Discussion Paper No. 2/2014 (39)

August 2014

# USE OF PEDESTRIAN BRIDGE: A CASE STUDY IN KOLKATA

**Tarun Kumar Sarkar**

Centre for Urban Economic Studies

Department of Economics

University of Calcutta

# USE OF PEDESTRIAN BRIDGE: A CASE STUDY IN KOLKATA

**Tarun Kumar Sarkar**



August 2014

Centre for Urban Economic Studies
Department of Economics
University of Calcutta
1 Reformatory Street
Kolkata 700 027
India
cuescu@gmail.com
+91-33-2479-0156

First Published: August 2014

Publisher: Mahalaya Chatterjee
CUES
1 Reformatory Street
Kolkata 700027

Printer: Suban
33/A, Bipḷabi pulin Das Street
Kolkata – 700 009

## Foreword

A pedestrian footbridge is an installation for grade separation, usually done to decongest roads from pedestrian traffic. There are a number of such foot bridges in different parts of the city and its adjoining suburban towns, constructed at different point of time. The user profile in general is not very encouraging. The pedestrians generally prefer to cross the road at the same level, sometimes to save time, sometimes of sheer ignorance and sometimes out of lethargy. As a result, none of the objectives of grade-separation (decongestion, prevention of accidents, increasing the speed of the vehicular traffic) can be achieved to the fullest extent. As the policy-makers are usually not interested in impact assessment of such public investment, it falls upon the academicians to look into the utilization of public money in a country like India. Tarun Sarkar has started the effort in the right direction taking up the Sealdah footbridge, situated at the central part of the city. One of the main railway stations of the city, a major government hospital and government youth centre surround the footbridge, not to talk of a number of schools, wholesale and retail markets. The paper is based on a primary survey done at the sight followed by a rigorous statistical analysis. I expect this study will help the policy-makers, researchers, transport planners and students in their endeavour.

August 2014

Mahalaya Chatterjee

# CONTENT

## USE OF PEDESTRIAN BRIDGE: A CASE STUDY IN KOLKATA

# USE OF PEDESTRIAN BRIDGE: A CASE STUDY IN KOLKATA

## 1. Introduction:

Every trip, notwithstanding the various modes of public transport used in between, almost always consists of a number of journeys on foot – at least, one at the beginning and another at the end of it. With the process of urbanization and increase in rates of motorization, the infrastructure, amenities, and services relating to the needs of the pedestrians are often neglected. Kolkata is the seventh biggest city of India in terms of area and population. Yet, Kolkata has a road to surface ratio of just 6% compare to 23% in Delhi and 17% in Chennai besides the problems of hawkers, illegal occupants, peak time traffic congestion and jaywalkers and therefore is unable to provide enough space for fast moving as well as slow vehicles. The grievances of the victims of road accidents and the hue and cry raised by the traffic managers have forced the city planners to undertake the construction of pedestrian bridges at prime locations in the city.

The pedestrian bridges of Kolkata are unique in themselves. Over the time-span of a decade and a half, ten pedestrian bridges have come up within the city. While a couple of them, given their derelict condition, seem best suited as spots for promoting horror tourism, others seem desperate to prove that money spent on, the pedestrian utility systems, has in no way gone down the drain.

The paper is divided into following sections: a literature review follows this introductory session, there is a literature review. It is followed by an introduction to the main object of study and its importance in Kolkata traffic scenario. The last section deals with a primary survey of the users and a statistical analysis of the data.

### Literature Review

The rapid population growth and increasing economic activities have resulted in the tremendous growth of motor vehicles. This is one of the primary factors responsible for road accidents in many metropolitan cities, including Kolkata in India. Road accidents are essentially caused by improper interactions between vehicles and other road users and/or roadway features. The situation that leads to improper interactions could be the result of the complex interplay of a number of factors such as pavement characteristics, geometric

features, traffic characteristics, road users' behaviour, vehicle design, drivers' characteristics and environmental conditions. So, the whole system of accident occurrence is a complex phenomenon. A number of studies on road safety have also been carried out in India, in different cities such as Delhi, Mumbai, Chennai, Kolkata and Ernakulam as well as on some highways. The notable studies include *Srinivasan and Prasad* (1979), *Tuladhar and Justo* (1981), *Kadiyali* (1983), *Valli and Sarkar* (1997), *Chandra* (1999), *Sing and Misra* (2001), *Chakraborty, Shukla and Sing* (2001) and Chakraborty and Roy (2005).

Most pedestrian crossing facilities are provided at grade (at the same level of the road) Pedestrian Bridge or Footbridge or Overpass and Subways are constructed at levels different from that of roads, having separated vehicular traffic and pedestrian flows. Compared to at-grade crossings, grade-separated crossing provide better safety protection to pedestrians and cause less disruption to traffic. Several studies have been conducted on the planning, provision and the utilization of pedestrian bridges and subways. *Paddy Tillett has* argued that footbridges have enormous potential to improve the walking environment through safety, convenience and delight, yet are rarely used-and when used, are too often done so inappropriately.

*Audit Commission, Hong Kong, 2007* has conducted a review of the planning, provision and utilization of pedestrian bridges and subways, and found that there is room for improvement. A significant study pertaining to pedestrian perceptions of crossing facilities was conducted in Scotland. The main reasons cited for not using the overpass facility were that traffic was light or that it would take too long to cross the road .

A study was conducted to find out factors that influence use / non-use of pedestrian bridges in the central business district (CBD) of Ankara, Turkey. It was argued that bridge use or non-use was a habit and not coincidental behavior of pedestrian.

A significant study pertaining to assess the effect of a pedestrian bridge on the rates of pedestrian crashes and injuries was conducted in Nakawa on the Kampala-Jinja Highway, Uganda in 1999. Pedestrians had a high perception of risk which, however, did not seem to influence pedestrian bridge use. Though age difference among pedestrians was not seen as significantly influencing use of pedestrian bridges, there was a considerable difference in the use by the male when compared to that made by the female members. There were more traffic crashes, and pedestrian injuries, but fewer fatalities after the construction of the bridge.

However, no study has been done so far as to their utilization pattern after their construction. Moreover, most of the studies are outside India, whereas Indian cities, being unique in different aspects, may come out with totally separate findings.

**Objective of study**

The modal share of pedestrians in developing cities tends to be very high. But with the process of urbanization the infrastructure, amenities, and services relating to pedestrians are often neglected. In this context, the basic objective of the city planners of a country is to construct foot over bridges in the crowded areas considering the two major dimensions (a) to provide safety to the pedestrians and (b) to ensure the smooth flow of traffic. The fulfillment of the objectives of a pedestrian bridge or Foot-over bridge, in other words the very basis of the existence of a pedestrian bridge, is achieved only if the bridges are used. The frequency of road accidents in which the unfortunate pedestrian is a victim raises a question regarding the use as well as the misuse of these bridges. My study makes an attempt to assess/evaluate the use / non-use of the pedestrian bridges and also to examine if there is any discernible pattern of use / non-use of pedestrian bridges.

**Methodology**

Ours is a case study of one pedestrian bridge. Over the time-span of a decade and a half, ten pedestrian bridges have come up within the city of Kolkata. The pedestrian bridge at Sealdah is one of the oldest, and most important of them all. It is located at central business district of the city. The survey was conducted on various days over a period of ten months in order to capture the seasonal influence, if any, upon the rate of the use of the pedestrian bridge. Also, within the same day survey was conducted at different points of time in order to capture the changes in flow of pedestrian movement over the pedestrian bridge throughout the day.

Behaviour of both the user and non-user of the pedestrian bridge has been taken into account in the survey. By user we mean those who use the pedestrian bridge, and by non-user we mean those who should have or could have used the pedestrian bridge and yet do not use it.

During the date and time of survey the total number of people using the pedestrian bridge and those not using it has been counted, and some of them have been interviewed on the basis of a questionnaire. It may be noted here that while interviewing the pedestrian on the move, the possibility of sampling them in a pre-determined or pre-structured manner is feeble simply because they never present a stationary constellation of objects or a known population to

choose from. The interview was undertaken by requesting a pedestrian on the move. While very few may acquiesced to the request, a majority did not agree to be interviewed by a stranger for several reasons, like being busy or hard-pressed for time which was the most important and also most cited of them all.

For the purpose of the study both the user and non-user pedestrians have been classified into two categories: (a) general (non-student) and (b) student. For convenience sake the students have been identified if they are in school uniforms. However, whether in uniform or not, the students who have been interviewed have established identity in response to the questionnaire presented to them.

While counting as well as while interviewing them, the pedestrians' sex and age have been noted. Thus, our study is both gender-based and age-based. The age classification has been done on the basis of following format: 6-18yrs; 19-30yrs; 31-50yrs; 51 and above. For students the classification is: 6-11yrs and 12-18yrs. We have tried to find out the habit of using bridge with respect to different age groups of general people and of student, and also with respect to gender by using multinomial logit model.

The survey was conducted only on working days (excluding Saturdays, Sundays and other holidays). The days when the survey was conducted, it was conducted during the daylight hours, viz., from 8 AM till 8 PM, and this time period has been divided into three categories: (a) peak hours I – 8 AM till 12 noon; (b) slack hours – 12 noon till 4 PM; (c) peak hours II – 4 PM till 8 PM.

The flow of pedestrians has been marked from each of the two ends of the pedestrian bridge. Eight research assistants were recruited, trained and deployed for the purpose of the survey. Two among them stood at two ends of pedestrian bridge counting pedestrians using the pedestrian bridge, and two others interviewed the same. Similarly two others stood at two sides of the road counting pedestrians crossing the road, while two other interviewed them.

An attempt at analysing the movement of the various types of vehicles passing underneath the pedestrian bridge was undertaken by placing video cameras at strategic locations on the bridge which helped at manually counting as also classifying vehicle movement in the area on an average per day.

The surveyed data are analysed both in aggregative and disaggregative ways as required for analyzing various perspective of the study.

**An overview of the area served by the Pedestrian Bridge at Sealdah, named as Sealdah Pedestrian Bridge (SLPB)**

Sealdah is one of the major train stations serving Kolkata in India. Sealdah is located at 22.33°N 88.22°E/ 53.91; 07.14. Sealdah is one of the busiest railway stations in India. It is famous as a suburban local train terminal too. There are two sections, Sealdah North and Sealdah South. Surrounding Sealdah station are Nil Ratan Sarkar (NRS) hospital and college, Nafar Babu's Bazar, a whole sale vegetable market, and the Sealdah market which are among the oldest markets in Kolkata. Sealdah flyover flies over B.B.Ganguly Street, Beliaghata road, Serpentine lane and passes very close to Sealdah Railway station and Sealdah judicial court. Street hawkers, selling various wares occupy the entire place under the Sealdah flyover (Vidyapati Setu). Moulali Yuva Kendra Sealdah which meets both academic and cultural purposes is located nearby. Loreto Sealdah Girls' school, which is one of the most sought-after schools in the city, is situated on A.J.C. Bose road on the western ramp of the foot bridge. Goenka College of Commerce and Business Administration, one of the renowned government colleges, is situated near this locality. Besides, Surendranath, Bangabasi and City colleges are also situated nearby. Picture-1 shows Sealdah Places of Interest.

Picture-1: Sealdah Places of Interest


Picture-2: Sealdah Pedestrian Bridge


**An overview of the Sealdah Pedestrian Bridge:**

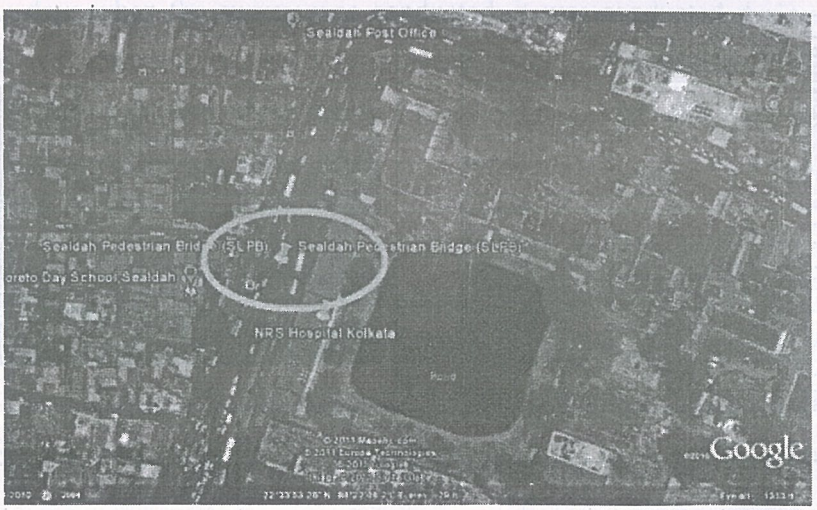
The bridge was constructed by Jessop Company in 1990-91. The height of the footbridge is 5.5 m and its width is 2.1 m. The length of the foot bridge is 55m, the used up area of footpath is 45 Sq. m. and the area of road fencing (Iron) adjacent to the bridge is 20 m. Picture-2 shows the Sealdah Pedestrian Bridge. This bridge is under poor electrification,

paintwork, rain guard and proper grab rails. It is not a sophisticated foot bridge and both the stair cases and the facilities do not attract children to use the bridge.

The bridge is situated on A.J.C.Bose road. The western access ramp of it is situated in front of Loreto Sealdah girls' school and Prachi cinema hall and the eastern access ramp takes one to the entrance of Nilratan Sarkar Medical College and Hospital. Picture-3 shows surrounding areas of Sealdah Pedestrian Bridge. It is situated near the approach to the Southern ramp of Sealdah flyover adjacent to Sealdah railway station. The western side of the pedestrian bridge falls under ward number 50, under Muchipara police station, of Kolkata Municipal Corporation which has a total population of 17251 (2011, Census). The eastern side of the pedestrian bridge falls under ward number 55, under Entally police station, of Kolkata Municipal Corporation which has a total population of 32245 (2011, Census).

The adjacent ward at the eastern side the pedestrian bridge is 54 whose population is 36235 (2011, Census). On the other side, the adjacent ward at the western side of the pedestrian bridge is 49 whose population is 19416 (2011, Census). The grand total population and households surrounding the pedestrian bridge are 105147 and 13411 respectively.

Picture-3: Sealdah Pedestrian Bridge




It is observed that population and household of surrounding area of the bridge are 2.34% and 2.06% respectively of total Kolkata Municipal Corporation (KMC) area. Male-female ratio of the study area is 56.09:43.91, whereas overall Male-female ratio of KMC area is 52.41:47.59.

## Traffic Flow and Road Accidents in Kolkata:

The rapid population growth and increasing economic activities have resulted in the tremendous growth of motor vehicles. This is one of the primary factors responsible for road accidents in many metropolitan cities, including Kolkata, India.

In Kolkata there were 762924 **registered motor vehicles** in 2001 which increased to 911921 in 2005, indicating an increase of 19.53 per cent over a five-year period and the growth rate of motor vehicles over 2006 to 2010, (411025 registered vehicles in 2010) went down to 56.64 per cent (-56.64%). It is also observed that registered vehicles decreased to 46.13 per cent (-46.13%) during 2001 and 2010, although the registered vehicles over the period 2011 to 2012 was positive (increase to 65.76%). In addition, the roads under Kolkata Traffic Police jurisdiction have taken extra daily load of outstation vehicles.

It is further observed that **compound annual growth rate (CAGR)** of registered vehicle in Kolkata 4.56 per cent over a five-year period of 2001 to 2005, whereas subsequent five-year period, 2005-2010 the CAGR decreased to 15.39% (-15.39%). The CAGR over a period of ten-year period of 2001 to 2010 was -6.64%. The negative CAGR was because the Government of West Bengal cancelled the live vehicles registered prior to 1.1.1993 with effect from 1.1.2010, as these vehicles were over 15 years old, although the CAGR over the period 2008 to 2012 was positive (increase to 5.18%).

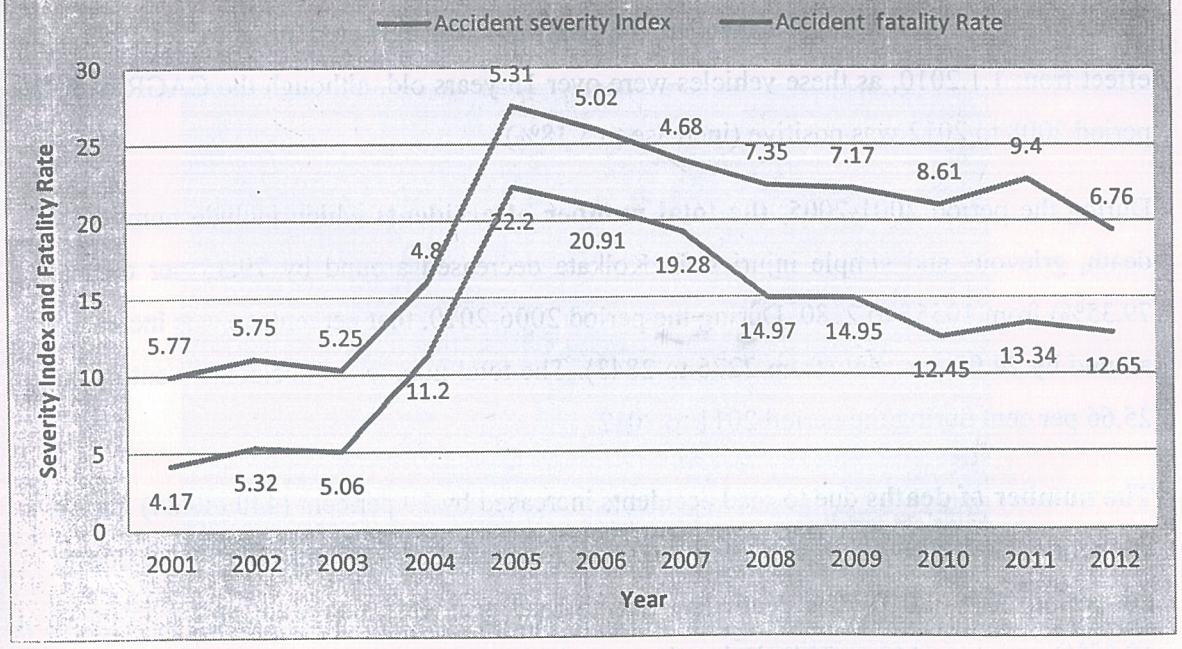
During the period 2001-2005, **the total number of accidents** which include number of death, grievous and simple injuries, in Kolkata decreased around by 79.35 per cent (-79.35%) from 10555 to 2180. During the period 2006-2010, that percentage was increased around by 24.91 per cent (from 2276 to 2843). The total number of accidents went up by 25.66 per cent during the period 2011 to 2012.

**The number of deaths** due to road accidents increased by 10 per cent (440 to 484) during the period 2001-2005 but that percentage went down by 25.63 per cent (-25.63%) during the period 2006- 2010. The death rate due to road accidents also went up by 19.55 (-19.55%) per cent (440 to 354) during the period 2001-2010. An increased 18.29 per cent was found for the period 2008-2012. It is observed that the rate of death increased by 19.14 percent over the period 2011 and 2012.

Figure: 1 presents the Accident severity index and Accident fatality rate for Kolkata during the period 2001-2012. The Accident severity index measures the seriousness of an accident [6]. It is defined as the number of persons killed per 100 accidents. It is seen that the accident severity index has gradually increased from 4.17 in 2001 to 22.20 in 2005, a decrease of around 43.92 per cent from 22.20 to 12.45 during 2005-2010, but has, since 2000, been increasing. An increased trend was observed from 2010. It is observed that in 2005 there was a sudden rise of fatal accidents resulting in the increase of the accident severity index.

The Accident fatality rate is defined as the number of deaths per 10,000 vehicles. There was a substantial decrease in fatality rate from 5.77 in 2001 to 4.68 in 2007, though this rate increased to 6.76 in 2012. It may be noted here that although the number of accident deaths in Kolkata did not decrease significantly (increased by 5% over the period of 2001 to 2007), the vehicle population in the same period increased from 7, 62,924 to 9, 86,814 (29.35%), which resulted in a decrease of fatality rates of more than 18 per cent (18.89%). The accidental death significantly increased (18.29%) over the period

Figure- 1 Accident Severity Index & Accident Fatality Rate of Kolkata



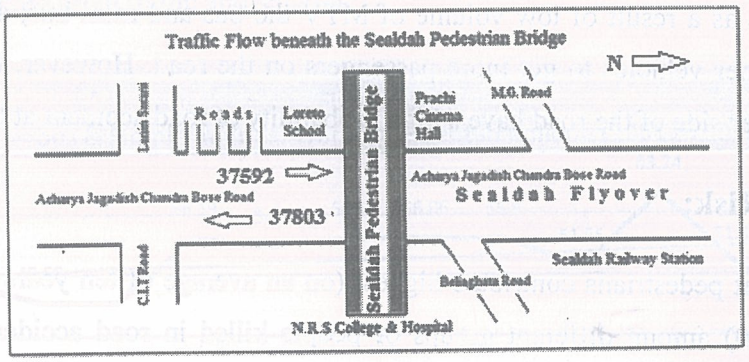

of 2008 to 2012, although the vehicle population of the same period increased by 28.70%, which was more and less same (29.35%) as 2001-2007.

*It indicates that there was a substantial increase in the rate of death (%) in 2008-2012 over 2001-2007.which resulted in an increase of the rate of death (%) in Kolkata more than 265%.*

## SURVEY RESULT

The Sealdah Foot Bridge falls under the jurisdiction of East Traffic guard of Kolkata Traffic Police. This pedestrian bridge stands on the A.J.C. Bose road. It is observed that this junction is one of an accident-prone area of Kolkata.s. A total of 75395 vehicles movement beneath the bridge Average Weekday (8 am to 8pm) in P.C.U is observed. The traffic flow per day from Moulali Crossing to Sealdah Fly Over Bridge (Vidyapati Setu) is 37592 and from southern end of Sealdah flyover to Moulali Crossing is 37803. Figure-1 depicts the traffic flow beneath Sealdah Pedestrian Bridge. The traffic flow from Moulali Crossing junction to Sealdah Fly Over Bridge is 37592 out of which 22249 are motor cars and taxis, 5165 buses and mini-buses and 1363 trucks. On an average 369 auto rickshaws and 6470 motor cycle and scooters and 152 trams, in addition to 1824 slow moving vehicles are plying on average Weekday (8 am to 8pm) in P.C.U.

Figure- 2: Traffic Flow beneath the Sealdah Pedestrian Bridge.

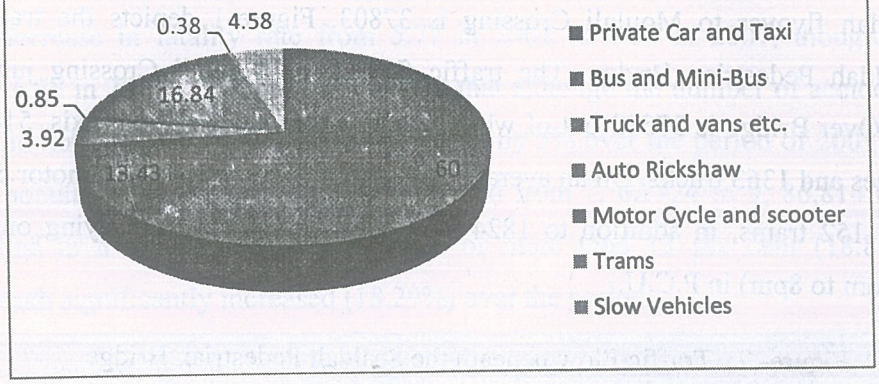



On the other side of the road, the volume of traffic from southern end of Sealdah flyover to Moulali Crossing is 37803. 22996 private cars and taxis, 4962 buses and Mini-buses and 1592 trucks pass through on an average week day. 6223 motor cycles and scooters and 131 trams and 1626 slow moving vehicles are passing through this area.

Figure-3 presents the traffic composition crossing under the Sealdah Pedestrian Bridge. It is to be noted here that on an average 60 per cent of the total vehicles on either side of the road are private cars and taxis. On an average the percentage of bus and mini bus, auto rickshaw and trams are 13.43 per cent, .85 per cent and .38 per cent respectively. The ratio of mass transit vehicles (MTV) and non-mass transit vehicles (NMTV) is 84:16. It is noted that on an

average per cent of "Mass Transit Vehicles" which is used by general public, is 14.66 per cent of total traffic flow. By contrast, 16.84 per cent motor cycles including scooters and 60 per cent car and taxi are plying on this road. It is noted that 76.84 per cent of the total vehicles are in the nature of private vehicles including motor cycle and scooter and those run beneath the pedestrian bridge at steady speed.

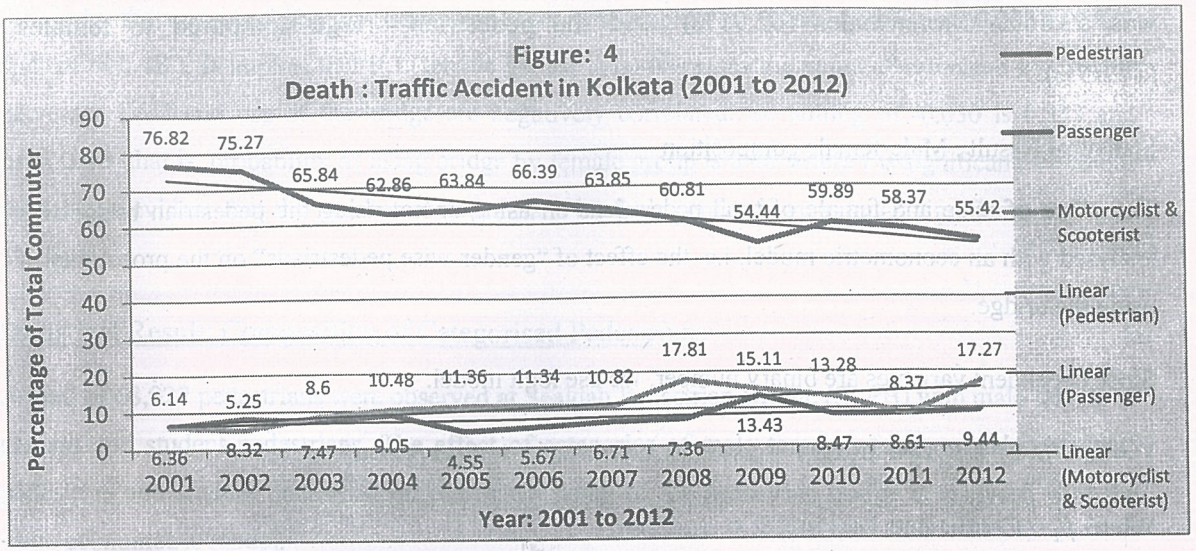
Figure- 3
Classified Traffic Volume on an Average Weekday
( % of Total Traffic Volume)



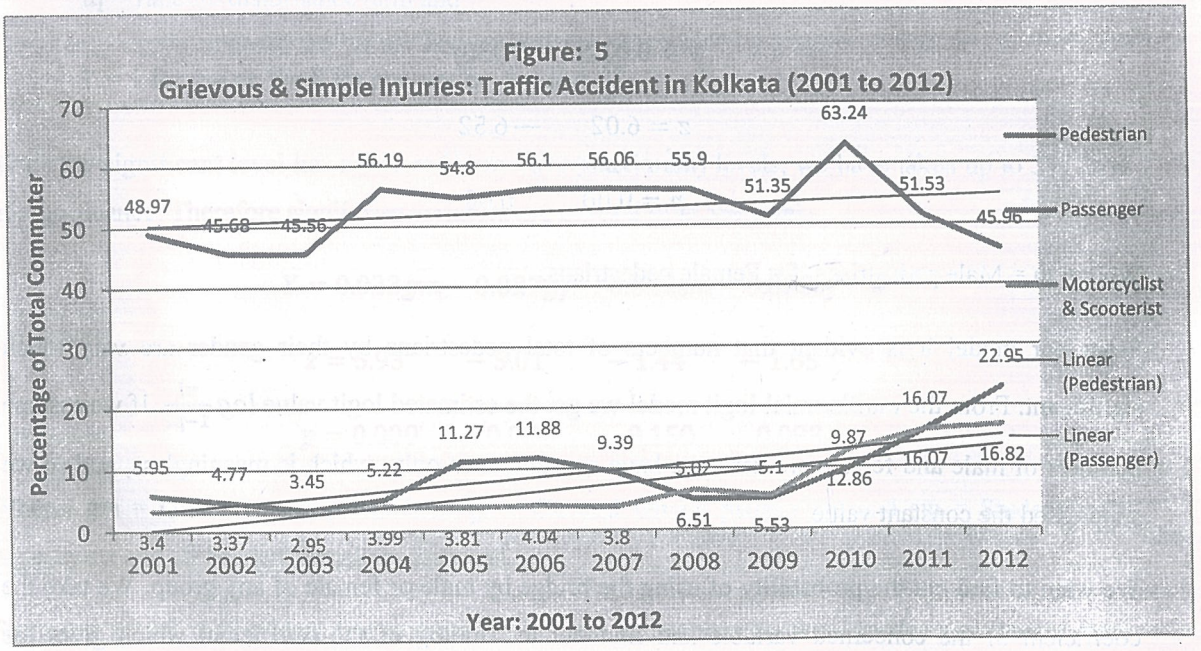

It is evident that, as a result of low volume of MTV the bus and mini bus, and auto driver drivers' block other vehicles to get more passengers on the road. However, the pedestrians who cross to either side of the road have a high probability of road accident at this area.

## Pedestrians' Risk:

It is observed that pedestrians contribute highest (on an average of ten years 65.22 per cent during 2001-2010) among different groups of people killed in road accident followed by motorcyclist & scooterist at 10.91 per cent. On average 7.64 per cent passenger pedestrians was killed in road accident during 2001 to 2010. Similar results were observed in 2011-2012. Figure-4 reports the pedestrians' share of total death decreased around by 27.86 per cent (from 76.82% to 55.42%) over the period 2001 and 2012, thus a descending trend is observed. Increasing trends were observed in case of passenger and motorcyclist & scooterist for the same period.




Similarly, on an average 52.49 per cent of total commuter involved in road accident injury were pedestrians, where as 6.69 per cent passenger and 4.79 per cent motorcyclist and scooterist were injured in road accident during 2001-2012. Similar results were observed in 2011-2012. Figure-5 shows the pedestrians' share of injuries (grievous and simple) of total commuters decreased around by 6.15 per cent (from 48.97% to 45.96%). Thus increasing trends are observed in all of the above cases.




## Pedestrian Bridge Utilisation

A total of 68927 pedestrians were observed, with a male female ratio of 5.7:4.3. The overall prevalence of pedestrian overpass use was 40.54% while percentage of non-user pedestrians

was 59.46%. More males (62.95%) used the pedestrian bridge compared to females (37.05%).

Statistical Result : Male-female composition

The effect of male and female of total pedestrians on using or not using the pedestrian bridge was analysed with an econometric model, i.e. the effect of "gender-wise pedestrians" on the probability of using the bridge.

Since dependent variables are binary number, we use logit model.

$$Y = \alpha + \beta_1 x_2 + \beta_2 x_3 + \beta_3 x_4 + \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots + \beta_{11} x_{12} + u_i$$

Where $\beta_i$ = Coefficients i.e. i = 2, 3, 4.....n

$\alpha$ = Intercept

$u_i$ = random disturbance term and

$y = 1$ for use or $y = 0$ for non-use or $y = log \frac{pi}{1-pi}$

Since the significant level lies between 1% to 10% (maximum) levels, we have taken upto 5% level of significance. Therefore both m and f variables are significant.

$$y = 0.021m - 0.030f$$

$$z = 6.02 \quad -6.52$$

$$p = 0.00 \quad 0.00$$

Where: m = Male pedestrians, f = Female pedestrians.

From our model it is evident that numbers of total pedestrians by their gender are very much significant. From the multinomial logit model we get the estimated logit value $log \frac{pi}{1-pi}$. If we assume numbers of male and female are zero, we have constant term only, which is meaningless, and so we suppressed the constant value.

We want to find out the probability of using the bridge by male or female of any group. We take the coefficient of the concerned variable and find out the antilog of the coefficient which gives the respective probabilities. For example, the variable m (male pedestrians) where coefficient is 0.021 (antilog of 0.0021 is 1.051 and $pi = 0.51$ ) It implies that if m increases the value of estimated logit value increases, so m and the use of bridge are positively correlated. The probability of using the bridge by male group is 0.51 where m is significant.

Similarly, the variable f (female pedestrians) where coefficient is -0.030, (antilog of -0.030 is 0.933 and $pi = 0.48$ ). It implies that if f (female pedestrians) increases the value of estimated logit value decreases i.e. f and use of the bridge are negatively correlated. So antilog of -0.030 is 0.933 and $pi = 0.48$ that is, probability of using bridge by female group is 0.48 where f is significant. From our model it is evident that the number of pedestrians by their gender is very much significant at 1% to 5% levels.

Statistical Result: Composition of Categorised Pedestrians

A total of 68,927 pedestrians were observed at Sealdah Pedestrian Bridge (SLPB) with male female of general and student pedestrians. The effect of categories of male female of general (Non student) pedestrian and student pedestrian on use or not using of the pedestrian bridge is analysed with the same econometric model.

Since dependent variables are binary number, we use logit model.

$$Y = \alpha + \beta_1 x_2 + \beta_2 x_3 + \beta_3 x_4 + \cdots \ldots\ldots\ldots\ldots\ldots\ldots\ldots + \beta_{11} x_{12} + u_i$$

Where $\beta_i$ = Coefficients i.e. i = 2, 3, 4.....n

$\alpha$ = Intercept

$u_i$ = random disturbance term and

$Y = 1$ for use or Y= 0 for non-use or $y = log \frac{pi}{1-pi}$

Since the significant level lies between 1% to 10% (maximum) levels, we have taken up to 5% level of significance. Therefore significant variables are gm and gf at 5% level.

$$Y = 0.023gm - 0.027gf - 0.022sm - 0.028sf$$

$$z = 5.93 \quad -5.01 \quad -1.44 \quad -1.65$$

$$p = 0.000 \quad 0.000 \quad 0.150 \quad 0.098$$

Where: gm = General male pedestrians; gf = General female pedestrians and sm = Student male pedestrians and sf=Student female pedestrians.

From our model it is evident that numbers of general pedestrians by their gender and student male pedestrians are very much significant.

From the multinomial logit model we get the estimated logit value $log \frac{pi}{1-pi}$. We want to find out the probability of using the bridge by male and female of student and non-student group. We want to find

out the probability of using the bridge by male and female of student or non-student group. We take the coefficient of the concerned variable and find out the antilog of the coefficient which gives the respective probability. For example, the variable gm where coefficient is 0.023, (antilog of 0.023 is 1.055 and $pi = 0.51$ ). It implies that that if gm increases the value of estimated logit value increases i.e. if gm increases the probability of using or not using the bridge increases. So the probability of using the bridge by general male persons (gm) is 0.51, where gm is significant. But the variable gf is significant and is inversely correlated with the probability of use of the bridge, and the probability of using the bridge by gf is 0.48. The variables sm and sf are not significant and they are inversely correlated with probability of use of the bridge and the probability of using the sm and sf are 0.49 and 0.48 respectively. From our model it is evident that number of general pedestrians by their gender only is very much significant at 1% to 5% levels. And there exists the overall significance of the model.

**User and Non-user Pedestrians**

**User:** Out of 27943 total user pedestrians the male and female percentages are 62.95% and 37.05% respectively (Table-1). Out of total user pedestrians, 25809 is of the general category (92.36% of total user) and 2134 (7.64% of total user) is of the student category. The percentage of the male user and female user of the general category is 59.12% and 33.24% respectively. It is noted that the percentage of the male and female of the Student category remained same of both sexes (3.82%).

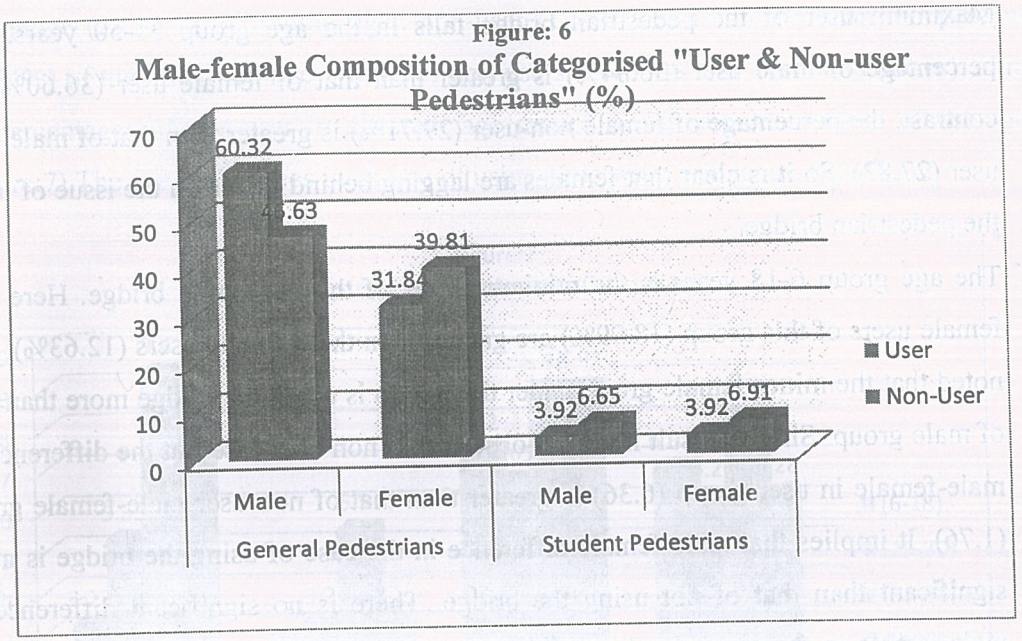
Table-1

| % Composition of Categorised Pedestrians (User& Non-User and Sex wise) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Category of User Non-user | Grand Total | General Pedestrians (Non-student Pedestrian) | | | Student Pedestrians | | | % Total of M/F of U/NU | |
| | | Male | Female | Total GMF | Male | Female | Total SMF | Male | Female |
| User | 100 | 59.12 | 33.24 | 92.36 | 3.82 | 3.82 | 7.64 | 62.95 | 37.05 |
| Non-User | 100 | 46.73 | 39.59 | 86.32 | 6.85 | 6.83 | 13.68 | 53.58 | 46.42 |

**Non-User:** Out of 40984 total non-user pedestrians the male and female percentages are 53.58% and 46.42% respectively (Out of total non-user pedestrians, 35377 is of the General category (86.32% of total non-user) and 5607 (13.68% of total non-user) is of the student category. The percentage of male non-user and female non-user of the general category is 46.73% and 39.59% respectively. The percentage of the male and female of the student category are 6.85% and 6.83% respectively. It is noted that the difference of percentage of

male and female is very negligible (0.02%). Figure-6 shows the male female composition of categorized "User & Non-user Pedestrians" in percentage.

**Figure: 6**




Out of 68927 total pedestrians the user and non-user percentage are 40.54% and 59.46% respectively. It is observed from Table-2, that 25.52% of male and 15.03% of female are using pedestrian bridge, where as 31.85% of male and 27.60% of female are crossing the road through traffic without using pedestrian bridge. It is further observed that 55.52% of male pedestrians are using road crossing instead of using pedestrian bridge, where as 64.76% of female pedestrians are crossing the road through traffic without using pedestrian bridge. The percentages of male and female pedestrians using the bridge are 44.48% and 35.24% respectively. It implies that male pedestrians preferred to use pedestrian bridge than female pedestrians.

Table-2

| Composition of Pedestrians (% of Total Pedestrians) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Category of User Non-user | Grand Total | General Pedestrians (Non-student Pedestrian) | | | Student Pedestrians | | | Total of M/F of U/NU | | M/F of U/NU | |
| | | Male | Female | Total GP | Male | Female | Total SP | Male | Female | Male | Female |
| User | 40.54 | 23.97 | 13.48 | 37.45 | 1.55 | 1.55 | 3.10 | 25.52 | 15.03 | 44.48 | 35.26 |
| Non-User | 59.46 | 27.78 | 23.54 | 51.32 | 4.07 | 4.06 | 8.13 | 31.85 | 27.60 | 55.52 | 64.74 |
| Total Pedestrians | 100 | 51.75 | 37.02 | 88.77 | 5.62 | 5.61 | 11.23 | 57.37 | 42.63 | 100 | 100 |

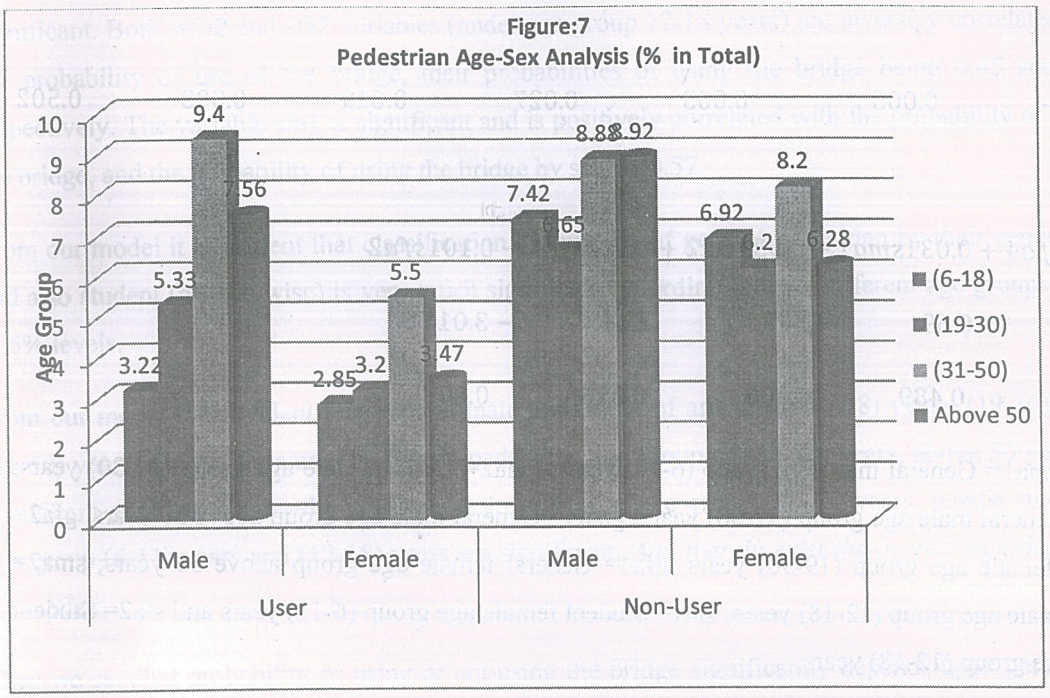
**Pedestrian Age-Group and Gender Analysis**

Observations of the study are that:

- Maximum user of the pedestrian bridge falls in the age group 31-50 years. The percentage of male user (36.84%) is greater than that of female user (36.60%). In contrast, the percentage of female non-user (29.71%) is greater than that of male non-user (27.82). So it is clear that females are lagging behind males on the issue of using the pedestrian bridge.
- The age group 6-18 years is the minimum user of the pedestrian bridge. Here also female users of this group (18.99%) are greater than that of male users (12.63%). It is noted that the minor female group under this group is using the bridge more than that of male group. Similar result has been observed in non user case but the difference of male-female in user group (6.36) is greater than that of non user male-female group (1.76). It implies that male-female difference in the case of using the bridge is more significant than that of not using the bridge. There is no significant difference of male-female in the case of using or not using the bridge under the age group 19-30 years.
- The percentage of male user (29.64%) is greater than that of female user (23.10%) under the age group above 50 years. Similar result has been observed in the case of non-user. It is noted that the male-female difference in using the bridge is greater than that of non-using under the age group above 50 years. The difference in the percentage of non-user male and non-user female is 5.24%, whereas the user male and user female difference is 6.54%. The rate of using the bridge by male pedestrian over the female is greater than the rate of non-using the bridge by male pedestrian over the female pedestrian. It also implies that aged females try to avoid using pedestrian bridge.
- The overall percentage of male-user group (9.40% under 31-50yrs) is greater than that of male-non-user group (8.88% under 31-50yrs), whereas, the percentage of female-non-user group (8.20% under 31-50yrs) is more than the percentage of female-user group (5.50% under 31-50yrs).
- Under the age group 51yrs and above, the % of male non-user (8.92%) is significantly higher than that of female user (6.28%). So aged male pedestrians generally do not use the pedestrian bridge.

The percentage (23.43%) of middle aged user (19-50 yrs) is greater than the percentages (17.10%) of the other two age-groups users (6-18 yrs and 51yrs and above). Similarly the percentage (29.93%) of middle aged non-user (19-50 yrs) is greater than the percentages (29.54%) of the other two age-groups of non-users (6-18 yrs and 51yrs and above), although the percentages of non-user in different age groups are greater than those of user groups (Figure:7).The age differences in choice of using pedestrian bridge are significant.

**Figure:7**
**Pedestrian Age-Sex Analysis (% in Total)**




Statistical Result: Categorised Pedestrian's Age-Group and Gender Analysis.

A total of 68,927 pedestrians were observed at Sealdah Pedestrian Bridge (SLPB) with male female of general and student pedestrians. The effect of age of male female of general (Non student) and student on using or not using of the pedestrian bridge is analysed with an econometric model.

Since dependent variables are binary number, we use logit model.

$$Y = \alpha + \beta_1 x_2 + \beta_2 x_3 + \beta_3 x_4 + \cdots \ldots\ldots\ldots\ldots\ldots\ldots\ldots + \beta_{11} x_{12} + u_i$$

Where $\beta_i$ = Coefficients i.e. i = 2, 3, 4…….n

$\alpha$ = Intercept

$u_i$ = random disturbance term and

$y = 1$ for use or $y = 0$ for non-use or $y = log \frac{pi}{1-pi}$

Significant variables are gma1, gma2, gma3, gma4, gfa2, gfa4, sma2, sfa1 and sfa2, and other variables are insignificant at 5% level (gfa1, gfa3 and sma1).

$$Y = -0.089gma1 + 0.005gma2 + 0.041gma3 + 0.024gma4 + 0.013gfa1 - 0.021gfa2 - 0.010gfa3$$

$$z = -3.66 \quad 2.81 \quad 3.01 \quad 2.22 \quad 0.5 \quad -3.02 \quad -0.67$$

$$p = 0.000 \quad 0.005 \quad 0.003 \quad 0.027 \quad 0.619 \quad 0.003 \quad 0.502$$

$$-0.042gfa4 + 0.031sma1 - .093sma2 + 0.122sfa1 - 0.101sfa2$$

$$-2.98 \quad 0.69 \quad -2.79 \quad 2.41 \quad -3.01$$

$$0.003 \quad 0.489 \quad 0.005 \quad 0.016 \quad 0.003$$

Where: gma1= General male age group (6-18) years; gma2= General male age group (19-30) years; gma3= General male age group (31-50) years; gma4= General male age group above 50 years; gfa2= General female age group (19-30) years; gfa4= General female age group above 50 years; sma2= Student male age group (12-18) years; sfa1= Student female age group (6-11) years and sfa2= Student female age group (12-18) years.

*From our model it is evident that number of general pedestrians classified by their gender, age and also student (gender wise) are very much significant.*

From the multinomial logit model we get the estimated logit value $log\frac{pi}{1-pi}$. We want to find out the probability of using the bridge by male, female, student or non-student of any age group. We take the coefficient of the concerned variable and find out the antilog of the coefficient which gives the respective probability. For example, probability of the variable gma1 (male of age group 6-18 years of general pedestrian) where coefficient is -0.089, (antilog of -0.089 is 0.81 and $pi = 0.45$ ) is 0.45. It implies that if gma1 increases the value of estimated logit value falls. Here the variable gm1 is significant but it is inversely correlated with the probability of use of the bridge, and the probability of using the bridge by general male persons of age group 6-18 years is 0.45. The variables gma2, gma3 and gma4 are significant and they are positively correlated with probability of use of the bridge and the probability of using the gma2, gma3 and gma4 are 0.53, 0.52 and 0.51 respectively.

Similarly, the variable gfa2 under the female of age group 19-30 years of general pedestrian and the variables gfa4 of female of age group above 50 years of general pedestrian are significant but they are inversely correlated with the probability of use of the bridge, their probabilities of using the bridge are 0.47 and 0.48 respectively. Other two variables (gfa1 and gfa3) of general female age groups are insufficient, gfa1 is positively correlated with probability of use of the bridge and gfa3 is inversely correlated with probability of use of the bridge.

It is observed from the model, all variables of students' age groups except variable sma1 are significant. Both sma2 and sfa2 variables (under age group 12-18 years) are inversely correlated with the probability of use of the bridge, their probabilities of using the bridge being 0.45 and 0.44 respectively. The variable sfa1 is significant and is positively correlated with the probability of use of the bridge, and the probability of using the bridge by sfa1 is 0.57.

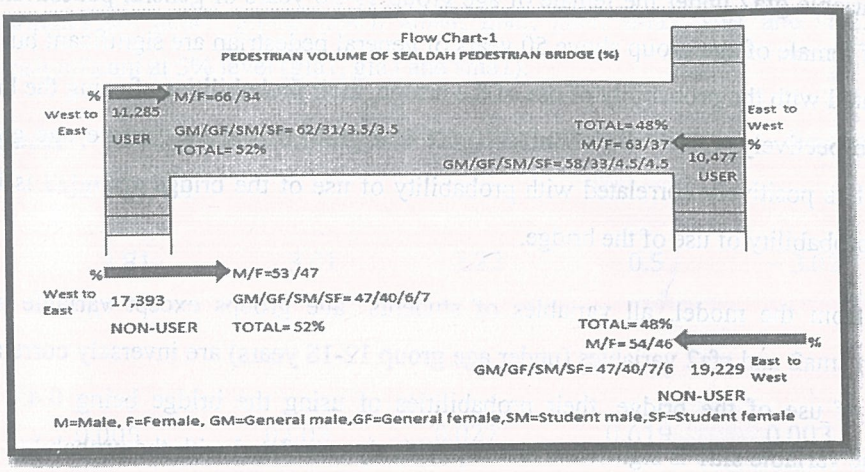
From our model it is evident that classification of numbers of general pedestrian by their gender, age and also student (gender wise) is very much significant according to their different age groups at 1% to 5% levels.

From our model it is evident that general male pedestrian of age group (6-18) years, (19-30) years, (31-50) years, above 50 years, and female pedestrian age group of (18-30) years, above 50 years are significant at 1% to 5% levels. Similarly male student of age group (12-18) years, female student of age group (6-11) years and (12-18) years are significant. *And therein exist the overall significance of the model.*

Thus we see that probability of using or not-using the bridge significantly depends upon gender and age of different categories. The result shows that in particular, number of male pedestrians is more significant than the females in case of non-student persons. Again number of female students is more significant than male to cause the probability of using or not-using the bridge.

**Direction wise Pedestrian Flow Analysis**

It is observed that the flow of user-pedestrians on either side of the pedestrian bridge is almost equal i.e. East to West (48.00%), NRS hospital side and West to East (52.00%), Loreto school side. Non-user pedestrians from NRS hospital side (East to West), at 53.00%, is slightly more than Loreto school side (West to East), (47.00%). Male female ratio both of user and non-user groups, either side of the Pedestrian Bridge is equal (Flow Chart: 1). Pedestrian flow per day on an average per day (8 am to 8 pm), 4011 general pedestrians and 341 students use this bridge where as 6329 general pedestrians and 993 students are crossing the road through traffic.

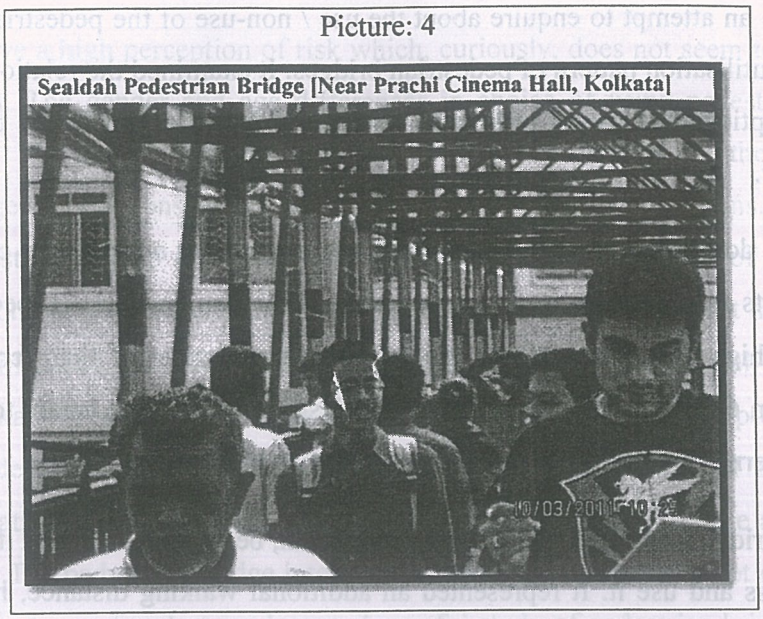



**Pedestrian Perception of risk**

Four hundred and seventy-three pedestrians were interviewed (male: female ratio of 7:3), adults constituted 91% of them. Nearly 79% of the respondents cross this road daily and 46% of them use the pedestrian bridge. The bridge was untidy, with teenagers frequently loitering on it, in spite of the fact that it is situated in a well-lit, area busy with activities round the clock so anti-social activities is minimal. Picture: 4 depicts commuter of the bridge.

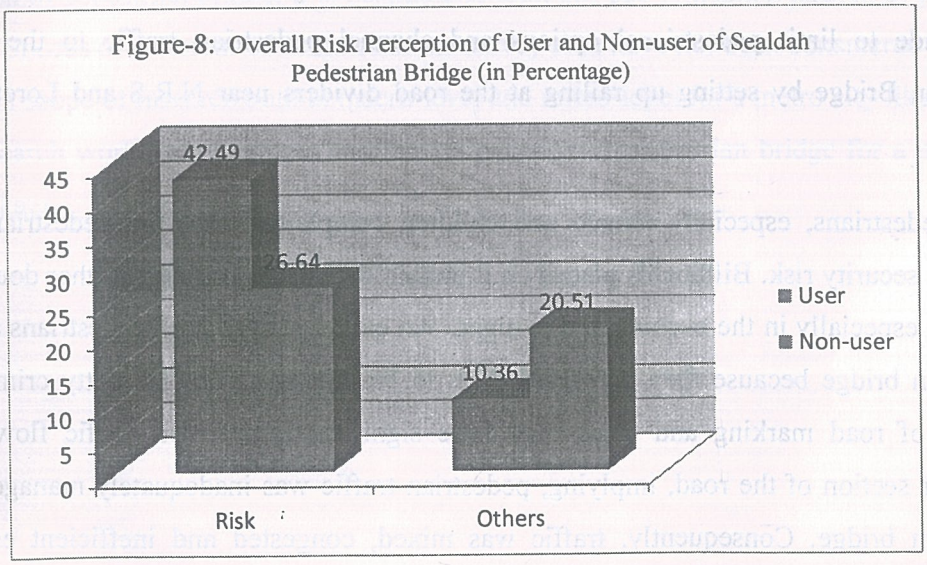
It is observed in the study that most (69.13%) respondents were worried about their safety on the road, but only 52.85% used the pedestrian bridge. It is interesting to note that 26.64% of sample shows that there is a risk in crossing the road which may be avoided by using the bridge, yet people do not use it (Figure:8). Of those who crossed through traffic, 33.18% cited the extra walking distance and time, and availability of nearby crossing facility as reasons for not using the pedestrian bridge. 51.12% avoided it citing health reasons, while 15.70% feared for their security on the pedestrian bridge.

Picture: 4




Of those who used the pedestrian bridge, 80% did so to avoid accidents. 69% respondents claimed to know the purpose of the pedestrian bridge. 89% thought it was meant for reducing pedestrians' accidental risk, while 11% thought it was constructed for children, particularly for students.

Figure-8: Overall Risk Perception of User and Non-user of Sealdah Pedestrian Bridge (in Percentage)



**Discussion**

This study made an attempt to enquire about the use / non-use of the pedestrian bridges and also to examine utilisation pattern of pedestrian bridges. It examined the relationship between pedestrian perceptions and use of pedestrian bridge, the extent to which the bridge secured pedestrian safety.

There was a low dominance of pedestrian bridge use, suggesting a flaw in its conception and design. Despite its advantages in resolving pedestrian-vehicular conflicts at specified crossing points, and the high perception of risk among pedestrians, most of them crossed through traffic; more than 60% were not aware that the pedestrian bridge was meant to address their road safety concerns.

The pedestrian bridge was not popular among pedestrian, because most found it inconvenient, difficult to access and use it. It represented an additional walking distance, high stairs and long crossing time compared to the alternative of crossing through traffic. Pedestrians are known to avoid facilities that add to their walking distances. Since pedestrian options were not restricted the pedestrian bridge, most of them crossed at "convenient" points through traffic. This was a major weakness in the pedestrian bridge intervention, it assumed that pedestrians would excise "sensible judgments" based on their knowledge and perceptions of risk and use it, which did not happen, Milton Mutto et al. (2007). Some deliberate attempts were made to limit pedestrians' options and channel pedestrian traffic to the Sealdah Pedestrian Bridge by setting up railing at the road dividers near N.R.S and Loreto Girls' School.

Many pedestrians, especially female and children complained that the pedestrian bridge offered a security risk. Billboards placed on it impaired visibility, casting further doubt about its safety especially in the evening and at night. An earlier study found pedestrians avoiding pedestrian bridge because they perceived them to be common sites for petty crime [7]. The absence of road marking and signs may have significantly affected traffic flow on the particular section of the road, implying, pedestrian traffic was inadequately managed at the pedestrian bridge. Consequently, traffic was mixed, congested and inefficient especially during peak hours when the volume of traffic increased. The pedestrian bridge could have resolved pedestrians-vehicular conflicts at the crossing point, if its location and design facilitated its use by pedestrians [8].

## Conclusion and Suggestions

Pedestrians have a high perception of risk which, curiously, does not seem to influence their use of bridges. The gender and age differences in choice of using pedestrian bridges are significant too. The use rate may be improved, if the safety benefits and the convenience of using the bridge without considerable time loss are made clear to pedestrians. The use or non-use of a pedestrian bridge is a habit and not a coincidental behavior of a pedestrian. A strategy that combines public education, law enforcement and environment modification may significantly influence use / non-use of pedestrian bridges in the central business district (CBD) of Kolkata. Besides, the bridges should be brought under regular police surveillance so that the pedestrians can use them without fear and harassment. Use of better technology such as installation of escalators etc. can make the pedestrian bridges more attractive as well as convenient. The pedestrian bridge intervention is therefore expensive not only in monetary term but also in term of pedestrian losses. A careful study of pedestrian bridge interventions is suggested before they can be replicated elsewhere.

Vehicle with high speed may cause high accidental risk of road users' particularly for the pedestrians. It is generally accepted that there are substantial safety benefits from the use of lower speed limit by vehicles [9]. Though a limited study has been reported so far in the area of utilisation of pedestrian bridge, it is desirable to look into the utilisation pattern of pedestrian bridges. Speeds of different of vehicles in the survey area have not been considered and there is enough scope of research both at macro-level and micro-level for a metro city like Kolkata. This research work only attempts at a macro-level use of pedestrian bridge for a metro city like Kolkata.

## BIBLIOGRAPHY


Audit Commission Hong Kong, "Provision of Footbridges and Subways" 25 October 2007; Report No. 49 of the Director of Audit. (3)

Chakraborty. N., Shukla. A. and Sing. H.C. (2001), Aggression and risk taking behaviour a threat to road safety, Proc. International Seminar on Sustainable Development in Road Transport, vol. II, pp. 159-174 (New Delhi, Indian Road Congress).

Chand M., 1999. An analytical study of bus-related accidents in India, Indian Highways, vol. 27, No. 9, pp. 9-20.

D. O'Cinneide, University College – Cork, The Relationship Between Geometric Design Standard and Safety. (9)

Firth. D.E. "Pedestrian Behavior." In: A.J. Chapman, F.M. Wade and H.C. Foot (Eds.) Pedestrian Accidents. Chichester. Wiley and Sons. 1982.

Holst V H, Nygren A and Thord R. Transportation, Traffic Safety and Health. Springer-Verlag Berlin. Heidelberg 1997. (7)

Kadiyali, L.R., T.V. Gopalaswami, P.R. Lakshmikanthan, U.N. Pathak and A.K. Sood, 1983. Effect of road characteristics on accident rates on rural highways in India, Highway

Ken, Gwilliam (2002). Cities on the Move. Washington, D.C.: World Bank.

Kolkata Traffic Police: Review for the Year: 2004 to 2012 and Report of Transport Department of Government of West Bengal. Transport Department, 2001 and 2003. (1)

Mikho Rasanen, Timo Lajunen Farahnaz Alticafarbay and Cumhur Aydin (2006). Pedestrian Self-reports of Factors Influencing the Use of Pedestrian Bridges, Accident Analysis And Prevention, Volume 39, Issue 5, September 2007, Pages 969-973. (4)

Milton Mutto, Olive C Kobusingye and Ronsld R Lett (1999). The Effect of An overpass on pedestrian injuries on a major highway in Kampala-Uganda, African Health Sciences Volume 2, No.3, December 2002. (5)

Paddy. Tillett, (2005) "Leaping the Canyon-Footbridges, Used and Misused" Walk21V-VI"Everyday Walking Culture", The 6th International Conference on Walking in the 21st Century, September 22-23 2005, Zurich, Switzerland. www.walk Chandra 21.ch. (2)

Sandip Chakraborty and Sudip K. Roy, Traffic Accident Characteristics of Kolkata, Transport and Communications Bulletin for Asia and the Pacific No. 74, 2005. (6)

Sing S.K., and A. Misra, 2001. Road accident analysis: a case study of Patna, Urban Transport Journal, pp. 60-75.

Srinivasan, N, and K. Prasad, 1979. Fatal accident rates in Delhi, Indian Highways, vol. 4, No. 3.

Transport and Road Research Committee. Towards safer roads in developing countries: A guide for Planners and Engineers. Crowthorn, Berkshire, UK. 1994. (8)

Tuladhar, S.B.S and C.E.G Justo, 1981. Analysis of accident rates – a case study, Highway Research Bulletin, Indian Roads Congress, vol. 16, (New Delhi, Indian Road Congress).

Valli, P. and P.K. Sarkar, 1997. Models for road accidents in India, Highway Research Bulletin, vol. 56, pp. 1-11 (New Delhi, Indian Road Congress).

Annexure 1

Classified Traffic Volume on an Average Weekday (8 am to 8pm) in P.C.U of Sealdah Pedestrian Bridge.

| *Types of Vehicles* | *South to North (Moulali crossing to Vidyapati flyover)* | *North to South (Vidyapati flyover to Moulali crossing)* |
|---|---|---|
| Private Car and Taxi | 22249 | 22996 |
| Bus and Mini-Bus | 5162 | 4962 |
| Truck and vans etc. | 1363 | 1592 |
| Auto Rickshaw | 369 | 273 |
| Motor Cycle and scooter | 6470 | 6223 |
| Trams | 152 | 131 |
| Slow Vehicles | 1824 | 1626 |
| | 37592 | 37803 |



Annexure: 2

Categorised Pedestrians' Age Sex composition of User and Non-user groups (% of Total Population)

| Age Group | User | | | | Non-User | | | | Age-Group Total (Gender wise) | | Age-Group Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | General Pedestrian | | Student Pedestrian | | General Pedestrian | | Student Pedestrian | | Total Male | Total Female | |
| | Male | Female | Male | Female | Male | Female | Male | Female | | | |
| | GMU | GFU | SMU | SFU | GMNU | GFNU | SMNU | SFNU | | | |
| (6-11) | 0 | 0 | 0.65 | 0.67 | 0 | 0 | 1.29 | 1.46 | 1.94 | 2.13 | 4.07 |
| (12-18) | 0 | 0 | 0.9 | 0.88 | 0 | 0 | 2.78 | 2.61 | 3.68 | 3.49 | 7.17 |
| (6-18) | 1.67 | 1.31 | 0 | 0 | 3.35 | 2.86 | 0 | 0 | 5.02 | 4.17 | 9.19 |
| (19-30) | 5.33 | 3.2 | 0 | 0 | 6.65 | 6.2 | 0 | 0 | 11.98 | 9.4 | 21.38 |
| (31-50) | 9.4 | 5.5 | 0 | 0 | 8.86 | 8.2 | 0 | 0 | 18.26 | 13.7 | 31.96 |
| Above 50 | 7.56 | 3.47 | 0 | 0 | 8.92 | 6.28 | 0 | 0 | 16.48 | 9.75 | 26.23 |
| Total | **23.96** | **13.48** | **1.55** | **1.55** | **27.78** | **23.54** | **4.07** | **4.07** | **57.36** | **42.64** | **100** |

| Annexure: 3 | | | | | | |
|---|---|---|---|---|---|---|
| **Death and Injury of Traffic Accident in Kolkata (2001 to 2012) (% of Total)** | | | | | | |
| Year | Pedestrian death | Passenger death | Motorcyclist & Scooterist Death | Pedestrian injured | Passenger injured | Motorcyclist & Scooterist injured |
| 2001 | 76.82 | 6.36 | 2.43 | 48.97 | 5.95 | 3.4 |
| 2002 | 75.27 | 8.32 | 4.77 | 45.68 | 4.77 | 3.37 |
| 2003 | 65.84 | 7.47 | 4.16 | 45.56 | 3.45 | 2.95 |
| 2004 | 62.86 | 9.05 | 6.33 | 56.19 | 5.22 | 3.99 |
| 2005 | 63.84 | 4.55 | 6.19 | 54.8 | 11.27 | 3.81 |
| 2006 | 66.39 | 5.67 | 8.06 | 56.1 | 11.88 | 4.04 |
| 2007 | 63.85 | 6.71 | 7.56 | 56.06 | 9.39 | 3.8 |
| 2008 | 60.81 | 7.36 | 8.23 | 55.9 | 5.02 | 6.51 |
| 2009 | 54.44 | 13.43 | 15.44 | 51.35 | 5.1 | 5.53 |
| 2010 | 59.89 | 8.47 | 11.99 | 63.24 | 9.87 | 12.86 |
| 2011 | 58.37 | 8.61 | 75.16 | 51.53 | 16.07 | 16.07 |
| 2012 | 55.42 | 9.44 | 8.35 | 45.96 | 22.95 | 16.82 |

| Annexure: 4 | | | |
|---|---|---|---|
| Year | Total Number of Persons Killed | Total number of Road Accidents | Total Registered Motor Vehicles |
| 2001 | 440 | 10 555 | 789705 |
| 2002 | 457 | 8 592 | 821188 |
| 2003 | 442 | 8 728 | 875156 |
| 2004 | 420 | 3 751 | 911921 |
| 2005 | 484 | 2 180 | 947926 |
| 2006 | 476 | 2 776 | 986814 |
| 2007 | 462 | 2396 | 1027544 |
| 2008 | 421 | 2812 | 1062047 |
| 2009 | 417 | 2789 | 1643295 |
| 2010 | 354 | 2843 | 411025 |
| 2011 | 418 | 3133 | 444718 |
| 2012 | 498 | 3937 | 737152 |

Source: Road Transport Year Book (2007-2009) Volume-I, Transport Research Wing, Ministry of Road Transport & Highways, Government of India, New Delhi, March 2011 and Kolkata Traffic Police, Review 2004-2012.

| Annexure: 5 - Result-1 | | | | | |
|---|---|---|---|---|---|
| Multinomial logistic regression | | | | | Number of obs = 265 |
| | | | | | LR chi2(2) = 67.78 |
| | | | | | Prob > chi2 = 0.0000 |
| Log likelihood = -149.79554 | | | | | Pseudo R2 = 0.1845 |
| Unu | Coefficient | anti log | pi= pi/1+pi | z | P>\|z\| |
| 1 | | | | | |
| M | 0.0216858 | 1.051201084 | 0.51 | 6.02 | 0.000 |
| F | -0.0304242 | 0.932343184 | 0.48 | -6.52 | 0.000 |
| | | | | | |
| (unu=0 is the base outcome) | | | | | |

| Annexure: 6 - Result-2 | | | | | |
|---|---|---|---|---|---|
| Multinomial logistic regression | | | | | Number of obs = 265 |
| | | | | | LR chi2(4) = 80.25 |
| | | | | | Prob > chi2 = 0.0000 |
| Log likelihood = -143.56102 | | | | | Pseudo R2 = 0.2184 |
| Unu | Coefficient | anti log | pi= pi/1+pi | z | P>\|z\| |
| 1 | | | | | |
| Gm | 0.0232417 | 1.054973863 | 0.51 | 5.93 | 0.000 |
| Gf | -0.0268667 | 0.940011788 | 0.48 | -5.01 | 0.000 |
| Sm | -0.0224096 | 0.949708664 | 0.49 | -1.44 | 0.150 |
| Sf | -0.0276164 | 0.938390495 | 0.48 | -1.65 | 0.098 |
| | | | | | |
| (unu=0 is the base outcome) | | | | | |

| Annexure: 7 - Result-3 | | | | | |
|---|---|---|---|---|---|
| Multinomial logistic regression | | | | | Number of obs = 265 |
| | | | | | LR chi2(12) = 135.33 |
| | | | | | Prob > chi2 = 0.0000 |
| Log likelihood = -116.01992 | | | | | Pseudo R2 = 0.3684 |
| Unu | Coefficient | anti log | pi= pi/1+pi | z | P>\|z\| |
| 1 | | | | | |
| gma1 | -0.0897853 | 0.81323245 | 0.45 | -3.66 | 0.000 |
| gma2 | 0.0522416 | 1.127824696 | 0.53 | 2.81 | 0.005 |
| gma3 | 0.0410846 | 1.099219945 | 0.52 | 3.01 | 0.003 |
| gma4 | 0.0244678 | 1.057956473 | 0.51 | 2.22 | 0.027 |
| gfa1 | 0.0125865 | 1.029405537 | 0.51 | 0.5 | 0.619 |

| | | | | | |
|---|---|---|---|---|---|
| gfa2 | -0.0512745 | 0.888639267 | 0.47 | -3.02 | 0.003 |
| gfa3 | -0.0100791 | 0.977059249 | 0.49 | -0.67 | 0.502 |
| gfa4 | -0.0419278 | 0.907971465 | 0.48 | -2.98 | 0.003 |
| sma1 | 0.0306113 | 1.073028606 | 0.52 | 0.69 | 0.489 |
| sma2 | -0.0926888 | 0.807813673 | 0.45 | -2.79 | 0.005 |
| sfa1 | 0.1222881 | 1.325220361 | 0.57 | 2.41 | 0.016 |
| Sfa2 | -0.1008218 | 0.792826577 | 0.44 | -3.01 | 0.003 |
| (unu==0 is the base outcome) | | | | | |

## Centre for Urban Economic Studies

*Discussion Paper Series*

1. Solid Waste Management in Calcutta Metropolis – *Pabitra Giri and Sulipi De* (May 1992)
2. Waterlogging and Issues Relating to Drainage in Calcutta Metropolitan District – *Arpita Bhattacharyya* (June 1992)
3. The Structure and Working of an Urban Labour Market in India: A Survey of Two Residential Locations in Calcutta – *Asis Kumar Banerjee* (July 1992)
4. Evolution and Growth of Municipal Towns in Calcutta Metropolitan Area –*Mahalaya Chatterjee* (August 1992)
5. Wholesale Market: Study of a Market in Calcutta –*Projjwal Sengupta* (September 1992)
6. Thika Tenancy in Bustees of Calcutta: A Study – *Swati Ghosh* (October 1992)
7. Aspects of Goods Flow in Calcutta Metropolitan Area –*Pabitra Giri* (November 1992)
8. Housing in Calcutta: Problems and Policy Issues – *Nipa Ghosh* (December 1992)
9. The Metro Rail of Calcutta: A Study – *Kuntala Lahiri* (January 1993)
10. Passenger Transport in Calcutta Metropolitan District –*Sudeshna Sen* (February 1993)
11. Consumption and Income in Calcutta Metropolitan Area – *Indrani Chakrabarty* (March 1993)
12. Some Aspects of Calcutta Port – *Arun Prasad Sen* (April 1993)
13. Metropolitan Growth and Demographic Changes in Calcutta –*Pabitra Giri and Sukla Bhaduri* (May 1993)
14. Urban Environmental Issues: A Study of Calcutta – *Ashish K. Ghosh* (January 1994)
15. Calcutta Port: Problems and Prospects – *Sachinandan Sau* (February 1994)
16. Urban Decentralization: A Case Study of Kalyani Township –*Nandita Dasgupta* (August 1994)
17. Urban Sanitation Problems: A Study of Calcutta –*Swadesh Kumar Bhattacharya* (September 1994)

18. Market Towns in Tamilnadu and West Bengal – Eight Development Issues for Field Research and Action – *Barbara Harriss-White* (June 1997)
19. Wetlands and Urban Environment - *Ashish K. Ghosh, Sivabrata Chatterjee and K. J. Nath* (July 1999)
20. Contrasting Urban Patterns: West Bengal, Punjab and Kerala –*Biplab Dasgupta* (May 2000)
21. The Indian Hill Stations: A Study in Social Space – *Aditi Chatterji* (July 2000)
22. Transportation Policy for the Control of Vehicular Air Pollution in Urban Areas: Applying Lessons from North to Calcutta, India – *Madumati Dutta* (September 2001)
23. Urbanisation in the Pre-colonial Bengal –*Biplab Dasgupta* (December 2001)
24. Emerging Issues in Bio-Medical Waste Management – *Sushma Wadhwani* (January 2002)
25. Urbanization and Agricultural Change in North-Eastern India – *J. B. Ganguly* (October 2003)
26. An Analytical Study of the Growth Experience in the Small Industries of Howrah and Burdwan Districts, 1988-2000 – *Nandita Basak* (October 2003)
27. Truck Terminals in Kolkata Metropolitan Area: Master Planning and Market Response – *Anis Mukhopadhyay* (August 2004)
28. Labour Market Segregation and Gender Bias –*Pampa Sengupta* (September 2004)
29. Urbanisation, Migration and Urban Society in Colonial Bengal - *Biplab Dasgupta* (December 2005)
30. The Growth Experience of the Small Scale Industries of North 24 Parganas and Medinipur Districts, West Bengal, 1988-2001- *Nandita Basak* (October 2007)
31. An Environmental Valuation of an Urban Wetland: A Case Study of the Jodhpur Park Lake – *Simanti Banerjee and Ashish K. Ghosh* (2007)
32. Evolution and Growth of Municipal Towns in Kolkata Metropolitan Area –*Mahalaya Chatterjee* (August 2008)
33. Polluting Behaviour of Different Modes of Transport in Big Cities and Policy Implications for Pollution Reduction: The Case of Kolkata, India – *Madhumati Dutta, Mohit Roy and Sudip K. Roy* (July 2009)
34. Spatial and Economic Changes in Asansol, 1951-2001(1/2012) - *Mousumi Ghosh*
35. Some Aspects of Urbanisation in Eastern India (2/2012)- *Somali Chakravorty & Malabika Dasgupta*
36. Modern Mobility, rejuvenation of Howrah and East-West Metro (1/2013)- *Anis Mukhopadhyay*
37. Kolkata Metro: A Study On Passenger Movement And Financial Health (1990-2010) (2/2013) - *Koyel Bhattacharjee*
38. Symbolic Urban Landscape: Science City, Kolkata (1/2014) – *Aditi Chatterji*

*Database Series*

1. Functional Classification of Urban Areas in India 1961, 1971, 1001 –*Mahalaya Chatterjee and Pabitra Giri* (August 2001)