Coursera IBM Capstone Project

Hospital Coverage for Traffic Collisions in Los Angeles

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Project Introduction

Problem Background

- Victims of traffic accidents need to be quickly taken to the nearest hospital
- Any individual hospital can provide timely health services only to accident victims located within a coverage radius of 10 to 12 km around it. The hospital coverage zone can be visualized as a circle with the hospital at the centre and radius as coverage radius, which is set at a distance of 12 km for the purpose of this analysis .
- **Having a hospital nearby the accident location can be the crucial difference between life and death**
- Assuming that Los Angeles city administration wants to open a few new hospitals for catering to traffic collision victims, this analysis aims to identify the optimum locations in order minimize hospital coverage gaps

Scope, Target Audience and Assumptions

- **Scope** : Analysis is **limited to the city of Los Angeles**
- **Target Audience**: **Local Administration of Los Angeles City and Private Players interested in opening new hospitals in LA**
- **Assumptions**: Resources like funds, space along with necessary permissions are assumed to be available for opening few new hospitals at proposed locations. It is assumed that future traffic collisions will follow similar pattern as last four years.

Objective

- **Visualize last few year's traffic collision history in Los Angeles**
  - ➤ Do the central regions of the city have higher intensity of accidents than the outskirts?
- **Identify the hospital coverage gaps**
  - ➤ What percentage of recent traffic accidents occurred too far from the nearest hospital (outside hosp. coverage zones)?
- **Provide policy recommendations to Los Angeles administration**
  - ➤ If the LA city administration can afford to open a few new hospitals, where should they be located in order to minimize the hospital coverage gaps?
  - ➤ How many hospitals would need to be opened and where for reaching coverage target of (i)85%? and (ii)90%?
  - ➤ If the administration has resources to open 3 new hospitals, what coverage level can be achieved?

Data (1/3)

What data is required for this project?

- Location data of last few year's traffic collisions in Los Angeles city (2016 onwards)
- Location of hospitals in Los Angeles city

Data Sources

- **Traffic Collision History**
  - Public Dataset : Available from below link
    https://data.lacity.org/

- **Hospital Locations**
  - Foursquare API: The city is divided into search zones and browse for hospitals at each zone
  - Public Dataset: Available from below link
    https://hub.arcgis.com/datasets/lacounty::hospitals-and-medical-centers
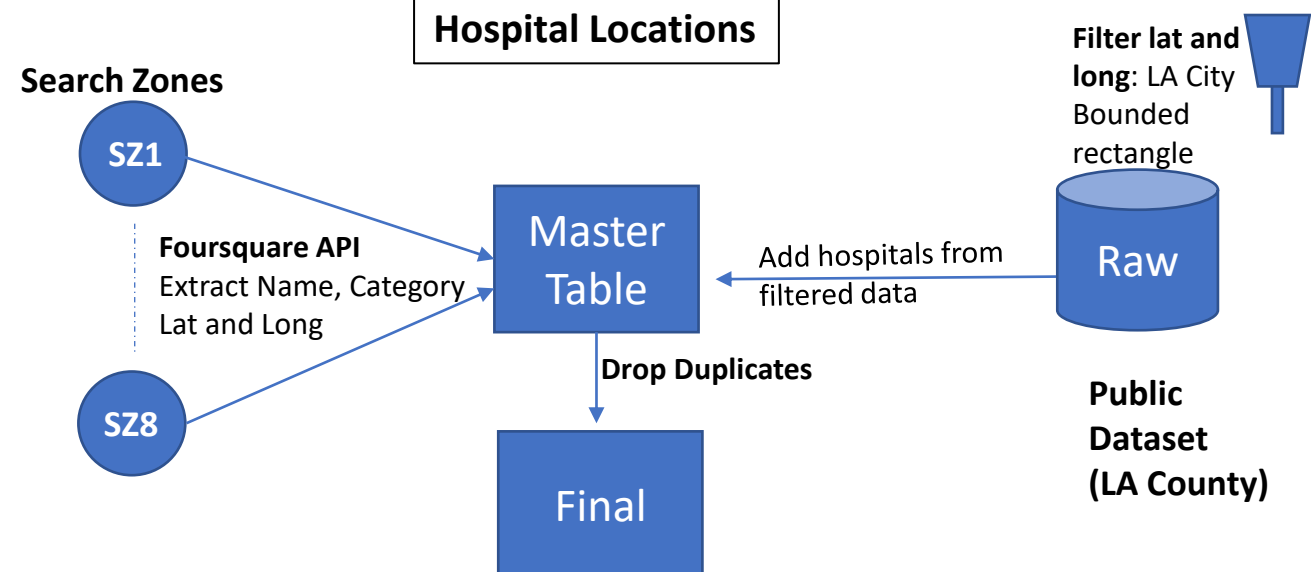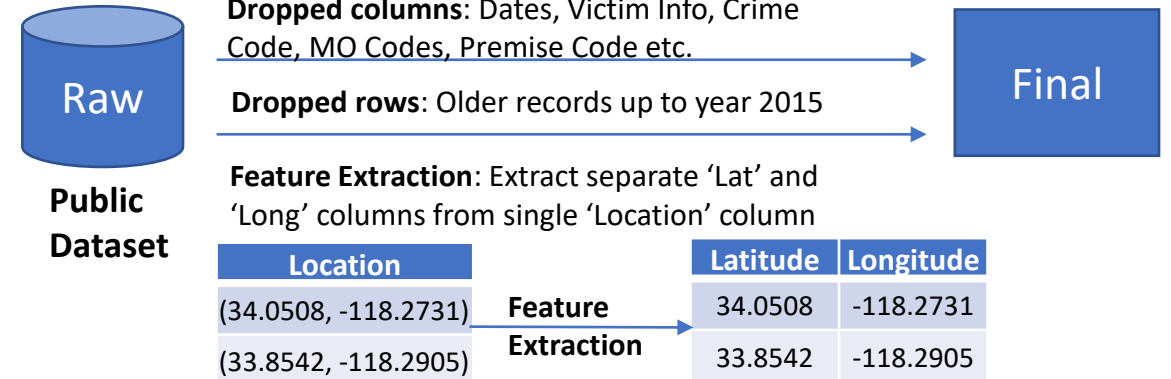
Data (2/3)

Data Processing Methodology

Traffic Collision History

- Dropped: Older records up to year 2015
- Dropped: Most columns like accident date, victim details along with rows outside LA city limits
- Latitude and Longitude are extracted to separate columns from a single column in the raw data

Hospital Locations

- The city is divided into 8 search zones. Each search zone is a circle with radius 30 km. The centres of these search zones are set through trial and error using visual inspection of the map.
- Foursquare API is used to browse for hospitals at each search zone. The API limits the results per zone to max 50.
- The results from all the search zones are aggregated into a single hospital master table with removal of duplicates.
- The public dataset lists hospitals from all cities in LA county. Hospitals are added to the master table using the public dataset, after limiting results by filtering latitude and longitude to get a bounded rectangle encompassing LA city.
- Duplicates are removed to get the final table

Traffic Collision History

Raw — **Public Dataset**

Dropped columns: Dates, Victim Info, Crime Code, MO Codes, Premise Code etc. → **Final**

Dropped rows: Older records up to year 2015 →

Feature Extraction: Extract separate 'Lat' and 'Long' columns from single 'Location' column

Location		Latitude	Longitude
(34.0508, -118.2731)	Feature Extraction →	34.0508	-118.2731
(33.8542, -118.2905)		33.8542	-118.2905

Hospital Locations

Search Zones

SZ1 → **Master Table**

Foursquare API Extract Name, Category Lat and Long

SZ8 →

Filter lat and long: LA City Bounded rectangle

Add hospitals from filtered data ← **Raw** — **Public Dataset (LA County)**

Drop Duplicates ↓

Final

4

Data (3/3)

Sample Final Data after Processing

Traffic Collision History

	Area Name	Address	Cross Street	Latitude	Longitude
1	Rampart	UNION	JAMES M WOOD	34.0508	-118.273
2	Harbor	VERMONT	KNOX	33.8542	-118.291
3	Hollywood	FRANKLIN AV	ARGYLE	34.1052	-118.325
4	Southwest	LA BREA AV	JEFFERSON BL	34.0255	-118.3548

Hospital Locations

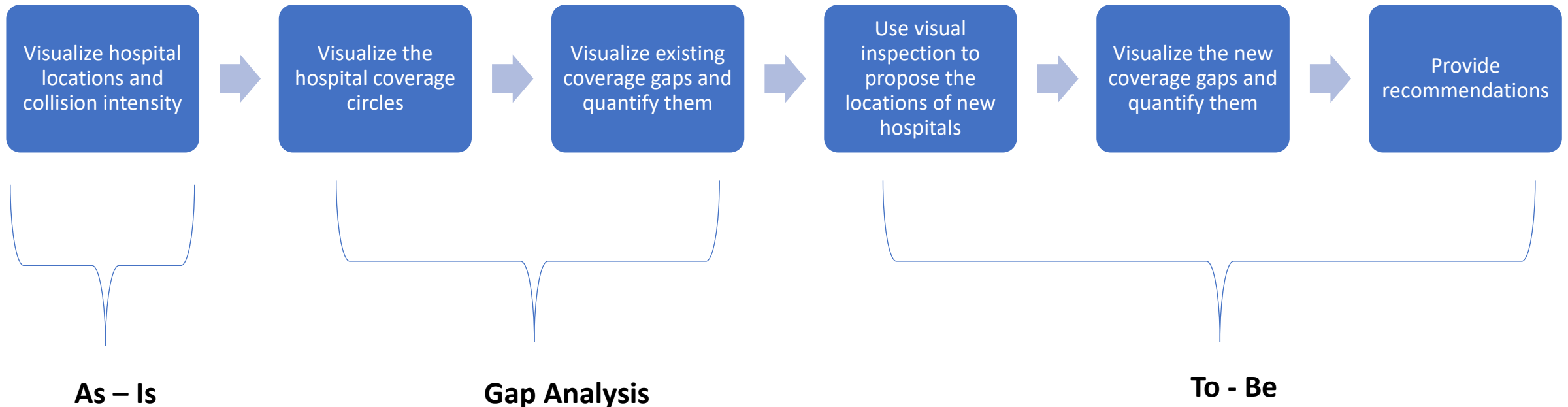|	Name	Category	Lat	Long
1	Ronald Reagan UCLA	Hospital	34.0665	-118.4465
2	Healthline Medical Group / Urgent Care	Urgent Care Center	34.1945	-118.4642
3	Santa Monica UCLA	Hospital	34.0272	-118.4865
4	Sherman Oaks Hospital	Hospital	34.1603	-118.4495

Methodology

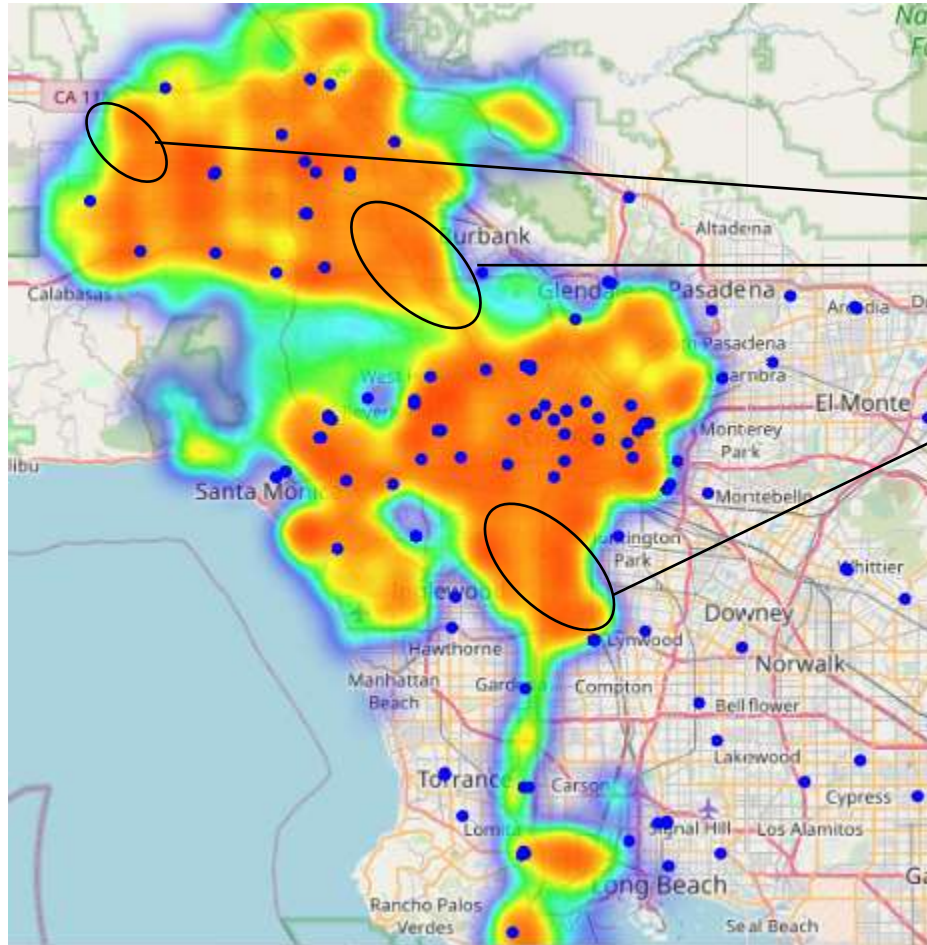**How is the data used to solve the problem?**

- Machine learning algorithms like regression and classification are not required for solving this problem
- The problem is solved using a combination of visual inspection and quantification of coverage/coverage gaps
- Folium library is used for map visualization and extracting coordinates of any location from the map
- The objects used for quantification include GeoDataFrames and MultiPolygon objects which are applied to the historical traffic collision data superimposed on the hospital locations
- Need to set appropriate coordinate reference systems to correctly calculate location within coverage zone and visualization on the map

Steps Followed

Visualize hospital locations and collision intensity → Visualize the hospital coverage circles → Visualize existing coverage gaps and quantify them → Use visual inspection to propose the locations of new hospitals → Visualize the new coverage gaps and quantify them → Provide recommendations

As – Is

Gap Analysis

To - Be

Results (As Is)

High intensity collision patches without hospitals

Blue dots denote hospital locations and the heatmap shows the intensity of traffic collisions (orange is the highest intensity)

It can be seen that collision intensity tends to higher in the central regions as compared to the outskirts

Results (Gap Analysis)

Visualize hospital coverage circles and existing coverage gaps
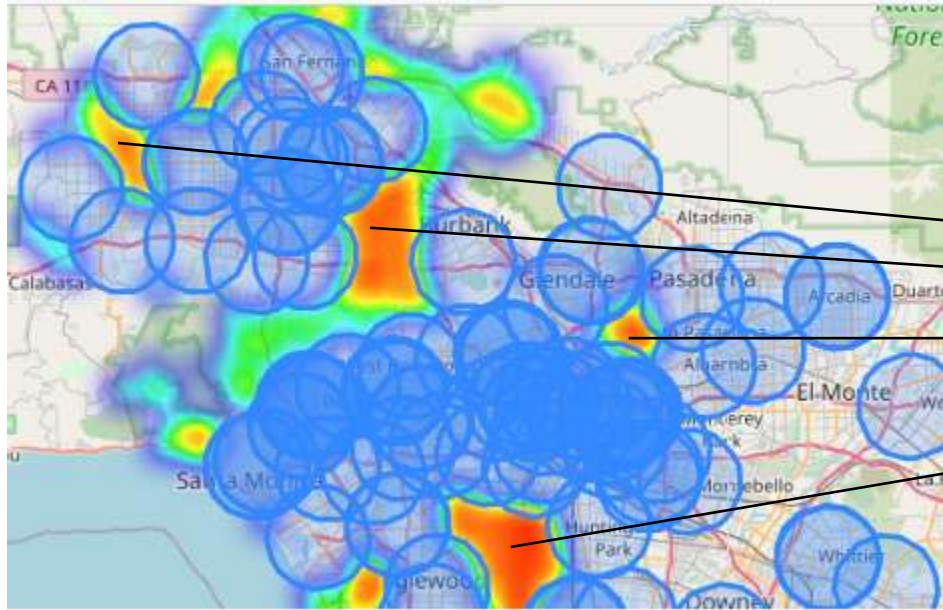
More accurate representation of gaps after incorporating existing hospital coverage circles

Coverage radius of an individual hospital is set at 12 kilometres. Blue circles denote the coverage of an individual hospital.

Existing Hospital Coverage = 81% and Coverage Gap = 19%
In other words, 19% of traffic accidents occurred more than 12 kms away from any existing hospital.

To Be (Proposed Solution)

Propose new hospital locations and quantification of their impact
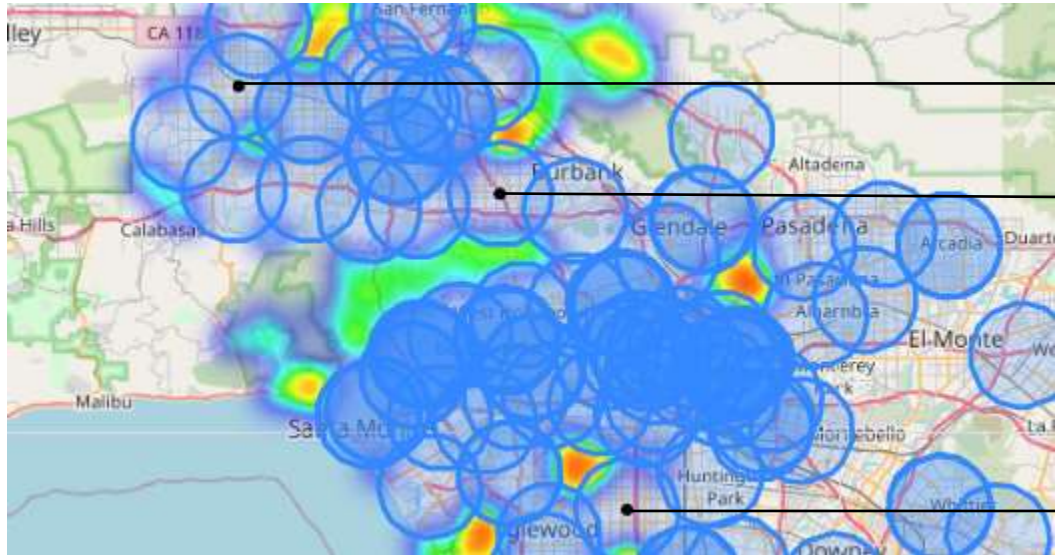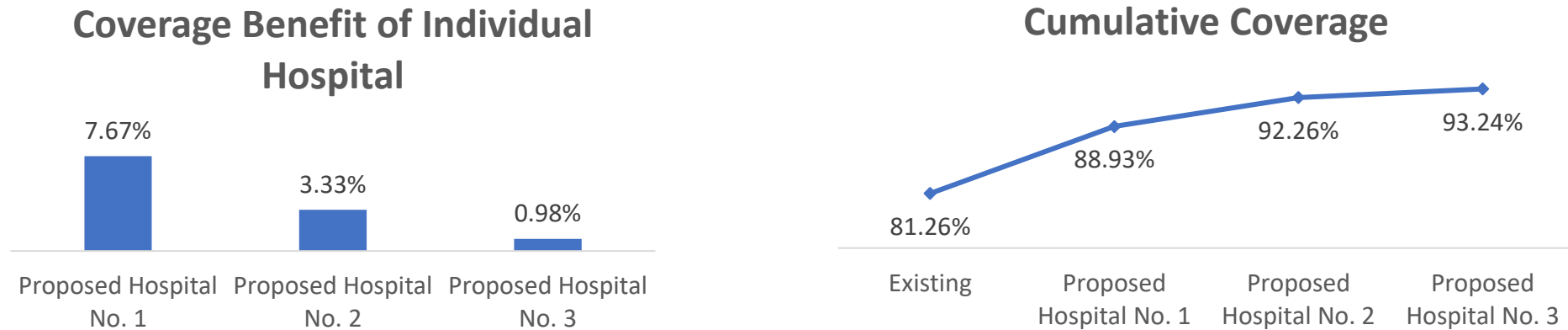

Proposed Hospital No. 3
(Lat: 34.2356, Long: -118.5864)

Proposed Hospital No. 2
(Lat: 34.1674, Long: - 118.3859)

Proposed Hospital No. 1
(Lat: 33.9672, Long: -118.2884)

Adding the 3 proposed hospitals increases the coverage from 81% to 93%
(assuming that future traffic collisions follow similar pattern as the last 4 years)

Discussion

What is the contribution of each proposed hospital to the overall coverage?

Coverage Benefit of Individual Hospital

	7.67%	3.33%	0.98%
	Proposed Hospital No. 1	Proposed Hospital No. 2	Proposed Hospital No. 3

Cumulative Coverage

Existing	Proposed Hospital No. 1	Proposed Hospital No. 2	Proposed Hospital No. 3
81.26%	88.93%	92.26%	93.24%

Hospital No. 1 provides the most coverage benefit and we see diminishing returns with further additions

Funding Options

- Proposed Hospital No. 1 and Hospital No. 2 are located in relatively central areas of the city

- The health needs of residents nearby to Proposed Hospital No. 1 and No. 2 are unfulfilled currently, as there are no hospitals nearby

- Both these hospitals are likely to be commercially viable for private players, as they can cater to all the basic health needs of nearby residents (not just limited to accident victims).

- Proposed Hospital No. 3 is situated at the outskirts, so may not be commercially viable for private players

- The local administration can choose to fund a smaller scale hospital for Proposed Hospital No. 3

Recommendations

If the target is to achieve 85% coverage:

- **Building Proposed Hospital No. 1 is enough** to surpass the 85% coverage target

- It can be built preferably through private players with city administration role limited to ensuring availability of space and permissions

- In case private funding cannot be secured, local administration resources should be prioritized for this hospital

- Proposed Hospital No. 1 can be full scale hospital catering to all basic health needs of nearby residents

If the target is to achieve 90% coverage:

- **Build Proposed Hospital No. 1 and Proposed Hospital No. 2**, preferably funded and operated by private players

- Both these can be full scale hospitals catering to all basic health needs of nearby residents

- In case private funding cannot be secured, local administration resources should be prioritized for proposed No. 1, then No. 2

If 3 new hospitals can be built:

- **Coverage level of 93.24 % can be achieved with 3 new hospitals**

- Proposed Hospitals No. 1 and 2 can be full scale hospitals, built preferably through private players

- Proposed Hospital No. 3 can be smaller scale and may need to be built through public-private partnership or fully public owned

- In case private funding cannot be secured, local administration resources should be prioritized according to the hospital number

Not recommended to add more than 3 hospitals in order to make judicious use of public resources

Conclusion

Final Remarks

- Considering recent historical collision data from 2016, existing hospitals offer a coverage for 81% of the collisions

- Thus **19% of recent collisions occurred more than 12 km away from the nearest hospital**

- Collision intensity tends to be higher in the central city regions as compared to the outskirts

- Assuming that future traffic collisions will also follow a similar pattern as recent years - **Adding just one hospital can improve the coverage to 89%, adding two can lead to 92% and adding 3 can lead to 93% coverage**

- The locations of the proposed hospitals are Proposed Hospital No. 1 (Lat: 33.9672, Long: -118.2884), Proposed Hospital No. 2 (Lat: 34.1674, Long: - 118.3859) and Proposed Hospital No. 3 (Lat: 34.2356, Long: -118.5864). Slight deviations from the target locations (within 500 metres) should still give similar results.

- New Hospitals must be **prioritized in the order of their individual coverage benefit**. Hence No. 1 has the top priority and No. 3 has last

- The local administration must seek **private ownership model** to conserve its resources. **Proposed Hospitals No. 1 and No.2** are attractive candidates, being located in relatively central regions of the city and their services will not be limited to traffic collisions only

- **Proposed Hospitals No. 1 and No. 2 can be full scale hospitals** catering to all the basic health needs of the nearby residents

- Being located towards the outskirts, **Proposed Hospital No. 3 can be a smaller scale hospital** and can be funded through public – private partnership model or fully public owned

- It is not recommended to add more than 3 hospitals in order to make judicious use of public resources

End of Presentation