

**FEASIBLE STUDY FOR THE PROVISION OF PEDESTRIAN SKYWALK – A  
CASE STUDY ON KALUPUR STATION ROAD**Paras Rasadiya<sup>1</sup>, Ashok Patel<sup>2</sup>, Hardik Sukhadia<sup>3</sup><sup>1</sup> Civil Engineering Department, LDRP Institute of Technology and Research, Kadi Sarva Vishwavidhayala<sup>2</sup> Civil Engineering Department, LDRP Institute of Technology and Research, Kadi Sarva Vishwavidhayala<sup>3</sup> Civil Engineering Department, Sigma Group of Institute

**Abstract** - As a developing State, mixed flow of the Ahmadabad urban road traffic is most obvious characteristic at pedestrian crossing where conflicts between the pedestrians and motor vehicle occur frequently. In this thesis, aim is to reduce the accident ratio and time delay for the Pedestrian by providing a skywalk for the pedestrian. To check the adequacy of pedestrian facilities, pedestrian surveys is to be done and also check the Level of service of the existing pedestrian facilities are evaluated for the existing condition as per the guideline of HCM 2000 and feasibility study is done by T-test method. Guidelines of pedestrian facility IRC 103:2012 and suggestion is given with design required for the pedestrian skywalk. For this study there are a number of places in Ahmadabad which is suffering from heavy traffic. Among them “**Kalupur Railway Station**” is the study area which is facing the problems. So by providing a skywalk movement will be smooth, safely and have comfortable journey for the pedestrian

**Keywords** - Pedestrian, Level of Service, Skywalk, Pedestrian facility, Vehicle traffic

**I. INTRODUCTION**

Walking is one of the most relevant means of mode in transportation. Walking is considered as the most relevant form of mode for the people using public transport and for people having no vehicles. It observed that from the past few decades due to increasing in growth of personal vehicle use for transportation traffic increased due to this pedestrian are facing a problem and accident ratio increase. Due to heavy traffic pedestrian are not having a smooth and comfort walk and it also increase the delay time of pedestrian. Due to irregular shape and poor maintenance of footpath pedestrian are not using the footpath. Due to inadequate facility provided for the pedestrian movement, there exist a conflict between pedestrian and motor vehicle by sharing a limited space of road, and it result increase the road accident ratio. As Pedestrian friendly environment play an important role in encouraging the walking as a mode of transport. To overcome this problem a skywalk is provided to reduce the conflict between the pedestrian and vehicle movement and it also provide a safe, comfort and smooth walk for the pedestrian.

**1.1 Objective of Study**

- To collect data on traffic and pedestrian for the study.
- To estimate pedestrian level of service.
- To evolve guideline for the development of skywalk facility.

**1.2 Scope of Work**

- To access the present level of service LOS concept for the analysis of pedestrian facility using HCM 2000
- Finding the pedestrian flow rate, critical gap for per pedestrian, average delay for per pedestrian and suggest for the improving pedestrian facility.
- Provide requirement of design facility for skywalk.

**II. STUDY AREA**

Ahmadabad city is the administrative headquarters of the Ahmadabad district and is the seat of the Gujarat High Court. It is the sixth-largest city and seventh-largest metropolitan area of India. For the research project “**Kalupur Station Area**” was considered as the study area Coordination is 23°01'30"N 72°36'04". Kalupur is the central part of Ahmadabad. Ahmadabad Kalupur Railway Junction is the main railway station in Ahmadabad.

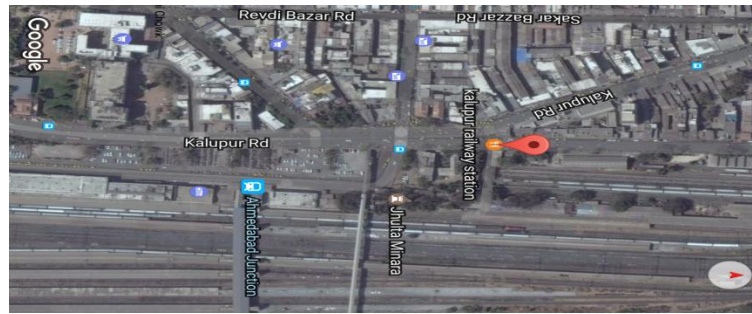
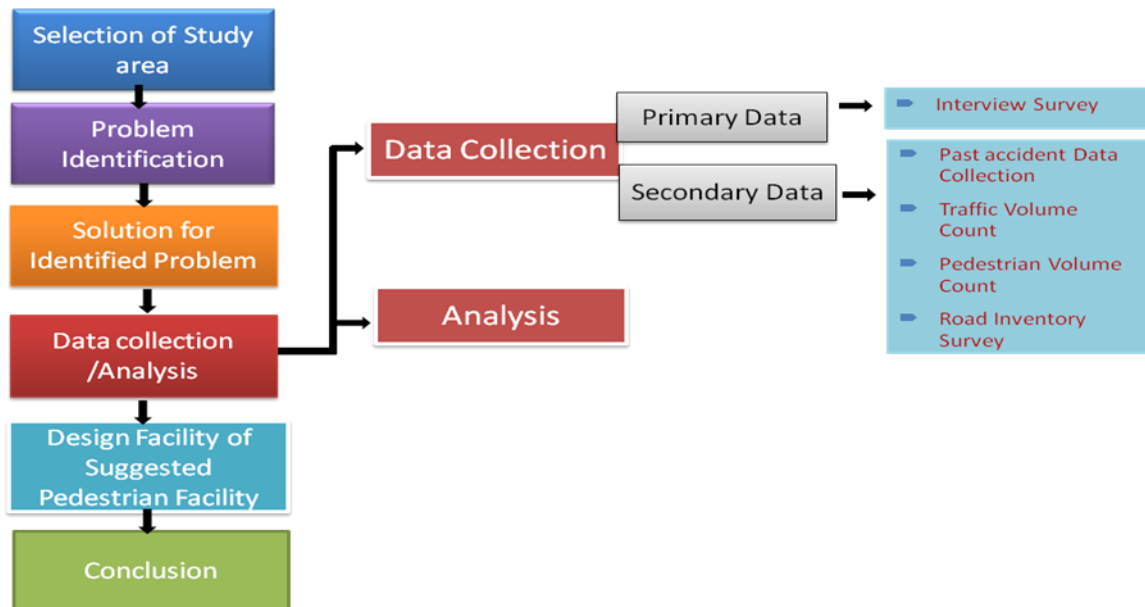


Figure 1. Google image of Kalupur Station

### III. METHODOLOGY



### IV. DATA COLLECTION AND ANALYSIS

#### 4.1 Past Accident Data Record

Past five year of major and minor accident data. There are 231 Major accident in which victims is hospitalized for more than 24 hrs or any victims who died within 30days of accident, 76 minor accidents in which victims suffer with minor injuries which are treated with first aid kit.

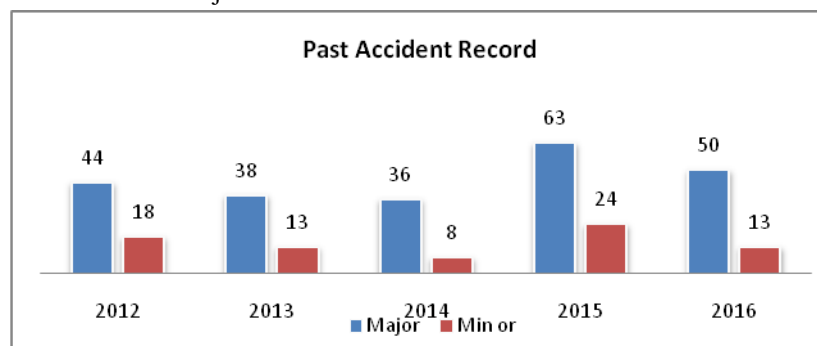


Figure 2. Past accident data

#### 4.2 Pedestrian Volume Count

Pedestrian volume count is done through videography and manual survey of peak hours of a day. Pedestrian volume count on normal working day of duration of 6hours from kalupur railway station to kalupur road is 10976 and at same time duration from kalupur railway station to saringpur is 9947. Total 20923 Pedestrian volume at kalupur on normal working day. Evening peak flow is found more prominent then morning peak flow, average peak per hour volume flow is 3487.

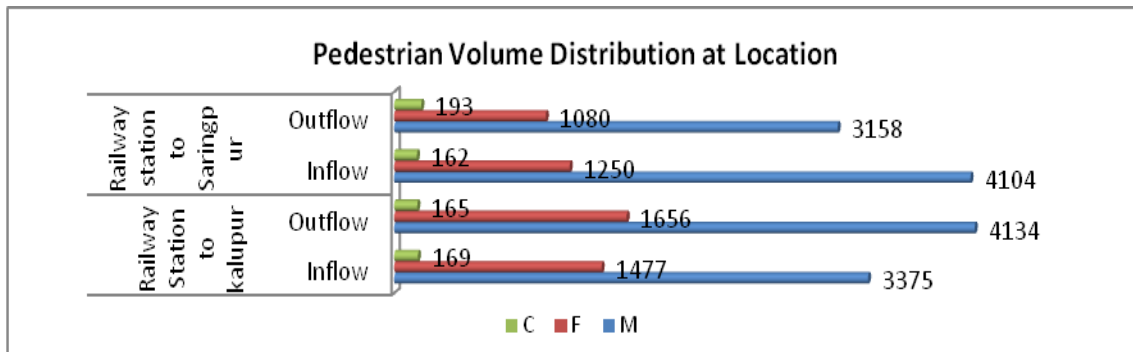


Figure 3. Pedestrian volume Distribution at Location

Pedestrian volume count on Weekend day of duration of 9hours from kalupur railway station to kalupur road is 5256 and at same time duration from kalupur railway station to saringpur is 4121. Total 9377 Pedestrian volume at kalupur on weekend day (Sunday). Evening peak flow is found more prominent then morning peak flow, average peak per hour volume flow is 1041.

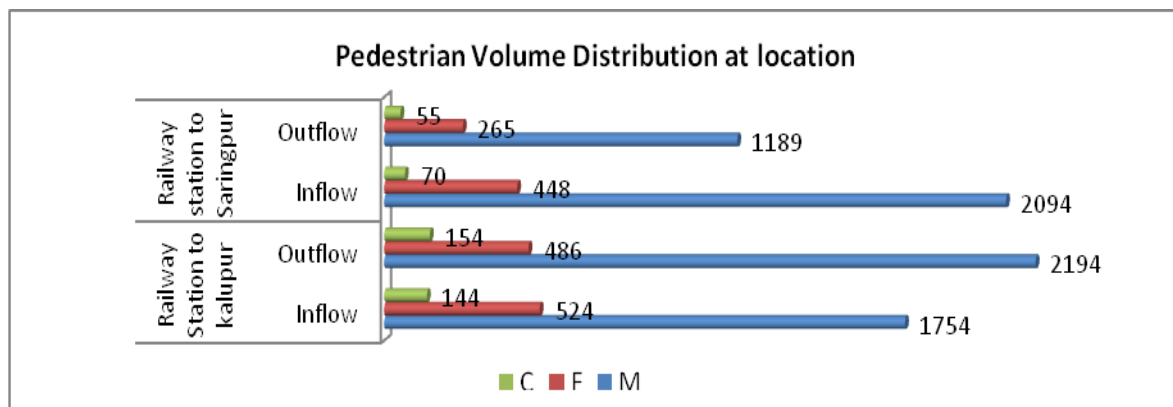


Figure 4. Pedestrian volume Distribution at Location

#### 4.3 Traffic Volume Count

Traffic volume count is collected through videography survey of peak hours of morning and evening normal working day. Traffic volume of 30393 was observed for duration of 6hours. Fig 5 shows the hourly variance of 6hour duration of two wheeler, car, bus, auto, cycle.

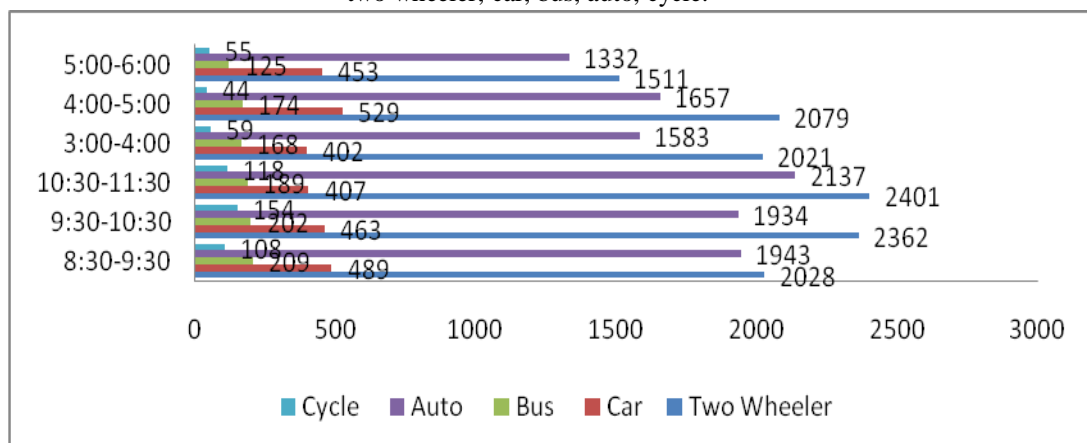
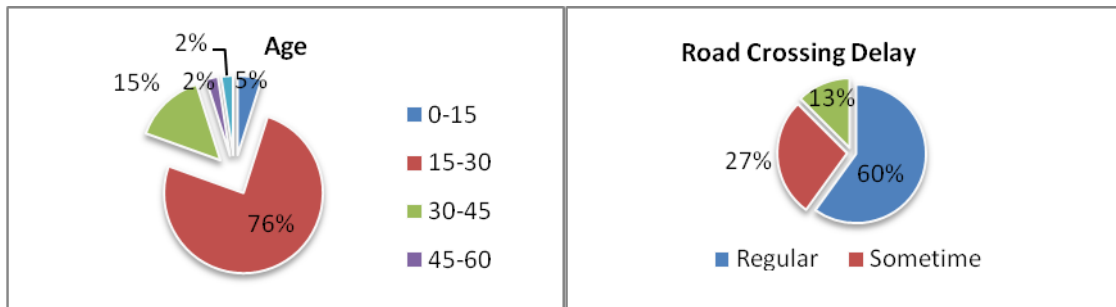


Figure 5 Hourly variance of traffic flow

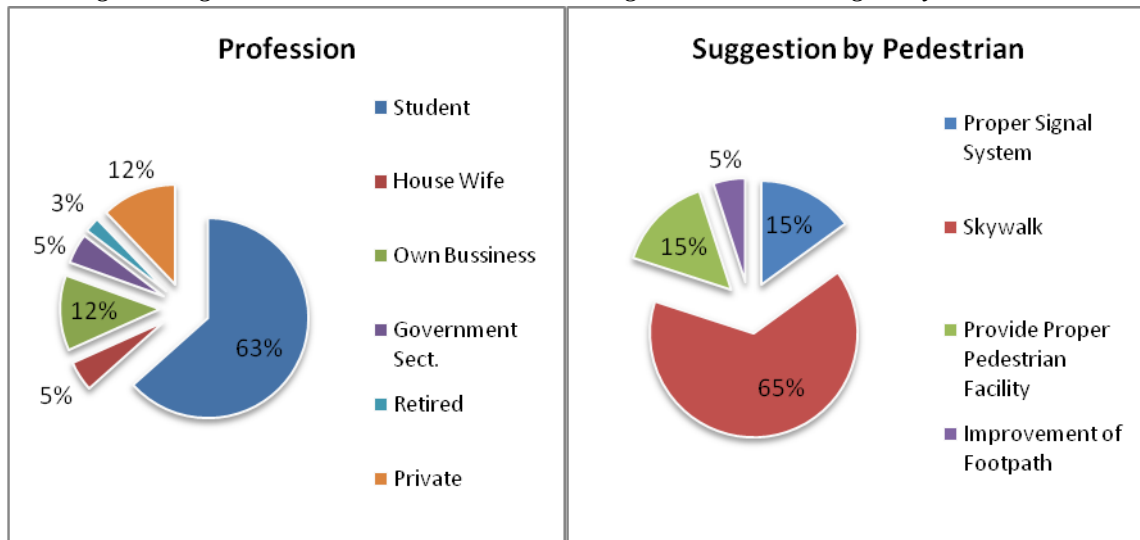
#### 4.4 Pedestrian Interview Survey

Pedestrian walking on study stretch were asked a set of questions to understand the socio economic characteristic, trip purpose, frequency and willingness to use the proposed skywalk. Out of total sample size 87%male and 13%female were interview with age range from 0 to 60 years. In that 5% responds were form 0-15 year, 76% were of 15-30 year of age,15% were of 30-45 year of age,2% were of 45-60 year of age, 2% were of more than 60years of age. Fig 6 shows the age wise distribution of pedestrian.



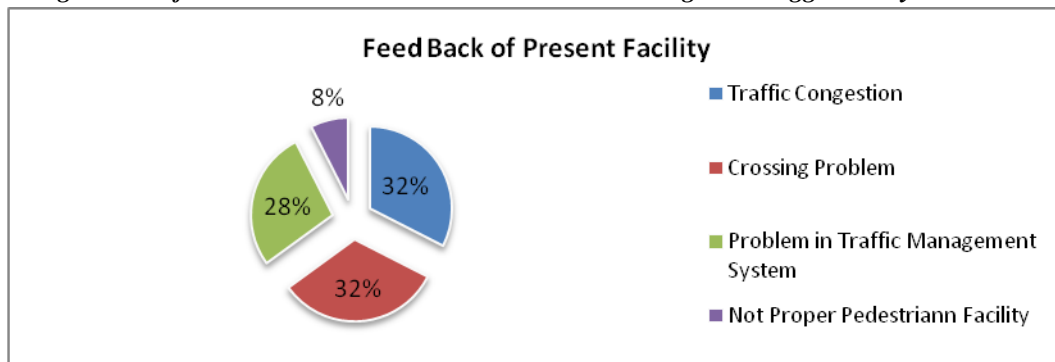
**Figure 6 Age wise Distribution**

**Figure 7 Road Crossing Delay Distribution**



**Figure 8 Profession wise Distribution**

**Figure 9 Suggestion by Pedestrian**



**Figure 10 Feed Back on Pedestrian Facility**

Delay occurred by pedestrian while crossing the road. Fig 7 shows the 60% regular 27% sometime and 13% often delay face by pedestrian while crossing the road.

Profession wise distribution shows that 63% were student, 5% were house wife, 12% in own business, 5% in government sector, 3% are retired, 12% were in private service. Fig 8 & 9 shows profession wise distribution of pedestrian and suggestion given by pedestrian for requirement of pedestrian facility.

Fig 10 shows the feedback given by pedestrian on present facility, 32% were facing a traffic congestion problem, 32% were facing crossing problem, 28% facing problem in traffic management system, 8% not proper pedestrian facility.

#### 4.5 Speed survey

Speed survey is to find the time taken by a pedestrian to walk a particular distance. After collecting the data from study location using video graphic technique, the analysis of pedestrian crossing speeds with respect to certain pedestrian characteristics is usually desired. For that purpose, firstly the pedestrian crossing time and waiting time is observed from the video of study locations. For this a sample of 5 pedestrian in which 3 male and 2 female at each 15mint interval is observed and speed of pedestrian is measured by using the stop watch. Speed survey is done for duration of 6hours videography survey.

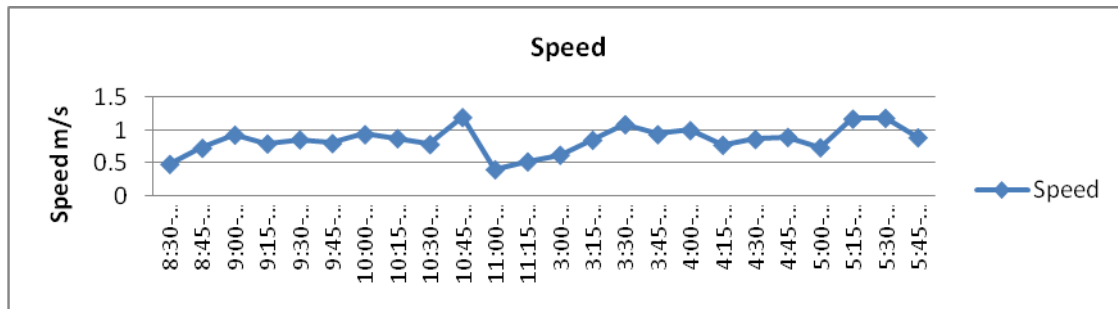


Figure 11 Line chart of Speed

Table 1. Pedestrian Speed

Gender	Average Speed m/s
Male (72)	1.043
Female (48)	0.862

## V. ANALYSIS OF LEVEL OF SERVICE BASE ON HCM 2000

### Analysis of Los for Normal working day

#### 5.1 Walkway and Sidewalk

As per HCM 2000 Pedestrian LOS for sidewalks and sidewalk is calculated using the pedestrian unit flow rate. Determination of the peak 15-min count and effective walkway width is required to compute pedestrian unit flow rate with equation

$$V_p = \frac{V_{15}}{15 * W_E}$$

Table 2. Pedestrian Characteristic on normal working day

Leg	Direction	Overall width (m)	Effective walkway width (m)	Flow ped/hour	15min – peak flow
A	Kalupur	1.35	1	1830	457
B	Saringpur	1.47	1	1657	415

#### For leg A:-

Pedestrian unit flow rate at Kalupur

$$V_p = \frac{457}{15 * 1}$$

$$V_p = 30.46 \text{ Ped/min/m}$$

Table 3. Pedestrian LOS for walkway and side walk

Leg	LOS	Space (m <sup>2</sup> /p)	Flowrate (p/min/m)	Speed (m/s)	v/c ratio
A & B	C	>2.2-3.7	>23-33	>1.22-1.27	>0.31-0.44

#### 5.2 Critical Gap for leg A and leg B:-

For a single pedestrian critical gap is computed according to HCM 2000

$$t_c = L/S_p + t_s$$

Average pedestrian walking speed is 1.22m/s, length of the cross walk is 9m, and start up time and end clearance time is 180s

$$t_c = 9/1.22 + 180$$

$$t_c = 154 \text{ s}$$

#### 5.3 Average Delay of Pedestrian for leg A and leg B :

As per HCM 2000 the average delay for per pedestrian is obtained by equation.

$$d_p = 1/v (e^{V_G/t_G} - 1)$$

Vehicular flow rate 5065 veh/hour

Vehicle flow rate (v) = 2 Veh/sec

$$d_p = \frac{1}{2} (e^2 * 154 - 2 * 154 - 1)$$

$$d_p = 414.4 \text{ s}$$

**Table 4. Pedestrian characteristic at unsignalised intersection**

LOS	Average delay/Pedestrian (s)	Likelihood of Risk taking Behavior
F	>45	Very High

#### Analysis of Los for Weekend day

#### 5.4 Walkway and Sidewalk

**Table 5. Pedestrian Characteristic on normal working day**

Leg	Direction	Overall width (m)	Effective walkway width (m)	Flow ped/hour	15min – peak flow
A	Kalupur	1.35	1	584	146
B	Saringpur	1.47	1	458	115

**Table 6. Pedestrian LOS for walkway and side walk**

Leg	LOS	Space (m <sup>2</sup> /p)	Flowrate (p/min/m)	Speed (m/s)	v/c ratio
A & B	A	>5.36	≤16	>1.30	≤0.21

#### 5.5 Critical Gap for leg A and leg B:-

$$t_c = \frac{9}{1.30} + 180$$

$$t_c = 145 \text{ s}$$

#### 5.6 Average Delay of Pedestrian:

$$d_p = \frac{1}{2} (e^2 * 145 - 2 * 145 - 1)$$

$$d_p = 390 \text{ s}$$

**Table 7. Pedestrian characteristic at unsignalised intersection**

LOS	Average delay/Pedestrian (s)	Likelihood of Risk taking Behavior
F	>45	Very High

#### 5.7 Future Population Prediction:

From the portal of worldmotors population prediction urban population of India in 2017 increases to 32.8% and in 2020 increases to 33.9%. From the data collection the present volume count of pedestrian for 6 hours at kalupur station road is 20923 so the future growth of Pedestrian after 10year

**Table 8. Population Forecast**

Year	Pedestrian
2017	20923
2018	28016
2019	37513
2020	50230
2021	67258
2022	90059
2023	120589

2024	161469
2025	216206
2026	289500
2027	387641

#### 5.8 T test of synthetic analysis:

##### Impact of change in speed of pedestrian after ten years at same location after providing a skywalk facility

In order to analyze the change in speed of pedestrian, we conduct this experiment by considering the average speed of pedestrian. We select the morning peak hour and evening peak hour pedestrian speed since it is more likely for pedestrian to cross the road during this period. Student T- test is conducted with null hypothesis ( $H_0$ ) and alternate hypothesis ( $H_1$ ). For these comparisons different hypotheses is tested using t-test at confidence level of 95 % or at significance level 0.05. For t test, sample of average speed of the 3 male and 2 female of each 5mint interval is considered. By using two equal same size and unequal variances, we obtained p- value.

**Table 9.T Test**

t-Test: Two-Sample Assuming Unequal Variances		
	<i>Male</i>	<i>Female</i>
Mean	30.08	30.63
Variance	93.91	118.07
Observations	24.00	24.00
Hypothesized Mean Difference	0.00	
df	45.00	
t Stat	-0.18	
P(T<=t) one-tail	0.43	
t Critical one-tail	1.68	
P(T<=t) two-tail	0.86	
t Critical two-tail	2.01	

As this is a two tail test the p value for two tail test is correct value therefore p value is 0.856 which is greater than level of significances 0.05. So the null hypothesis is not rejected. Therefore it proved that as speed increase the delay time will decrease.

## VI DESIGN FACILITY OF SUGGESTED PEDESTRIAN FACILITY

### Engineering Feasibility:

- Width of Skywalk - 2.50 -3.00 m
- Min Width of staircase - 2 m
  - Riser 150mm
  - Tread 300mm
- Vertical clearance -6.5 m must be kept free above Roadways
- Skywalk span
  - BRTS to Railway station 50m
  - AMTS to Railway station 70m
- Height of roof from the skywalk – 3.5 m

### Quality and type of construction:

- Light weight quick and easy to erect and space efficient structure system are recommended for skywalk
- The skywalk is covered with a roof of semitransparent polycarbonate sheets (minimum 10mm thick) with appropriate drainage system.



- Staircase should be covered from the top with polycarbonate sheet and guide rail is provided on both sides for the safety purpose.

## VII CONCLUSION

Study take in to account the time saving of the pedestrian, comfort safety and security, which is to be consider at the time of providing the pedestrian facility. There is a need of alternative mode of transport for the pedestrian to reduce the congestion. From the data collection and analysis the data it is found that pedestrian peak flow of pedestrian per hour on normal working day for leg A and leg B are 1830 and 1657 and for weekend day pedestrian per hour flow for leg A and leg B are 584 and 458. From the analysis of data collected it is found that level of service for pedestrian as per HCM 2000 at intersection on normal working day for sidewalk and walkway on leg A and leg B are LOS C with walking speed of 1.22 to 1.27 m/s and for Level of service for pedestrian on weekend day for leg A and leg B are LOS A with walking speed of 1.30m/s. After calculation as per HCM 2000 the critical gap for Leg A and leg B is 154 s on normal working day and 145s on weekend day. As per calculation of HCM 2000 at intersection delay of pedestrian is very high i.e. 414.4s on normal working day and 390s on weekend day which increases the illegal pedestrian crossing at intersection and increase the accident ratio. From the analysis of t test by using two equal same size and unequal variances, we obtained p- value is 0.856 which is greater than level of significances 0.05. So the null hypothesis is not rejected. Therefore it proved that as speed increase the delay time will decrease. So by providing a skywalk it reduces pedestrian delay time and pedestrian can move safely and comfortless. It also provide-security, safety, at the time of walking.

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