geeta Colony	25	223	5613	14	400.9285714	0.0397292	0.004453946	15.92857143	1.785714286
New_Delhi_Zone	Gokul Puri	23	231	3917	14	279.7857143	0.058973704	0.005871841	16.5	1.642857143
New_Delhi_Zone	Headquaters	0	0	2	2	1	0	0	0	0
New_Delhi_Zone	J.R. Road	55	151	3635	14	259.6428571	0.041540578	0.015130674	10.78571429	3.928571429
New_Delhi_Zone	Laxmi Nagar	2	57	2386	14	170.4285714	0.023889355	0.000838223	4.071428571	0.142857143
New_Delhi_Zone	Mandavali Mayur Vihar	14	182	4328	14	309.1428571	0.042051756	0.00323475	13	1
New_Delhi_Zone	Pai Walan	9	63	1970	14	140.7142857	0.031979695	0.004568528	4.5	0.642857143
New_Delhi_Zone	Rakab Ganj	0	19	693	14	49.5	0.027417027	0	1.357142857	0
New_Delhi_Zone	S.P.M. Marg	20	81	2933	14	209.5	0.027616775	0.006818957	5.785714286	1.428571429
New_Delhi_Zone	Shahadara	18	147	3179	14	227.0714286	0.046240956	0.005662158	10.5	1.285714286
New_Delhi_Zone	Shastri Park	23	267	3951	14	282.2142857	0.067577828	0.005821311	19.07142857	1.642857143
New_Delhi_Zone	Tahirpur	42	203	2985	12	248.75	0.0680067	0.014070352	16.91666667	3.5
New_Delhi_Zone	Teliwara	5	21	919	14	65.64285714	0.022850925	0.005440696	1.5	0.357142857
South_West_Zone	Dwarka	17	136	4417	14	315.5	0.030790129	0.003848766	9.714285714	1.214285714
South_West_Zone	Hari Nagar	9	62	2907	12	242.25	0.021327829	0.003095975	5.166666667	0.75
South_West_Zone	Janakpuri	36	358	8341	14	595.7857143	0.042920513	0.004316029	25.57142857	2.571428571
South_West_Zone	Najaf Garh	15	105	4235	14	302.5	0.024793388	0.003541913	7.5	1.071428571
South_West_Zone	Naraina	5	52	1621	14	115.7857143	0.032078964	0.003084516	3.714285714	0.357142857
South_West_Zone	Prasad Nagar	20	138	3924	14	280.2857143	0.035168196	0.00509684	9.857142857	1.428571429
South_West_Zone	Shanker Road	7	52	2116	14	151.1428571	0.024574669	0.003308129	3.714285714	0.5
South_Zone	Bhikaji Cama Place	24	201	5828	14	416.2857143	0.034488675	0.004118051	14.35714286	1.714285714
South_Zone	Chanakya Puri	21	114	2750	14	196.4285714	0.041454545	0.007636364	8.142857143	1.5
South_Zone	Mathura Road	34	188	5164	14	368.8571429	0.036405887	0.006584043	13.42857143	2.428571429
South_Zone	Okhla	2	45	773	14	55.21428571	0.058214748	0.002587322	3.214285714	0.142857143
South_Zone	Okhla Phase1	23	258	2403	14	171.6428571	0.107365793	0.009571369	18.42857143	1.642857143
South_Zone	Rashtrapati Bhawan	0	0	85	14	6.071428571	0	0	0	0
South_Zone	Safdarjung	20	135	3931	14	280.7857143	0.034342407	0.005087764	9.642857143	1.428571429
South_Zone	Sarita Vihar	24	112	2160	12	180	0.051851852	0.011111111	9.333333333	2
West_Zone	Badli	0	12	110	14	7.857142857	0.109090909	0	0.857142857	0
West_Zone	Bawana	12	49	2574	14	183.8571429	0.019036519	0.004662005	3.5	0.857142857
West_Zone	Bhor Garh	11	95	2739	14	195.6428571	0.034684191	0.004016064	6.785714286	0.785714286
West_Zone	DSIDC BAWANA	22	107	1853	12	154.4166667	0.057744199	0.011872639	8.916666667	1.833333333
West_Zone	Jahangir Puri	41	260	6067	14	433.3571429	0.042854788	0.00675787	18.57142857	2.928571429
West_Zone	Jawalapuri	40	218	4263	14	304.5	0.051137696	0.009383064	15.57142857	2.857142857
West_Zone	Jwalaheri	1	6	627	12	52.25	0.009569378	0.001594896	0.5	0.083333333
West_Zone	Keshavpuram	32	163	6367	14	454.7857143	0.025600754	0.005025915	11.64285714	2.285714286
West_Zone	Kirti Nagar	6	62	1814	14	129.5714286	0.034178611	0.003307607	4.428571429	0.428571429
West_Zone	Mangolpuri Ph 2	20	116	1876	12	156.3333333	0.061833689	0.010660981	9.666666667	1.666666667
West_Zone	Moti Nagar	24	166	4432	14	316.5714286	0.037454874	0.005415162	11.85714286	1.714285714
West_Zone	Narela	6	87	2032	14	145.1428571	0.042814961	0.002952756	6.214285714	0.428571429
West_Zone	Paschim Vihar	3	17	1167	14	83.35714286	0.014567266	0.002570694	1.214285714	0.214285714
West_Zone	Roop Nagar	28	265	8305	14	593.2142857	0.031908489	0.003371463	18.92857143	2
West_Zone	Sector 16 Rohini	17	153	3428	12	285.6666667	0.044632439	0.00495916	12.75	1.416666667
West_Zone	Sector-5 Rohini	47	407	8522	14	608.7142857	0.047758742	0.005515137	29.07142857	3.357142857
West_Zone	Tikri	3	26	579	12	48.25	0.044905009	0.005181347	2.166666667	0.25
West_Zone	Wazirpur	14	154	3504	14	250.2857143	0.043949772	0.003995434	11	1

Fig. 11

We see that highest risk to death in J.R. road area(3.92 deaths/year) and in Sector-5 Rohini (3.35 deaths/year)
Highest risk to injuries in Sector-5 Rohini (29.07 injuries/year), Janakpuri (25.57 injuries/year).
Similarly we can get risk values for all the areas in different zones of delhi.


fire risk to deaths
deaths/year
0
2
4
6
8
10
12
CBD SHAHDARA
Connaught Circus
Darya Ganj
Geeta Colony
Gokul Puri
J.R. Road
Laxmi Nagar
Mandavali Mayur Vihar
Pai Walan
Rakab Ganj
S.P.M. Marg
Shahadara
Shastri Park
Tahirpur
Teliwara
Dwarka
Hari Nagar
Janakpuri
Najaf Garh
Naraina
Prasad Nagar
Shanker Road
Bhikaji Cama Place
Chanakya Puri
Mathura Road
Okhla
Okhla Phase1
Safdarjung
Sarita Vihar
Badli
Bawana
Bhor Garh
DSIDC BAWANA
Jahangir Puri
Jawalapuri
Jwalaheri
Keshavpuram
Kirti Nagar
Mangolpuri Ph 2
Moti Nagar
Narela
Paschim Vihar
Roop Nagar
Sector 16 Rohini
Sector-5 Rohini
Tikri
Wazirpur
New_Delhi_Zone
South_West_Zone
South_Zone
West_Zone
Axis Title

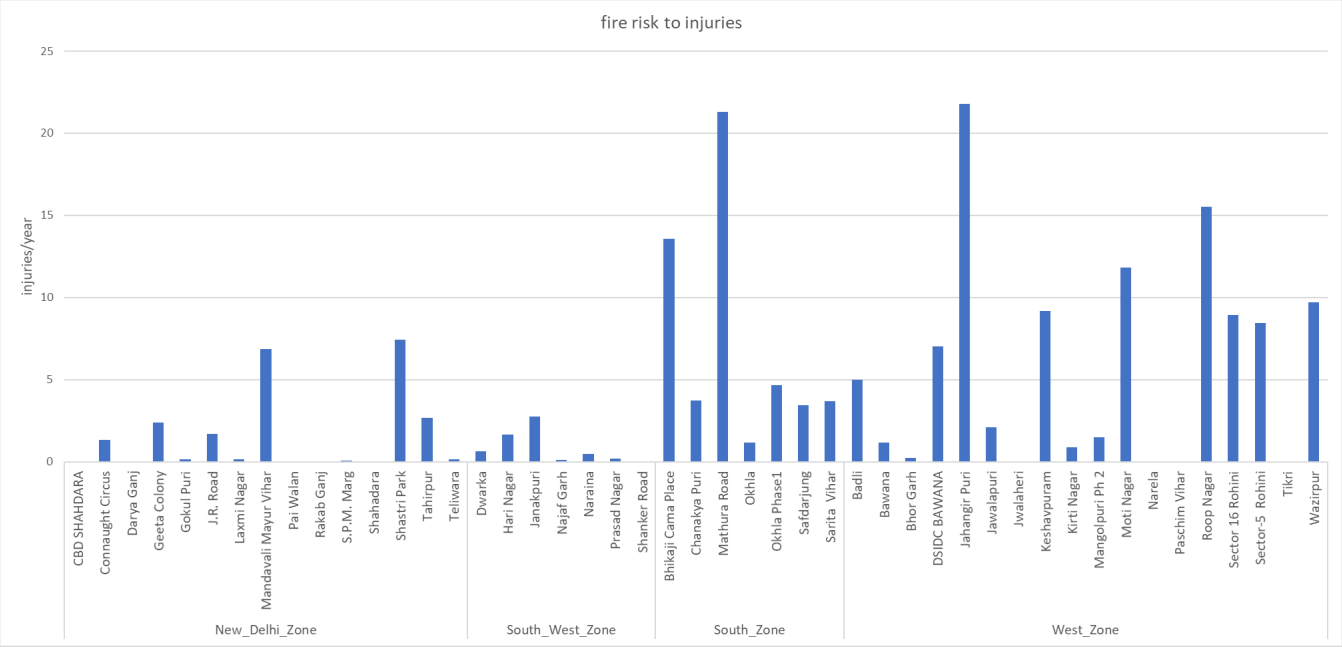
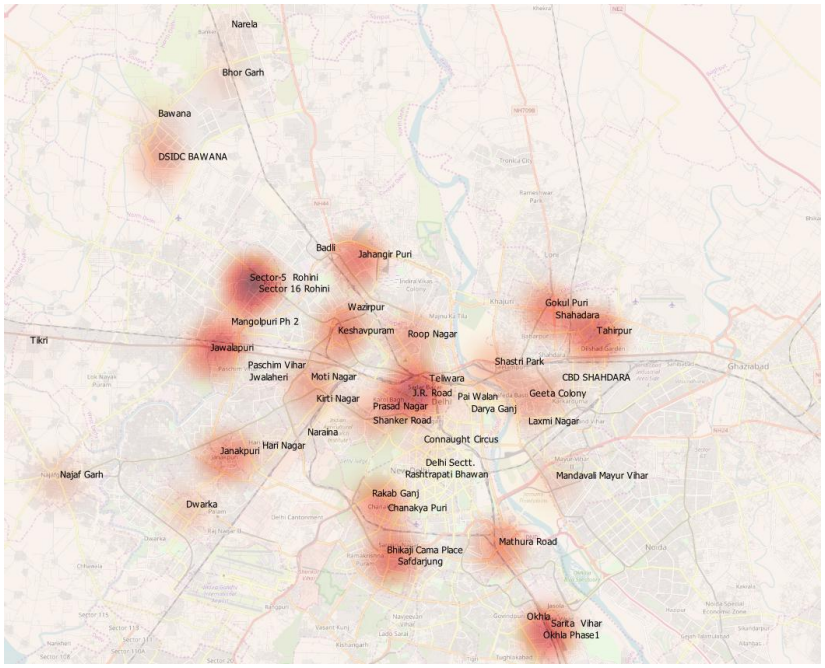

fire risk to injuries
injuries/year
0
5
10
15
20
25
CBD SHAHDARA
Connaught Circus
Darya Ganj
Geeta Colony
Gokul Puri
J.R. Road
Laxmi Nagar
Mandavali Mayur Vihar
Pai Walan
Rakab Ganj
S.P.M. Marg
Shahadara
Shastri Park
Tahirpur
Teliwara
Dwarka
Hari Nagar
Janakpuri
Najaf Garh
Naraina
Prasad Nagar
Shanker Road
Bhikaji Cama Place
Chanakya Puri
Mathura Road
Okhla
Okhla Phase1
Safdarjung
Sarita Vihar
Badli
Bawana
Bhor Garh
DSIDC BAWANA
Jahangir Puri
Jawalapuri
Jwalaheri
Keshavpuram
Kirti Nagar
Mangolpuri Ph 2
Moti Nagar
Narela
Paschim Vihar
Roop Nagar
Sector 16 Rohini
Sector-5 Rohini
Tikri
Wazirpur
New_Delhi_Zone
South_West_Zone
South_Zone
West_Zone

Fig. 12

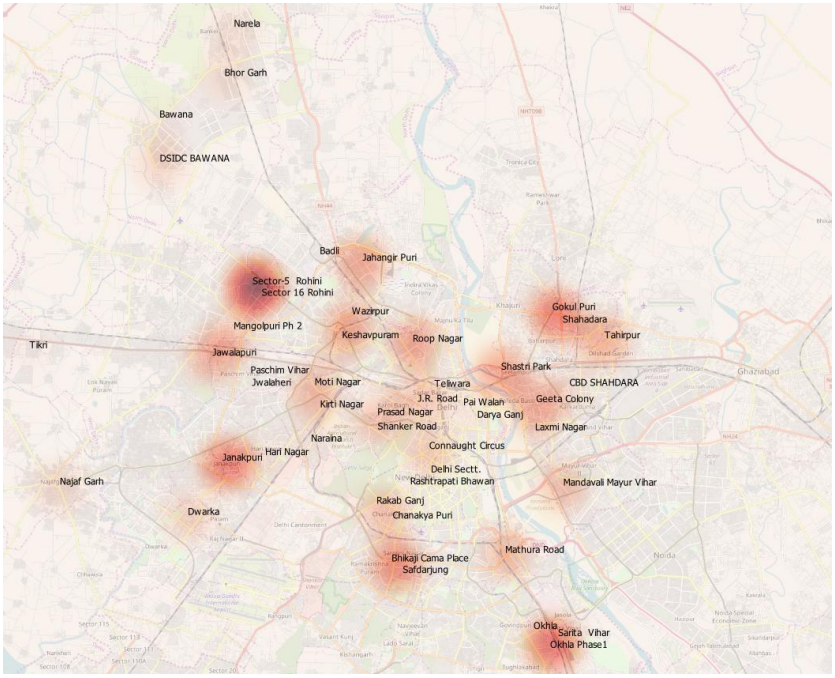
• • •

Risk Heatmap in shown below for Delhi for both injuries and deaths.

Fire Risk to Deaths Heatmap



Fire Risk to injuries heatmap



Event tree diagram Analysis

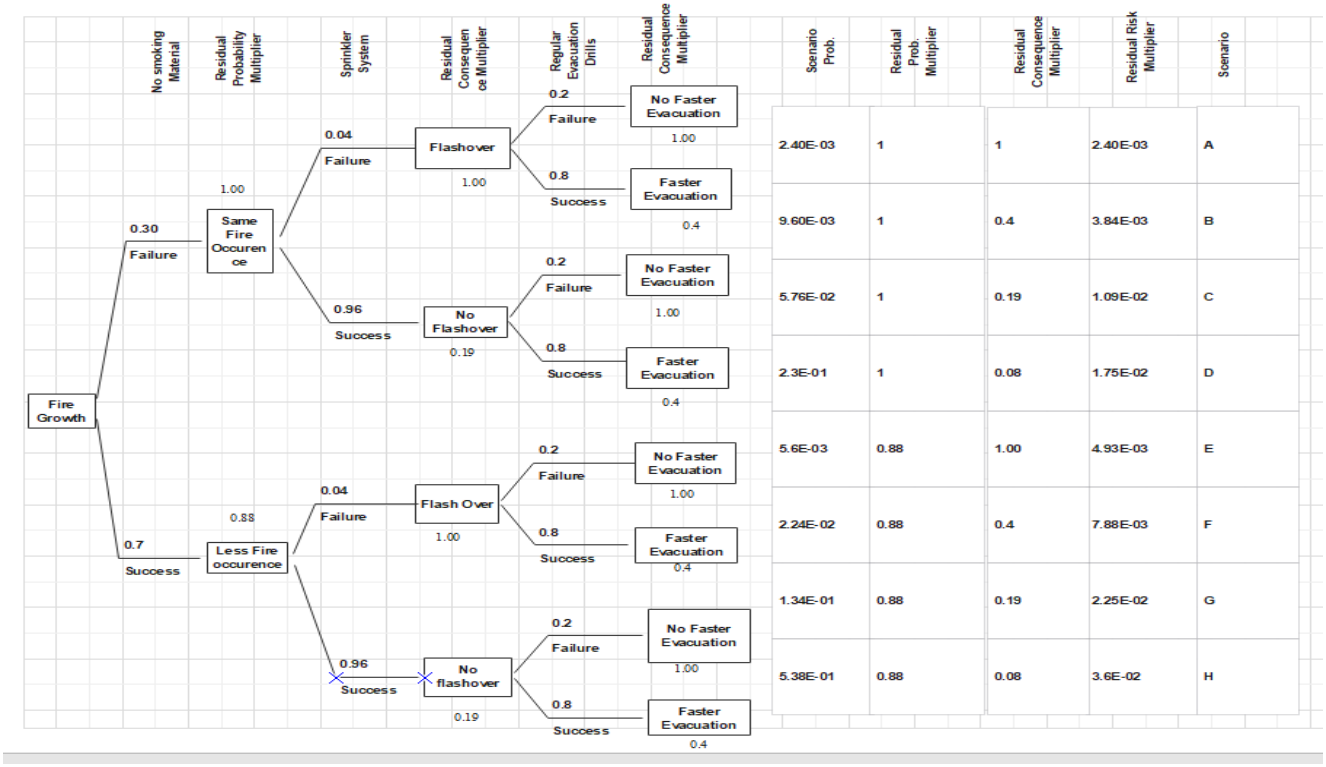
The event tree method involves the construction of an event tree of various fire scenario subsequent to the initiation of fire hazard. The fire scenario provides more logical information for the judgement or probability, consequence and risk values. A complete fire risk assessment would involve the identification of all potential fire hazards and the consideration of various protection measures to minimize risk.

Given below is an event tree diagram for an apartment building having three additional fire protection measure;1. No smoking material 2. Sprinkler system 3. Evacuation drills.

There are total 8 fire scenario, for example scenario A has a probability of 2.4E-03, the impact of each of the fire protection measures on the inherent rate of fire occurrence is assessed using a residual probability multiplier.

Some of these residual probability multipliers can be obtained from statistics, if they are available. If no such information is available, then subjective judgment may be required. For example, there is no statistical information that can be easily found on the reduction of fire occurrence of implementing a ‘no smoking material’ plan for apartment buildings. Without such statistical information, we have to make an assumption.

Similarly residual consequence multiplier is used to measure impact of fire protection measure on inherent consequence.



Conclusion

In this study, we tried to get inferences from fire report data and calculated fire risk to physical consequences such as deaths and injuries. Our main aim is to identify which type of buildings are more risks prone to fire in Delhi and which areas are mostly affected in context of physical consequences and more prone in context of fire occurrences. We also identified the seasonal variation of fire calls.

Due to covid19 pandemic we could not perform safety measurement audit in various type of buildings in Delhi. Further scope of this study is to use this statistical analysis with safety measurement audit in different type of buildings to perform risk assessment for different type of buildings. One can adopt event-tree analysis for the same.

References

1. Yung, David Tin Lam. (2008), Principles of fire risk assessment in buildings, John Wiley & Sons, Ltd