Chapter - VII

CONCLUSION AND SUGGESTIONS

7.1 SUMMARY OF THE WORK

CHAPTER I

Chapter I of this study has outlined the potential impact of the pedestrian bridges, particularly where the effect of the rapid population growth and increasing economic activities have resulted in the tremendous growth of motor vehicles at the expense of pedestrians having considerable social and economic burdens on the victims including various direct and indirect costs. In view of the above, this chapter mainly focuses on the review of literature on the issue leading to find out the gap in research and objectives of the study. Research Methodology has also been outlined there and finally the plan of work. The existing literatures attempt mainly to analyse the road accidents and its reasons and the need of pedestrian bridges in different cities like Kolkata but does not conduct a post-implementing review of pedestrian bridges after its construction. This study puts emphasis on the utilisation pattern of the pedestrian bridges in Kolkata and its social and economic impact both at micro and macro levels.

CHAPTER II

Chapter II of this study deals in an overview on the history of Kolkata and its traffic characteristics including population. Kolkata stands on the Eastern Bank of River Ganga and it has many densely populated towns and districts on its outskirts. The history of Kolkata as referred above has been analysed under following four categories.

Analysis 1- An overview

*Kolkata* city evolved more than 300 years ago when the British East India Company came to Bengal for exploring the business opportunities in this region. The British bought three villages Sutanuti, Gobindapur and Kalikata and laid the foundation of the present city. The capital city Kolkata (earlier known as Calcutta) was called by the British Raj, “The Jewel of the East” and it remained its capital here till 1911; Kolkata is now the capital of West Bengal, a state of India. It is the 7th biggest city of India in area and population. Out of 1480 sq.km boundary of Kolkata (London 1580 sq. km.), 185sq.km, 13.54sq.km and 15.59sq.km are within the Kolkata Municipal Corporation area, the South Dum Dum Municipality area and Bidhannagore Municipality (Salt Lake City) area respectively in the study area. The density of
population in Kolkata (KMC) was 24,760/sq.km as per Census, 2001, whereas the density of population in Kolkata has come down to 24,252/sq.km in Census, 2011. Population growth rate during (decadal) 1991-2001 and 2001-2011 in Kolkata are 4.11% and 2.05% respectively. This population density per sq km of Kolkata city is the highest in India in 2011, followed by Delhi, Chennai and Mumbai. Concomitantly, Vehicle density per km of Chennai city is the highest in India, followed by Mumbai, Kolkata and Delhi.

**Analysis 2- Traffic Characteristics**

**Analysis 2.1:** The evolution of Kolkata shows that transportation was the corner stone in shaping the city. Kolkata as compared to other metro cities in India is relatively new and a planned city. However, most of the roads are narrow and their geometrics and surface conditions are not very good. Lane discipline of traffic seldom is as per norm. Intersections are closely spaced and are not properly designed. The non-observance of the lane concept and movement of more than one type of vehicle through a single lane is a common phenomenon. The road-based passenger transport system of Kolkata mainly consists of cars, buses, minibuses, auto rickshaws (three-wheeled motorized vehicles), motorcycles, taxis, bicycles and hand-pulled rickshaws.

**Analysis 2.2:** India has experienced a tremendous increase in the total number of registered motor vehicles. The total number of registered motor vehicles increased from 55.0 million as on 31st March, 2001 to about 142 million as on 31st March, 2011. With the registered motor vehicle population of 1418 lakh in 2011, the State of Maharashtra accounted for the largest share (12.30%) of the total registered motor vehicles in the country followed by Tamil Nadu (11.02), Delhi (UT) (5.09%) and West Bengal (2.30%). Amongst the metropolitan cities of India, Delhi had the largest number of registered motor vehicles, followed by Chennai, Mumbai and Kolkata.

The CAGR of registered motor vehicle of Kolkata was 4.56 from 2001 to 2005, that rate came down to -56.64 during 2006-2010 due to cancellation of live vehicles registered prior to 1.1.1993. The growth rates of vehicles were increased by 8.20 and 65.76 per cent during the year 2010-2011 and 2011-2012. In addition, Kolkata roads are burdened with out-station traffic or floating vehicle population plying from various states of India.

**Analysis 2.3:** The share of two wheelers was about 72% of the total registered motor vehicles in India as on 31st March, 2011. An average shares of two wheelers were about 57% and 70% of total registered vehicles observed among metropolitan cities and their states respectively.
Analysis 2.4: Kolkata's position in respect of population and vehicle densities per sq. km. were first and third respectively among metropolitan cities in India in 2011. The share of population density over vehicles density of Kolkata is highest, closely followed by Delhi, Mumbai and Chennai which was the lowest among metropolitan cities, even though the vehicles density in Chennai city was the highest in 2011. This study however observes that there is no relationship among the vehicles density per km, population density per sq km and accident severity index in metropolitan cities of India. Individual parameter such as vehicle density, population and accident severity would be considered separately.

Analysis 3- Road Accident

Analysis 3.1: In India, in the decade 2000-2010, the growth in fatalities as well as registered vehicles edged upward vis-à-vis preceding decade (1990-2000), though the CAGR of the accidents, injuries and road network have moderately decreased. After a moderate increase of 2.72% during 2010, the number of accidents reported during 2011 showed a negative growth of 0.39%. The number of persons killed increased by 5.93 per cent during 2011 as compared to 7.05 per cent during 2010. The number of persons injured in road accidents during 2011 was 511394 which was less by 3.06 per cent as compared to 2010 level.

Road accident during 2010-11 was the highest in Tamil Nadu, followed by West Bengal and Delhi (UT). A decreased percentage of number of persons killed in road accident during 2010-11 was observed in West Bengal and Delhi (UT). The percentage of number of persons injured in all states of metropolitan cities in India also decreased during 2010-11 except Delhi (UT). In 2011, the highest Accident Severity Index was in West Bengal, followed by Delhi (UT) and Tamil Nadu. The lowest Accident Severity Index was in Maharashtra.

Analysis 3.2: To get an appropriate measure of incidence of accidents, normalized / standardized accident rates for Indian cities have been worked out in terms of number of accidents (a) per lakh persons, (b) per ten thousand motor vehicles, (c) per ten thousand kilometers of road length. The number of persons (d) injured per lakh of population, (e) killed per lakh of population, (f) injured per ten thousand vehicles and (g) killed per ten thousand vehicles are other important parameters which have been considered to measure and compare the incidence of road accident, injuries and death among the cities.

Analysis 3.3: While comparing the changes in accident related to above parameters, it is evident that change in number of road accidents, persons killed and injured per lakh persons
were more in Chennai than that in Kolkata, though just opposite results were observed in case of number of road accidents, persons killed and injured per ten thousand vehicles.

**Analysis 3.4:** It is observed that the number of road accidents per one lakh population and per ten thousand registered motor vehicles in Kolkata have increased in 2011 over 2010, though the number of **road accidents** per ten thousand kilometers of road length has decreased in 2011. Similarly, the number of persons **killed and injured** per one lakh population, per ten thousand kilometers of road length has decreased in 2011 but other parameters, such as number of persons killed per ten thousand kilometers of **road length**, persons injured per one lakh population and per ten thousand vehicles in Kolkata have increased in 2011.

The causes behind the aforesaid variations in accident related parameters in the city of Kolkata are (a) major portion of the population of the city of Kolkata has shifted to newly developed urban areas, (b) live motor vehicles which were registered prior to 1.1.1993 have been cancelled with effect from 2010 for which the number of registered vehicles in Kolkata has declined sharply, and (c) road length in kilometers in city of Kolkata has been increased in 2011.

**Analysis 3.5:** It is observed that among all categories of vehicles, buses comprised the single highest number of involvement in fatal accidents. Truck was the second highest vehicles involved in fatal category of vehicles involved, followed by the Car. It is further observed that “Bus and Mini/Omni” was the highest in fatal category and “Car and taxi” was the highest total fatal and grievous category of vehicles involved in the total road accidents in Kolkata. And car was more risky vehicle than taxi. On the other hand vehicles falling in the “Not Known” category indicated that the event of accident occurrence was not informed and/or recorded in time. A significant portion of unknown vehicles are also involved in fatal as well as grievous injury cases.

**Analysis 3.6:** This study observed that that **accident risk** decreased rapidly during 2001 to 2005 and after that it increases gradually from 2006 to 2011. During 2001 to 2005 the decreasing trend of accident risk indicated that the chances of non-fatal accidents were sharply decreasing, making the people of Kolkata more safe to the non-fatal types of accidents. However, the situation was deteriorated since 2006 with the trend of accident rates increasing, making the people of Kolkata more vulnerable to the non-fatal types of accidents once again.

The **accident severity index** of Kolkata has gradually increased during the period 2001-2011. An average accident severity index has decreased from 4.44 to 2.49 in 2001-2005 and 2006-
2010 respectively. There were a substantial decrease in accident fatality rate from 2001-2005 and an increase in 2006-2010. It is observed that in 2008 to 2010 there was a sudden fall of number of registered vehicles due to cancellation of live vehicles registered before 1.1.1993 resulting in the increase of the accident fatality rates. The rate of decrease of the accident fatality risk was higher in Kolkata than that of the all-India average. This indicates that the safety improvement measures undertaken in the city have been effective.

**Analysis 3.6:** It is evident that pedestrians contribute highest among different groups of people involved in road accident cases during 2001-10 in Kolkata, followed by passengers, two wheeler riders and occupants of “Truck & Lorries”. There were large number of persons belonging to “Other” category of road user, who were involved in road accident in Kolkata. The road users’ hierarchy composition concerning the total accident cases in Kolkata for the periods of 2001-05 and 2006-10 have remained more or less same.

It is observed that the percentage rate of pedestrians, “Occupants of Trucks and Lorries” and “Other” categories involved in road accident cases decreased in 2006-2010 over the period 2001-2005. Higher increasing rates were observed in “Car driver”, “Two wheeler rider including pillion rider”, “Non-motorized driver” and “Passengers” in road accident cases in 2006-2010 over the period 2001 to 2005.

**Analysis 3.7:** This study observes that the share of pedestrians’ killed was decreased by 7.62% whereas their injury shares were increased by 3.34% during 2006-2010 over 2001-2005 in Kolkata.

**Analysis 4- Statistical Analysis on Road Accidental Risk in Kolkata**

**Analysis 4.1:** In the present study, an up-to-date appraisal of the road users’ accidental risk in Kolkata has been prepared. To assess risk intensity of every traffic accident the probability of a definite traffic accident incidence and suitable appearance of traffic accident effects have been estimated based on published data of KTP review. To specify the risk of traffic, it is obligatory to measure probability of accident incidence ‘P’ and effects of traffic accident ‘C’. Risk assessment is practice of purported degree of risk ‘\(D_R\)’. Degree of risk designates how many times the specified cause of accident is more dangerous than statistically significant average cause of an accident (Stodola, 2008). The vehicle wise degrees of accidental risk both for all road users and pedestrians have been made in this study. Those degrees of accidental risks have been computed by Stodola methodology. Following results have been observed:
Result-1: All road users’ degree of risks for traffic accident is about 0.50 in both for death and injury. Both are significant at 1% level of significance at 2-tailed test.

Result-2: Pedestrians’ degree of risks for traffic accident is about 0.52 in both for death and injury. It is also significant at 1% level of significance at 2-tailed test.

As degree of ultimate risk depends very much on the observed and expected probabilities, it is necessary to check the validity of the level of significance. Here Sandler’s A-test is applied and it is significant at 5% level of significance.

**Analysis 4.2:** In this study a separate vehicle-wise degree of accidental risk for all users under study has also been computed by using Stodola methodology and same results have been observed in Analysis 3.5.

**CHAPTER III**

Chapter III of this study deals with structural, social and financial implication of pedestrian bridges in Kolkata. Over the time-span of two decades, seven pedestrian bridges have come up within Kolkata Municipal Corporation area and three PB within South Dumduum Municipality area. The study under this chapter has been divided into five categories, each of which has been analysed under some subgroups.

**Analysis 1- Population, Male Female Ratio, Number of Household and Land Use Pattern of Survey Area**

**Analysis 1.1:** To study the population of survey area adjacent to different pedestrian bridges, density of population per household has been calculated. It is observed that RBPB, PPB and SLPB are situated in the area where population per household is higher (about 5 persons per household) compared to other pedestrian bridges like LTPB, UTPB, EPB and DHPB (about 4 persons per household).

**Analysis 1.2:** This study reveals an interesting result of higher female share over male in DHPB (49:51) area. Conversely, female share over male are lower in RBPB (59:41), SLPB (58:42), PPB (53:47), UTPB (51:49), EPB (50:50) and LTPB (50:50).

**Analysis 1.3:** Land use pattern of pedestrian bridges in Kolkata reveals that total area occupied by business, hawkers and public utility services adjacent to pedestrian bridges was maximum (20.07%) in the vicinity of SLPB followed by RBPB (19.76%), UTPB (19.15%), EPB
(17.94%), DHPB (8.13), LTPB (6.79%), BSUPB (6.24%). The share of is lowest (1.92%) among them in case of PPB.

**Analysis 1.4:** An attempt has also been made to analyse the safety of pedestrians who face a frightening task in using roads and footpaths in Kolkata, where walk ability index is just 0.81 and it is lower than those of New Delhi, Mumbai but higher than that of Chennai. To calculate walking path ratio, available walking area of pedestrians has been divided by total area of footpath. The percentage of such walking path ratio of PPB was the highest, followed by LTPB, DHPB, UTPB, RBPB and SLPB. Walking path ratio of EPB was lowest among the pedestrian bridges

**Analysis 1.5:** Overall observations of the survey are: (a) higher flow of pedestrians leads to greater concentrations of hawker and business, (b) space encroachment or illegally occupied footpath is more if flow of pedestrians is high, (c) space used for public utility services is more if the width of footpath is more, (d) administrative restrictions and prohibitions can reduce the concentration of hawkers, (e) pedestrian bridges usually or generally are constructed keeping in mind the nearby residential-cum-business locality, market complex, educational institutions, hospital area, railway station and accident prone areas of the city and (f) the pedestrian flow is usually high in the nearby road crossing area.

**Analysis 2- Structure of Pedestrian Bridge**

This part of the study observes that the length of PPB (53.04m) was the highest, followed by DHPB (47.40m) and LTPB (43.28m), with EPB (28.35) having the lowest length among the PBs, whereas the lowest width of the bridge was seen in SLPB and PPB (2.13m), chased by EPB (2.44m) and DHPB (2.74m). The width of LTPB was the highest among the bridges.

**Analysis 3- Vehicle Flow**

This study analyses the vehicle flow beneath the pedestrian bridges in Kolkata. It is observed that during average week day the share of private car and taxi was the highest beneath all the bridges. The share of motor cycle etc. was second the highest in all cases except EPB, RBPB and UTPB. The position of auto rickshaws was second highest in EPB and UTPB. Bus and mini bus etc. took second position in RBPB. The highest percentage share of slow vehicles was seen beneath RBPB, followed by UTPB, DHPB, SLPB and EPB, with PPB having the lowest share.
Analysis 4 - Traffic Speed, Flow and Congestion Time

Analysis 4.1: Average actual speed of vehicles near SLPB was 9.64 (km/h) which was the lowest among other bridges. Average speed (km/h) was the highest near LTPB (23.11) followed by DHPB (19.45), PPB (16.56), RBPB (14.73), UTPB (12.06) and EPB (10.66). Similarly, Vehicle density was the highest in case of UTPB (764) followed by SLPB (652), EPB (402), PPB (389) and DHPB (282). Vehicle density per km near RBPB was the lowest (172) among pedestrian bridges in Kolkata.

Analysis 4.2: Overall vehicle speed and vehicle density relationship (linear regression) among different pedestrian bridges in Kolkata has been calculated in the study. It reveals that the actual speed (y) is inversely correlated with vehicle density per kilometer (x). That is actual speed is the function of the density per kilometer. Here \( y = 21.29 - 0.015x \), where \( R^2 = 0.4308 \) and Adjusted \( R^2 = 0.3169 \). It is not significant at 10% level, as Value of \( P > t = 0.109 \). Hence, the conclusion is that one unit increase in vehicle density per kilometer, actual speed of vehicle is decreased by 0.015 units though this result is not statistically significant.

Analysis 4.3: Vehicle-wise speed, flow and density relationship (Multivariate Regression method) among different pedestrian bridges in Kolkata has also been calculated in the study. It is observed that the vehicle-wise speed (y) is inversely correlated with vehicle-wise density per kilometer (x) but it is positively correlated with vehicle-wise flow per hour (z). Actual speed is the function of the density per kilometer and vehicles flow per hour. Here \( y = 13.80 - 0.0194x + 0.015z \), where \( R^2 = 0.2695 \) and Adjusted \( R^2 = 0.2474 \). It is significant at <1% level, as Value of \( P > t = 0.000 \). Hence, the conclusion is that the speed is negatively correlated with the density per kilometer but it is positively correlated with vehicle-wise flow per hour.

Analysis 4.4: This study observes that average congestion per second was the highest near UTPB (15.90). The position of EPB (13.82) was second highest. SLPB was in third position in average congestion per second. Average congestion per second was the lowest in LTPB (1.68). DHPB, RBPB and PPB lies between 6.49 to 3.21 km/h congestion range per second. It is further observed that the actual speed (y) is inversely correlated with congestion per second (x). Actual speed is the function of congestion per second. Here \( y = 21.56 - 0.7417x \), where \( R^2 = 0.7366 \) and Adjusted \( R^2 = 0.6839 \). It is significant at \( >1\% \leq 5\% \) level, as Value of \( P > t = 0.013 \). So the conclusion is that an increase in congestion by one unit; actual speed decreased by 0.742 units. This result is statistically significant.
Analysis 5 - Financial Costs and Revenues

Most of the pedestrian bridges in Kolkata have been constructed under PPP model. The government has been promoting the involvement of the private sector so as to optimise on the utilisation of government funds for priority projects, timely implementation of infrastructure projects and to offload the operational and market risks to the private sector.

The financial viability of the project is assessed with respect to the key parameters such as project IRR. The viability analysis includes the identification of revenue and expenditure streams of pedestrian bridge. Revenues are earned from advertisement and commercial activities, while the expenditure is made on account of capital as well as operating and maintenance (O&M) costs. Apart from the financial attractiveness, non-financial costs and benefits of a project should be considered to reflect social values of the project.

CHAPTER IV

Chapter IV deals with most important part of socio-economic analysis of pedestrian bridges i.e., the utilisation pattern of pedestrian bridges. This study is to find out the effects of different factors on overall incidence of using pedestrian bridges as well as on some selected bridges in Kolkata that have been shown both in simple percentage form and in probabilistic model by applying logistic regression analysis based on primary survey data.

Analysis 1- The Effects of Socio-Economic Factors on Overall Incidence of Using Pedestrian Bridges in Kolkata

Analysis 1.1: The use of PB is not uniform over different pedestrians’ sex groups. As we have divided total sex groups into 2 mutually exclusive groups, 1 dummy is incorporated into the model. The chance factor of using PB by male is less as compared to the use of PB by female group. So, it is evident that male pedestrians lag behind the female on overall incidence of using pedestrian bridges, which is however not significant at 10% level. So, the gender differences in choice of using PB were statistically insignificant. This finding is quite different from earlier study by Milton, Olive and Ronald (2002).

Analysis 1.2: The use of PB is not identical over different pedestrians’ age groups. Different age groups are represented by the dummy variables. As we have divided total age groups into 4 mutually exclusive age groups, 3 dummies are incorporated into the model. The chance factors of using PB by pedestrians’ age groups 19-30 yrs and 31-50 yrs are less as compared to the use of PB by pedestrians having age group 6-18 yrs. These are significant at 5% level.
**Analysis 1.3:** The use of PB is not uniform over different time intervals in a particular day. Different time intervals are represented by the dummy variables. As we have divided total working hours into 6 mutually exclusive intervals, 5 dummies are incorporated into the model. The probability of using PB is more during 8-9 hours as compared to the use during 19-20 hours and it is significant at 5% level. But the chance factor of using PB which is significant at 10% level is less during the peak hours (17-19) than those during 19-20 hrs (Base outcome).

**Analysis 1.4:** The perception about pedestrian bridge is quite different over different classes of pedestrians; some of them use the PB and others to cross the road without using the PB. It is observed in the study; out of 1495 bridge users interviewed 72.17% users were concerned with their road accidental risk, whereas 27.83% users were more conscious of other factors, like their time saving, avoidance of road pollution and scenic view of adjacent area by the use of PB.

It is evident that out of 1500 bridge non-users interviewed 67.07% were concerned with their road accidental risk, whereas 32.93% non-user perceived that construction of PB was mainly for earning revenue of the bridge promoters and or government by advertisement, and as a recreational spot.

**Analysis 1.5:** The study observes that overall 69.61% of total pedestrians were concerned with their road accidental risk factors, whereas 30.39% pedestrians were more conscious of other factors. Most (69.61%) respondents were worried about their safety on the road. It is interesting to note that 33.59% of sample perceived that crossing the road through traffic had an accidental risk and it might be avoided by using PB, yet they did not use it.

**Analysis 1.6:** The study observes that the structural problem (68%) was the main problems faced by the users of PB, followed by the poor conditions (22%) and poor facilities (10%). About 38% non-users cited the extra walking distance and time, and availability of nearby crossing facility. 43% non-users avoided PB mainly quoting health reasons while 7% feared for their security on the PB. 12% non-users quoted the lack of lift and escalators facilities as a cause of non-using the PB.

For the purpose of statistical analysis, different problems of pedestrians are represented by the dummy variables. As we have divided total problems into 4 mutually exclusive problem groups, 3 dummies are incorporated into the model where poor facilities appear to the most-referred problem.
The structural causes and poor conditions are the major contributors to the probability of non-using the PB. The value for the odds of variable ‘Structural Cause’ indicates that elimination of structural cause increases the use of PB by a factor of 1.78. The probability (0.64) of using PB by removing structural causes is more than that of the poor facilities. Similarly, the value of odds of variable “Poor Condition” indicates that, better conditions enlarge the use of PB by a factor of 3.35. The probability of using PB with improving conditions (0.77) of the PB is more than that of the poor facilities. Both the variables are statistically significant with their p-value < 0.0001. It implies that probabilities of using PB with removal of structural problems and ensuring better conditions of PB are more than the removal of poor facilities.

**Analysis 1.7:** The Pedestrian’s occupational status is an important socio-economic factor regarding the use of PB. Our estimated model considered unemployed, retired, household and other pedestrians as base outcome. Service holder variable indicates that, as number of service holder users increases the using the PB increases by a factor of 1.33 over other occupational group and it is significant at 10% level. Probability of using PB by service holder (0.57) is greater than that of “other” (Unemployed, retired, household and others) occupational status of bridge-users.

**Analysis 1.8:** Educational qualification of pedestrians is one of the socio-economic factors that may influence to the use of pedestrian bridge. In the logit model illiterate pedestrian is considered as base outcome. It observes that the probability of using PB by the pedestrians having education at primary level (0.58) is greater than that of the illiterate pedestrians. On the other hand, increase in number of pedestrians having education at higher education level, the use of PB decreases by a factor of 0.96, where probability (0.49) of using PB by the pedestrians having education at higher education level is less than that of the illiterate pedestrians. These variables are not statistically significant and are not however the major contributors to the prediction of using PB.

**Analysis 1.9:** The study observes that when pedestrians go for assigned work they do not use the PB, but they use PB at the time of returning home and go for other purposes.

Male pedestrians do not use PB at the time of rushing for the assigned works and it would be a cause of their tension on performing the assigned works. But male pedestrians use PB at the time of returning home and other purposes. It appears that they have less tension at those times. On the other hand, female pedestrians use PB at the time of rushing for the assigned works so that they could perform that duties safely, but they did not use PB at the time of returning home and other purposes.
Analysis 1.10: Obeying the traffic rules to cross the road is an alternative of using PB. The value of odds of “obey the traffic rules” indicates that, if this variable increases, the odds of using the PB increase by a factor of 1.70. Probability of using PB (0.63) for pedestrians who obey the traffic rules is more than that of the pedestrians who disobey traffic rules. This variable is statistically significant with its p-value < 0.0001.

Analysis 1.11: Pedestrian’s monthly income contributes to the prediction of using PB. The use of PB is not uniform over different pedestrians’ monthly income groups. As we have divided total respondents into 3 mutually exclusive income groups, 2 dummies are incorporated into the model. Here, a pedestrian having no monthly income is considered as base outcome of the statistical analysis.

The value of odds of pedestrian’s income which is greater than average income signify that, if this variable increases, the odds of using the PB decrease by a factor of 0.64. Probability of using PB (0.39) for pedestrians whose income is greater than the average income is less than that of the pedestrians having no income. It indicates that higher the income of pedestrian less is the chance of using PB or greater is the chance for non-using the PB. This variable is also statistically significant at 5% level.

Analysis 2- Logistic Regression Results of Selected Pedestrian Bridges in Kolkata

Analysis 2.1: This study observes that the chance factor of using Park Circus Pedestrian Bridge (PPB) by male pedestrians is less than that of female pedestrians. It can be inferred that female pedestrians play relatively more important role behind the use of PPB as compare to male pedestrians and this variable is significant at 1% level. The uses of PPB will be increased significantly (5% level) with the elimination of structural causes and poor conditions. The chance factor of using this bridge by pedestrians having education at higher level is more than those having no income; it is significant at 10% level. Our estimated model finds a positive and significant (5% level) impact of “Obeying the traffic rules” on the use of PPB. The estimated coefficient of income status of the pedestrians again plays a negative and significant role on the use of the bridge. It also shows that most of the pedestrians in this area belong to no income group.

Analysis 2.2: This study observes that the chance factor of using Sealdah Pedestrian Bridge (SLPB) by male pedestrians is more than that of female. The coefficients of pedestrians in the age groups like 19-30 yrs, 31-50 yrs and 51 yrs and above are inversely correlated with using the SLPB. Pedestrians (about 30% of users) choose better condition of the PB as an important
factor behind use of PB. It is observed that the coefficients of pedestrians belonging to service holders, businessmen and student groups are inversely correlated with the use of the PB. It implies that most of the pedestrians having “other occupational” category uses SLPB more; they are mostly the patient parties of NRS hospital. Most of the pedestrians in the age group of 6-18 yrs use SLPB. The reasons may be, it is situated adjacent to Loreto Girl’s School area, they are more conscious about the traffic rules, and the pedestrians belonging to 6-18 yrs’ age group are mostly the students of that school.

It is evident that the gender, age and pedestrian’s occupational differences in choice of using SLPB are statistically significant. It also observes that significant variables like, better conditions of PB, pedestrian’s journey for specific assigned duties and consciousness of traffic rules play an important role of using SLPB.

**Analysis 2.3:** This study observes that the use of Ultadanga Pedestrian Bridge (UTPB) is not uniform over different time interval in a particular day. We have taken 19-20 hrs as a reference time interval. Different time intervals are represented by the dummy variables. As we have divided total working hrs into 6 mutually exclusive intervals, 5 dummies are incorporated into the model. The chances of using the bridge are more during 8-9 hrs and 9-11 hours as compared to the use during 19-20 hours. But the chance factors of using UTPB are less during slack hours (11-12) and the peak hours (17-19) than those during 19-20 hours. It is further observed that the pedestrians belonging to service holder, pedestrian’s journey for specific assigned duties and consciousness of traffic rules made differences in the choice of using the bridge have positive and significant influence on using UTPB. Income differences in the choice of using the bridge are negative and significant in UTPB.

**Analysis 2.4:** This study observes that the chance factor of using Lake Town Pedestrian Bridge (LTPB) by male pedestrians is less than that of female pedestrians and this variable is significant at 10% level. An increase in pedestrians having option of structural problems of LTPB, the odds of using PB is decreased by a factor of 0.14. The probability of using PB by those pedestrians is less than that of pedestrians who opt for other causes. This variable is significant at 10% level. The student pedestrians acquire an important positive function behind use of LTPB and it is significant at less than 1% level. It is evident that variables like gender, problems of pedestrian and pedestrian’s occupational differences in the choice of using LTPB are statistically significant.
CHAPTER V

Chapter V of our study makes an attempt to identify the potential impact of the pedestrian bridge on the society. We use the technique of Cost Benefit Analysis (CBA) for the purpose which identifies the effects of the project on the individual welfare of all members of the community. CBA is an approach for systematic quantitative as well as qualitative evaluation and it appraises the investment on the bridge project in social or economic point of view and help to save resources for the best interest of the society. We divide the analysis into four major categories; which are again segregated into many subparts.

**Analysis 1- Existence of Free Economy for Maximization of Social Welfare or For Achievement of Pareto Optimality**

The aggregation of individual’s preferences is related to *Social welfare*. A project requires the identification of all the effects of the project on the individual welfare of all members of the community and these effects are to be measured in some common unit so that aggregate benefits can be compared with aggregate costs to maximise the social welfare. Optimal social welfare needs free economy and perfect competition. Due to imperfectness of the market systems, markets fail to ensure optimal allocation of resources. The major factors responsible for market failure are growth of monopoly power, incomplete information, existence of public goods, and externalities.

**Analysis 2- Exclusion Principle in Economics**

In economics, the *exclusion principle* states that the owner of private goods may exclude others from use of the goods unless they pay. This exclusion principle doesn’t pertain to public goods like pedestrian bridge. However, “free riders” in case of public goods are those who take the benefit of a good or service but don’t pay for it even though they are supposed or required to pay, voluntarily or otherwise. All pedestrians are able to use pedestrian bridge even if they don’t pay for it.

**Analysis 3- Externalities of an Economic Activity**

*Externalities* are common in virtually every area of economic activity particularly in case of public investment project. Externalities occur where there are significant social costs or benefits of production or consumption that are not reflected in market prices. However, sometimes, costs or benefits of public good may *spill* over to a third party not directly involved
in the project. A negative externality exists when a cost spills over to a third party. A positive externality exists when a benefit spills over to a third-party.

**Analysis 4- Social Cost Benefit Analysis on Pedestrian Bridge**

**Analysis 4.1:** Social Cost Benefit Analysis (SCBA) closely resembles financial appraisal, while financial costs and benefits are based on market prices, social costs and benefits are associated with ‘social values’ of goods and services which are derived by suitably adjusting their market prices. These adjusted market prices popularly known as ‘accounting prices’ or ‘shadow prices’.

Project Appraisal Division (PAD) in India follows a modified version of the Little-Mirrless approach. Indian financial institutions like ICICI, IDBI, and IFCI follow a similar approach which is a simplified version of Little-Mirrless approach.

The present study is based on the ‘partial Little-Mirrless’ approach. The social costs, both for capital costs and operating and maintenance costs, and the social benefits derived from the pedestrian bridge project are calculated on the basis of the shadow prices or social conversion factors (SCF) that are frequently used in the ICICI study and IDBI’s system on economic appraisal of projects financed by them, with some minor variations.

**Analysis 4.2:** The Net Present Value (NPV) of the project is calculated as $NPV = R - C$. The opportunity costs of time is done by discounting the flow of private benefits (B) and private costs (C) with the discount rate ‘d’ which in the study is set in at ‘d’ = 0.12. The net present value test is applied to determine the extent of private benefits over private costs of the project. Positive value of NPV represents overall benefits of the project. The benefit-cost ratio (BCR) is calculated to compare the value of different pedestrian bridges. Internal rate of return (r) is considered in this study so as to find out social efficiency of the project. A project is socially efficient if $r > d$, which means the rate of return on the project is larger than the time-preference of society. It is evident that NPVs of all pedestrian bridges in Kolkata are positive and BCRs everywhere are greater than one, but these values differ among pedestrian bridges.

**Analysis 4.3:** The ratio of the actual speed (AS) of respective location of pedestrians bridges to average standard speed (ASS) of Kolkata and the ratio of the congestion time /second of individual (ICT) location of pedestrian bridge to the average congestion time /second of total (ACT) bridges are considered in this study. Greater value of AS over ASS and lower value of ICT over ACT represent positive externalities of the pedestrian bridge. This study observes that only LTPB would claim to have a positive externality effect or benefit spillover to society,
and other bridges exhibit negative externalities on this issue. This study observes further that only LTPB, PPB and RBPB have positive externalities or benefits spillover to the society, whereas the results of UTPB, EPB and SLPB reveal a negative externality effect.

**Analysis 4.4:** Opportunity benefit of using a pedestrian bridge is measured by loss of calories of stair-users than non-climbers. It may be called as opportunity benefit of physical fitness (BPF). Similarly, the opportunity benefit of using a pedestrian bridge is assessed by the fines and penalties imposed on jaywalking (non-user of pedestrian bridge) by the local authorities. It implies that bridge users get advantage benefits (AB) of not paying any amount as fine and penalties. All pedestrian bridges show positive results of factors like BPF, AB, but have different values among pedestrian bridges in Kolkata.

**Analysis 4.5:** Study observes that out of 2995 pedestrians interviewed, 64.61% of pedestrians opined that extra time is required with the use of pedestrian bridge whereas 35.33% pedestrians made a contradictory opinion that the time could be saved with the use of PB.

Time saved with the use of PB (TSPB) or Time saved with the use of Road (TSR) and the value of time saved with the use of PB and Road have been computed in this study. The value of time saved has been calculated based on reported income of pedestrians. The value of time saved with the use PB (VTSPB) stands for a benefit of pedestrian bridge and the value of time saved with the use road (VTSR) is a cost of pedestrian bridge. It infers that greater VTSPB over VTSR represents a benefit of PB.

Greater value of ratios of TSPB to TSR and VTSPB to VTPB stand for benefits of pedestrian bridge and the lower values signify as a cost of the bridge. LTPB, PPB and UTPB have a positive externality effect or benefit spillover to the society and other bridges like SLPB, EPB and RBPB exhibit negative externalities or cost spillover to the society.

The study observed that total time saved and its value in case of pedestrians who believed that bridge use could save travel time were less than those pedestrians who think that the use of road could reduce the travel time and related value, despite the fact that it involves a chance of accidental risk.

**CHAPTER VI**

Chapter VI of this study makes an attempt to have a comparative analysis of different pedestrian bridges in Kolkata. We segregate the analyses into six major categories with number of subdivisions in each of them.
Analysis 1- Population, Number of Household Gender Ratio and Land Use Pattern of Survey Area

Analysis 1.1: This study observes that the percentage share of number of household is the highest in PPB area, followed by RBPB, LLPB, SLPB, UTPB and DHPB, with EPB having the lowest share. A higher number of persons reside in a same house in these areas which implies that density of population in the adjacent area of RBPB, PPB and SLPB are higher than those of LTPB, UTPB, EPB and DHPB areas.

This study observes that middle and lower income group families are concentrated in the area of PPB and RBPB. SLPB is located at Sealdah, and this bridge is surrounded by different markets, hospitals, educational institutions and old neighborhoods of Bowbazar areas. UTPB is surrounded by roadside market area, new neighborhoods of Salt Lake and old neighborhoods of Manicktala area. The percentage share of household of EPB and DHPB is observed to be lower because well educated, middle class people generally stay in these areas.

This study observes higher female share over male in DHPB area. Conversely, female share over male are lower in RBPB, SLPB, PPB and UTPB. Share of male and female is mostly equal in EPB and LTPB areas.

Analysis 1.2: We have studied the land use pattern adjacent to different pedestrian Bridges in Kolkata and observe that total area occupied by businesses, hawkers and public utility services adjacent to pedestrian bridge is maximum in the vicinity of SLPB followed by RBPB, UTPB, EPB, DHPB, LTPB and BSUPB. That share is lowest near PPB amongst all other pedestrian bridges in Kolkata.

Analysis 2- Traffic Flow, Speed, Vehicle Density and Congestion beneath the Pedestrian Bridges

Analysis 2.1: We have studied traffic flow beneath the different pedestrian bridges in Kolkata along with types of vehicles and observed that total vehicle flow per day beneath UTPB, PPB, SLPB, LTPB, DHPB, EPB and RBPB were 9214, 6446, 6285, 5589, 5485, 4286 and 2535 respectively. The share of private car and taxi was the highest in all the bridges. The share of motor cycle etc. was the second highest in all cases except EPB, RBPB and UTPB. The position of auto rickshaws was the second highest in EPB and UTPB. Bus and mini bus etc. was in second position in RBPB. The highest percentage share of slow vehicles was seen in RBPB, followed by UTPB, DHPB, SLPB and EPB, with PPB having the lowest share.
Analysis 2.2: Average actual vehicle speed of SLPB was the lowest among other bridges. Average vehicle speed (km/h) was the highest in LTPB followed by DHPB, PPB, RBPB, UTPB and EPB. Vehicle density per km near RBPB was the lowest (172) among pedestrian bridges in Kolkata. Vehicle density was the highest beneath UTPB (764) followed by SLPB (652), EPB (402), PPB (389) and DHPB (282).

Analysis 2.3: This study observes that average congestion per second was the highest in UTPB (15.90). The position of EPB (13.82) was the second highest. SLPB was in third position in average congestion per second. Average congestion per second was the lowest in LTPB (1.68). Congestion per second of DHPB, RBPB and PPB lies between 6.49 to 3.21 second.

Analysis 3- Relationship between Traffic Speed and Congestion Time

Overall vehicle speed and congestion relationship in Kolkata has been computed and is observed that actual speed (y) is the function of congestion per second (x), we get, y =21.56 - 0.7417x, where R² = 0.7366 and Adjusted R² = 0.6839. It is significant at >1% ≤ 5% level, as Value of P > t = 0.013.

This study further observes that the actual speed is inversely correlated with congestion and the power and strength of the relationship between two variables is diverse among different pedestrian bridges.

It is observed that in all the cases the congestion and vehicles speed are negatively and significantly associated. It is further observed that the coefficient of the congestion and vehicles speed of UTPB is the highest, followed by RBPB, SLPB, LTPB, DHPB and PPB, with EPB having the lowest figure.

Analysis 4- Structural Specifications and Financial Costs and Revenues

It is evident that structural specifications and financial costs and revenues of different pedestrian bridges in Kolkata are unique in character. Their shape and size are different from each other. The length of PPB was the highest, followed by DHPB and LTPB, with EPB having the lowest length among the PBs, whereas the lowest width of the bridge was seen in SLPB and PPB, chased by EPB and DHPB. The width of LTPB was the highest among the bridges. While making the comparative study of the project cost of different pedestrian bridges, the cost-type difference acts as the major obstacle for the comparison. With the
application of common size statement, where all the factors in the statement are expressed in the percentage of the total value, the cost difference has been attached to be assessed.

This study observes that the share of structural steel works cost including elevator and escalator costs was highest proportion in total project cost of different pedestrian bridges in Kolkata. Head wise O&M costs of different pedestrian bridges were different, though it is seen that the share of total maintenance costs was higher in most of the bridges.

**Analysis 5- Logistic Regression Results of Socio-Economic Factors among Selected Pedestrian Bridges in Kolkata**

**Analysis 5.1**: The estimated coefficients of gender difference are significant in PPB, SLPB and LTPB but not in UTPB, though the effects of gender difference on the use of PB vary among the bridges.

**Analysis 5.2**: The pedestrian’s age groups are significant in SLPB and these variables are negatively correlated with the bridge use. However, our estimated models didn’t find any significant result of pedestrian age group on the use of PPB, UTPB and LTPB.

**Analysis 5.3**: Our estimated model finds a significant impact of different time intervals in a particular day only on using UTPB, in other cases the impact is not significant.

**Analysis 5.4**: This study infers that with the removal of structural problems of PB, the probability of using PPB increases but a decreased probability is observed in LTPB; on the other hand, one unit increase in pedestrian who opt for better condition of PB, the probability of using PPB and SLPB is increased.

**Analysis 5.5**: The estimated models find the significant impact of pedestrian’s occupational status on using SLPB and UTPB but not in case of other bridges. It is evident that most of service holders, businessmen and students pedestrians do not use SLPB but the service holder factor has an important impact on the use of UTPB.

**Analysis 5.6**: We observe that pedestrian’s educational qualification doesn’t find any significant impact on the PBs except in the case of PPB where pedestrian possessing education at higher level has a positive effect on using the bridge.

**Analysis 5.7**: Pedestrian’s journey for assigned work is an important contributor to the prediction of using SLPB and UTPB only, although this effect quietly differs in nature between SLPB and UTPB.
Analysis 5.8: It is evident that pedestrians who obey the traffic rules have a positive and significant impact on using PPB, SLPB and UTPB. In case of other bridges the impact is not significant.

Analysis 5.9: This study observes that pedestrians whose income is more or less than average income have negative impact on using PPB and UTPB.

Analysis 6- Internal Costs and Benefits, and “Spillover Effect” of Pedestrian Bridges in Kolkata

Analysis 6.1: It is evident that NPV and BCR of internal costs and benefits were highest in UTPB followed by EPB, RBPB, SLPB and PPB.

Analysis 6.2: It observes the highest value of ASS and lowest value of ICT&ACT in LTPB followed by PPB and RBPB. The values of ASS and ICT & ACT are the lowest in SLPB and UTPB. The value of BPF is the highest in SLPB; on the contrary, the value of AB is the highest in RBPB, followed by EPB, with LTPB having the lowest figure.

7.2 SUGGESTIONS

On the basis of the overall work done some suggestions may be made so that improvement can be brought in in the utilisation of existing PBs of Kolkata and in constructing any new PB in future.

1. Short span (Length) of pedestrian bridges should not be considered particularly if the proposed construction is adjacent to the existing crossing facilities, otherwise most of the pedestrians will avoid using the bridge like EPB which is the modern mechanized short span bridge and it is situated near the existing crossing facility area.

2. Modern mechanized pedestrian bridge give a relief from climbing up stairs, hence is easily accepted by pedestrians subject to the pedestrian volumes and the space availability for construction of escalators / elevators on either side of the bridge.

3. The location of pedestrian bridge should be based on the pedestrian volumes and the space availability.

4. Intensity of commercial activities like CBDs, markets, shopping areas, locations of institutional areas like schools, colleges, hospitals, public places like theatres, play areas etc.
and potential for revenues through advertisements at the location are other parameters of pedestrian bridge locations.

5. The bridges should be brought under regular safety surveillance so that the pedestrians can use them without fear and harassment.

6. The local bus stand should be near the entrance of PBs to enhance the use of PB.

7. Pedestrian bridge locations selection should be prioritized based on the following criteria:

(a) Ease of implementation of the bridge project.

(b) Proposed road development plans of town planning authority.

(c) Accident prone areas.

(c) Identified risks – technical, legal and political compulsion etc.

8. Field survey and area analysis should be done to finalise the exact pedestrian bridge locations from the list of identified locations. Based on the pedestrian volumes and the space availability, escalators and elevators apart from the staircases shall be installed at these locations.

9. The exact locations of the pedestrian bridges should be finalised based on the following criteria:

a) Number of accidents at the given locations due to collision of high speed motorized fleet with the pedestrians crossing the road.

b) Traffic congestions at a given point/junction on the road corridors.

c) Time taken for pedestrian in crossing the road vis-à-vis the green signal time.

d) High-speed road corridors.

e) Nearness to bus shelters and the road junction’s area.

f) Intensity of commercial activities like CBDs, markets, shopping areas etc.

g) Locations of institutional areas like schools, colleges, hospitals etc. and location of public places like theatres, exhibition grounds, parks, play areas etc.

h) Potential for revenues through advertisement on pedestrian bridge and elevator shafts and ATM’s, Telephone booth & kiosks within the pedestrian bridge at the location.

i) Constant revenue stream for the government.

j) Reduction in travel time / smooth traffic movement.
10. Penalty and fine against non-user of PB should be enhanced and strictly imposed on the defaulters.

11. Pedestrian awareness programme should be sufficient; awards may be given to the regular user of PBs.

12. Scope of crossing the roads where PBs are located should be reduced by proper fencing, surveillance etc.

### 7.3 SIGNIFICANCE OF THE STUDY

1. The need to build an infrastructure of social importance requires large public expenditures. The need is now being increasingly felt that each public project is to be assessed not only in terms of its direct costs and benefits but also in terms of its wider social and economic implications. The present study will throw some light in this respect to the policymakers.

2. 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. Road traffic injuries leading in most cases to disabilities and hospitalizations impose severe social and economic burdens on the victims. This study is an attempt to make the pedestrians aware of this burden.

3. 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 pedestrian bridges. An attempt to enquire about the use / non-use of the pedestrian bridges and to examine if there is any discernible cause behind it, the present study will be very much helpful.

4. The present analysis determines the effects of different demographic and social factors on the incidence of use of pedestrian bridges in probabilistic sense in some selected important locations in Kolkata. The explanatory variables of this study are pedestrian’s sex, age-group, specified time-group, problems of using pedestrian bridge, occupational status, education and monthly income etc. So, this may be useful to the civic authorities to identify specially the problem area and apply suitable reaction or proactive measures.

5. Infrastructural developments and technical up-gradation of effective traffic management system with conscious support from the road users of Kolkata would pave the path for positive
results to the society. From this study the authority may get some guidelines for such developments or up-gradation.

6. Future researchers can also have good number of clues from this study while analysing the viability of public/social goods or while analysing the social cost and benefit of a project.

7.4 SCOPE OF FURTHER RESEARCH

Due to time and other constraints, all socio-economic aspect of pedestrian bridges in Kolkata could not be looked into exhaustively. So, there is sufficient scope for further research on the issue. Some of such areas are outlined below.

1. A comprehensive study can be conducted to highlight the position of the pedestrian bridges in other metro cities in India. A comparative study on the issue among different cities, different States of India and even among different countries can be made.

2. The use of pedestrian bridge depends on several socio-economic factors, this study considers only pedestrian’s related factors. The impact of pedestrian bridge on other road users, resident, shop owners, road sides’ hawkers etc. may be the study for further research.

3. Social Cost Benefit Analysis has been made in this study. All financial costs and benefits of the bridge have been converted into social costs and benefits by using SCF, SWR and SDR. The price of tradeable components with the use of SCF, the shadow price of labour and residual components have been taken into account based on the assumptions of ICICI study and IDBI’s system on economic appraisal of projects and other studies. So, there is an enough scope for further research with the variation of present valuations.

4. Present study makes an attempt to value a few “externalities” (both positive and negative externalities) or “Spillover” effects, like ASS, ICT&ACT, BPF, AB, TSPB, TSR, VTSPB and VTSR of pedestrian bridge. Valuation of other “Cost spillover” and “Benefit spillover” may be the subject matter of further research.

5. A study can be undertaken to calculate pedestrian’s road accident probability adjacent to the different pedestrian bridges in Kolkata.