

ASSESSING SAFETY LEVEL OF BUS STOPS IN THE ABSENCE OF CRASH DATA

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Objective:

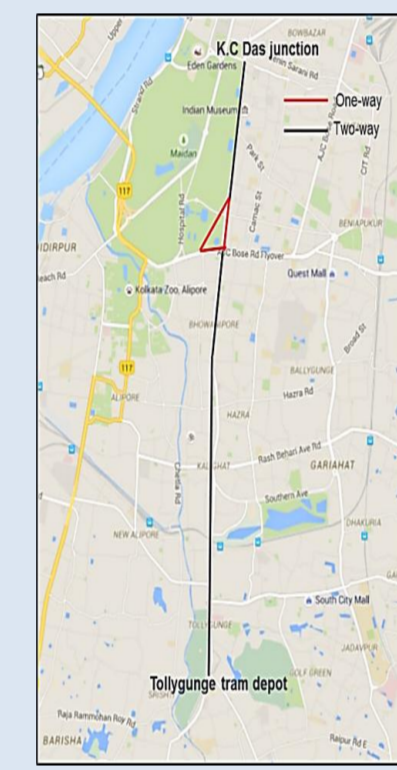
- Development of a methodology to assess the safety level of bus stops in the absence of crash data

Motivation

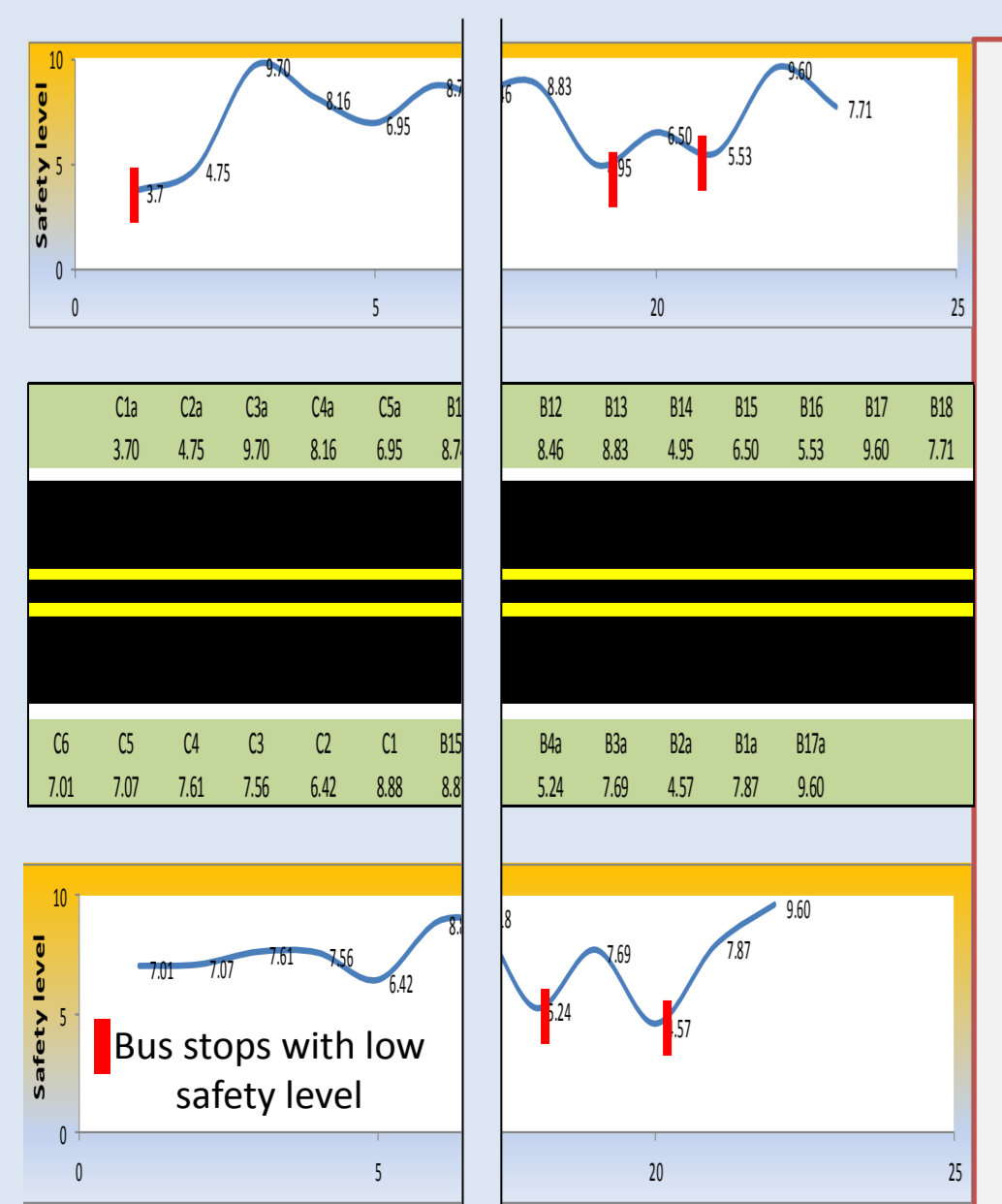
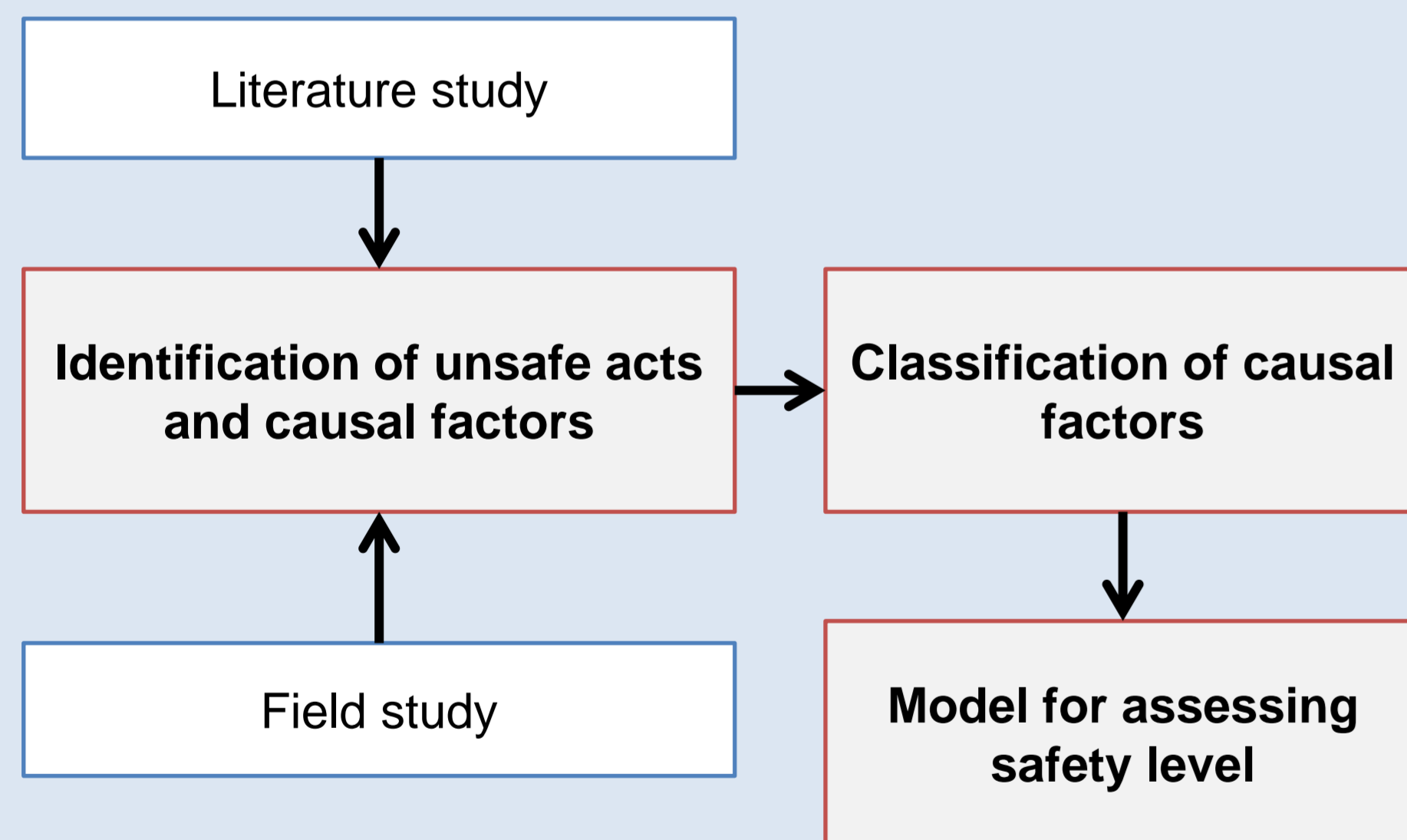
- Bus stops act as interfaces where the pedestrians interact with transit vehicles
- Safety level of bus stops in urban India have declined significantly due to the absence of necessary design and management measures
- It is essential to develop a methodology to prioritize bus stops, so as to carry out safety improvement works in different phases
- Availability of reliable and comprehensive accident database is highly limited in emerging countries
- Therefore, it is necessary to develop a methodology to prioritize the bus stops in terms of safety in the absence of crash data

Study Area

- A corridor of 8.2 km in Kolkata city, India is selected for application
- Corridor includes 45 bus stops



Methodology

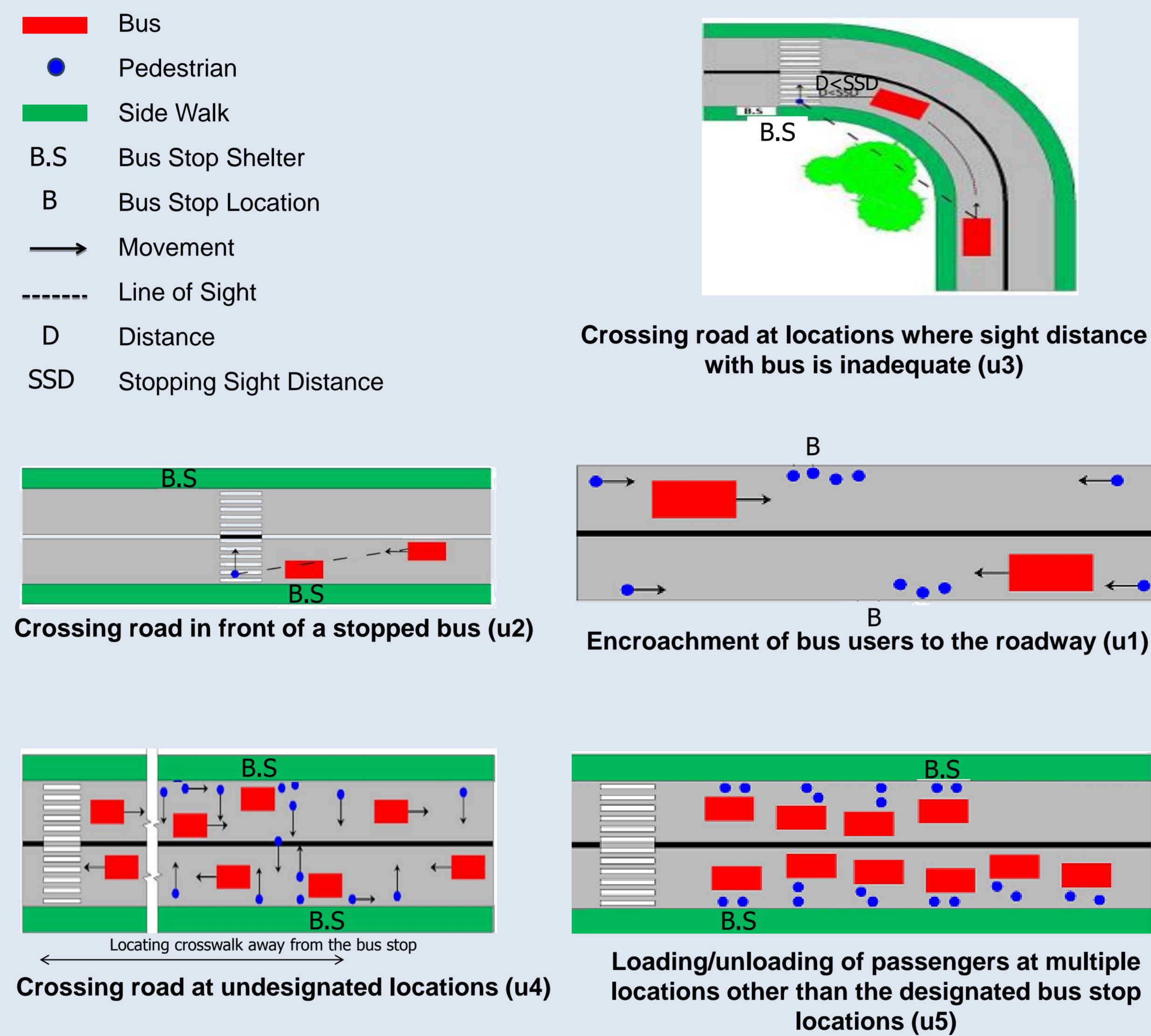


Prioritization of bus stops

Obtaining x_i by field investigation and calculation of safety level

Establishing w_i by expert survey

Unsafe Acts and Causal Factors



Classification of causal factors

| Facilities | Characteristics | Design deficiency | Resulting Unsafe Act | Resulting Unsafe Act | Management deficiency | Management | Facilities |
|---------------------|---------------------|---|----------------------|----------------------|---------------------------------------|-------------|--------------|
| Waiting area | Capacity | Inadequate Waiting area | u1 | u1 | Physical obstruction | Maintenance | Waiting area |
| | Location | Inadequate distance from intersection | u1 | u1 | Water logging | Enforcement | |
| | | Near side of intersection | u2 | u1 | Dirty surroundings | | |
| | | Immediately after a curve/ at the crest of hill | u3 | u4 | On-street Parking | | Maintenance |
| | Supporting Elements | Absence of lighting | u3 | u4 | Vehicle not stopping before crosswalk | | |
| Cross Walk | Capacity | Inadequate width | u4 | u1 | Physical obstruction | Maintenance | Sidewalk |
| | Location | Too far from bus stop | u4 | u1 | Patches and potholes | | |
| | | Far side of Loading area | u2 | u1 | untidy surroundings | | |
| Supporting Elements | Absence of lighting | u3 | u1 | Sidewalk Parking | Enforcement | | |
| Supporting Elements | Absence of drainage | u1 | u5 | Hawkers and vendors | | Maintenance | Loading area |
| Side Walk | Capacity | Inadequate width | u1 | u1 | Waterlogging | | |
| | Supporting Elements | Absence of lighting | u1 | u5 | Unreasonably higher dwell time | | |
| Loading area | Capacity | Length not satisfying bus frequency | u5 | u5 | On-street Parking | Enforcement | |
| | Supporting Elements | Absence of lighting | u3 | u5 | Unreasonably higher dwell time | | |
| | | Absence of drainage | u5 | u5 | | | |

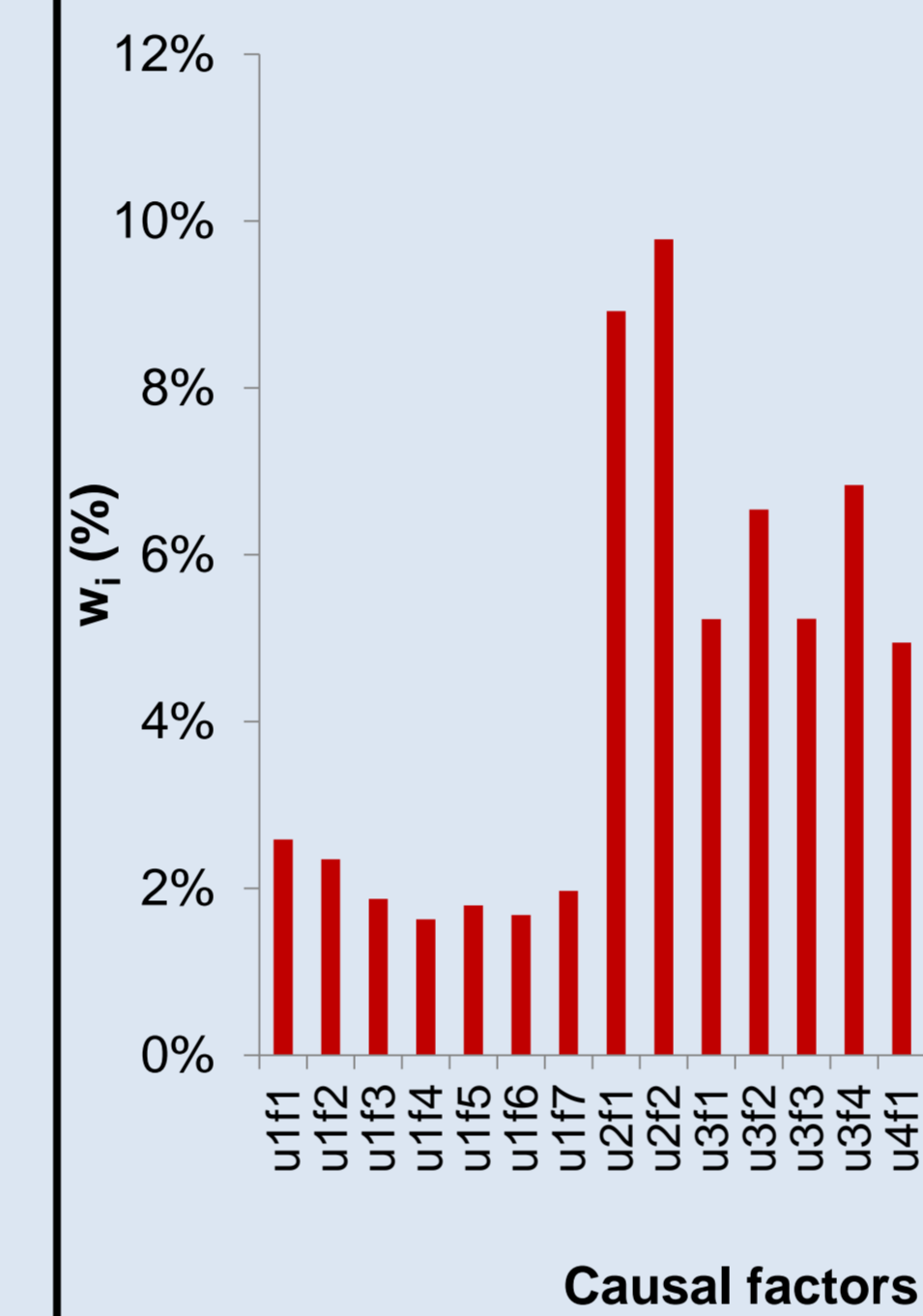
Model for Assessing Safety Level

$$S = 10(1 - \sum_{i=1}^n x_i * w_i)$$

- S = Safety Level of Bus stop
- X_i = Causal Factor
- W_i = Weightage of the Causal Factor

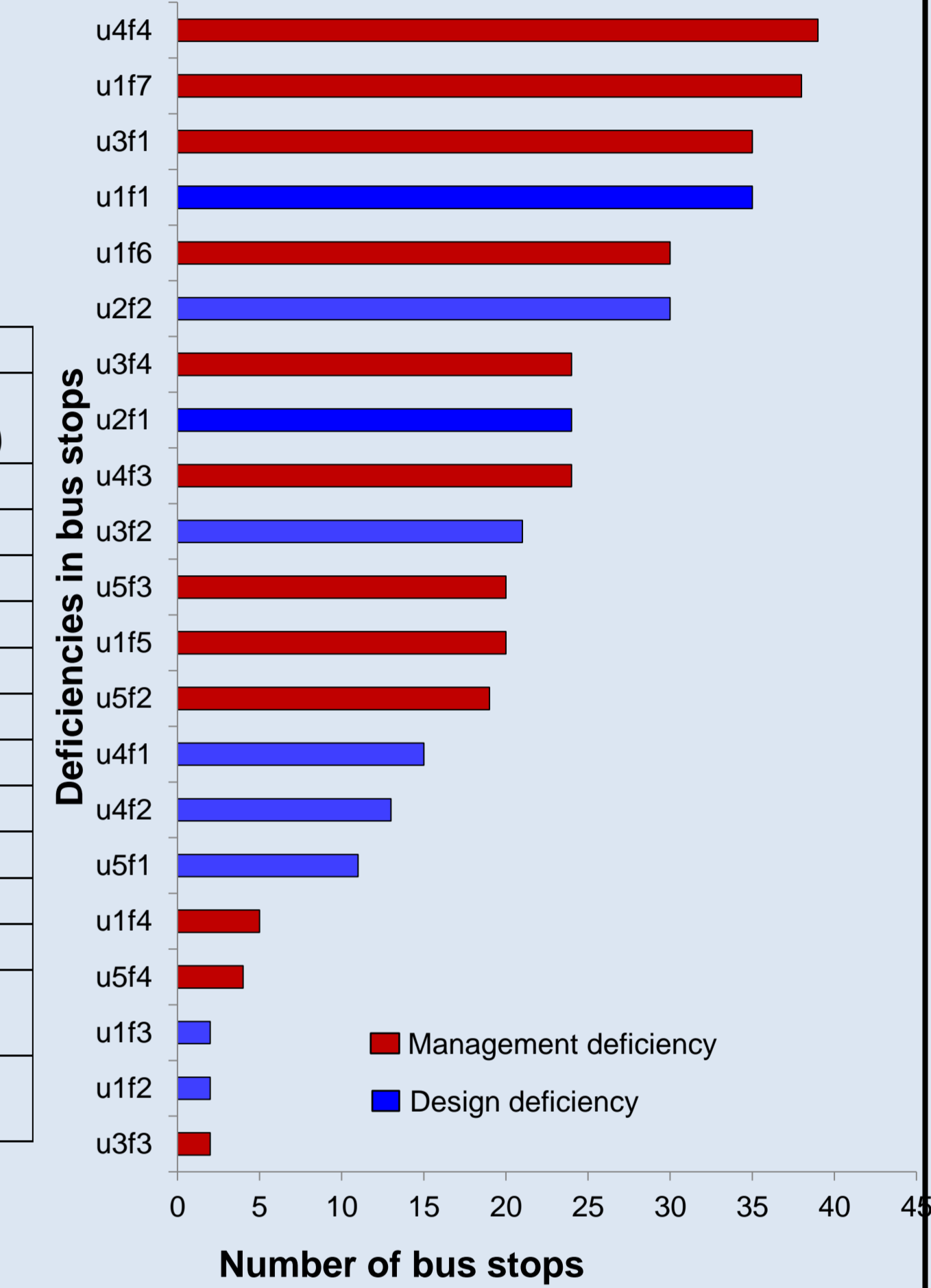
Results and Discussion

- Weightage of causal factor (w_i) = contribution index (c_i) x degree of danger (d_p)
- c_i and d_p were established using Analytical Hierarchy Process (AHP) and Rating technique respectively
- X_i values were obtained through field investigation

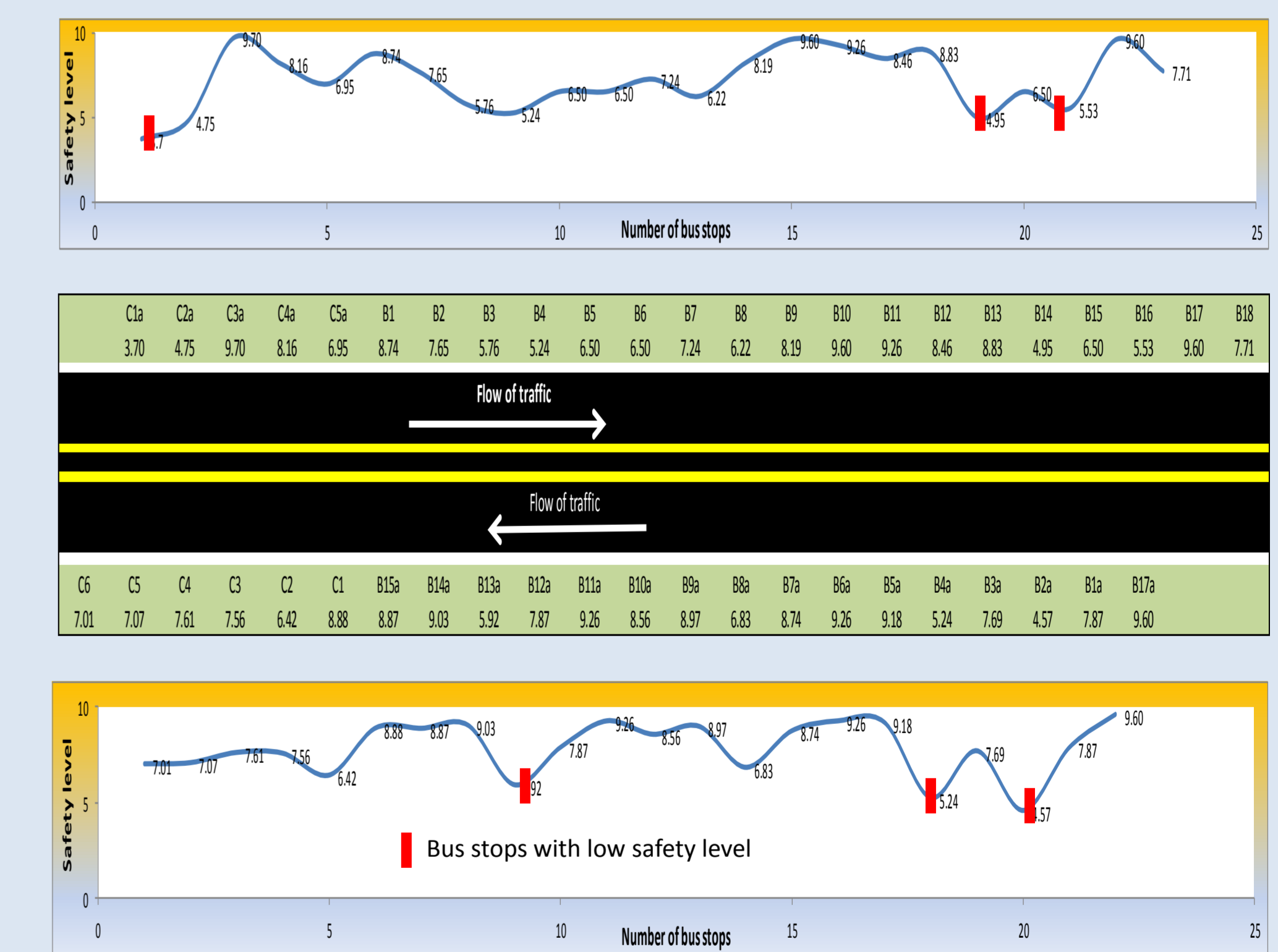


Example Sheet for Calculation of safety level

| Bus stop name: Charu market bus stop | | | | Landmark: SBI | | | |
|---|-------|-----------|-----------|----------------|-----------|-------|-----------|
| Causal factors | w_i | x_i | $w_i x_i$ | Causal factors | w_i | x_i | $w_i x_i$ |
| (a) | (b) | (a) * (b) | (a) | (b) | (a) * (b) | (a) | (b) |
| u1f1 | 0.026 | 1 | 0.026 | u3f3 | 0.052 | 1 | 0.052 |
| u1f2 | 0.023 | 1 | 0.023 | u3f4 | 0.068 | 1 | 0.068 |
| u1f3 | 0.019 | 0 | 0 | u4f1 | 0.049 | 0 | 0 |
| u1f4 | 0.016 | 0 | 0 | u4f2 | 0.083 | 1 | 0.083 |
| u1f5 | 0.018 | 0 | 0 | u4f3 | 0.073 | 0 | 0 |
| u1f6 | 0.017 | 0 | 0 | u4f4 | 0.102 | 1 | 0.102 |
| u1f7 | 0.020 | 1 | 0.020 | u5f1 | 0.035 | 0 | 0 |
| u2f1 | 0.089 | 1 | 0.089 | u5f2 | 0.035 | 0 | 0 |
| u2f2 | 0.098 | 1 | 0.098 | u5f3 | 0.028 | 0 | 0 |
| u3f1 | 0.052 | 0 | 0 | u5f4 | 0.031 | 0 | 0 |
| u3f2 | 0.065 | 1 | 0.065 | | | | |
| A = 0.321 | | | | B = 0.305 | | | |
| Safety level = $10 * (1 - (A + B)) = 10 * (1 - (0.321 + 0.305)) = 3.74$ | | | | | | | |



- Figure a, b, c (safety level 3.7, 4.3, 5.1 respectively) are the worst three bus stops in terms of safety level
- Figure d, e, f (safety level 9.7, 9.6, 9.6 respectively) are the best three bus stops in terms of safety level



Conclusions

- Most common deficiencies associated with bus stops are :
 - Vehicle not stopping at a safe distance from cross walk
 - Presence of street vendors along the sidewalk
 - On street parking near the bus stops
 - Absence of/inadequate waiting area
- Management deficiencies in and around the bus stops are dominant over design deficiencies
- Nearly 40% of the bus stops have a safety level less than 7.5