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An Economic Evaluation of Feasibility of Non-Motorized Transport Facilities in Mombasa Town of Kenya

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Abstract:

Kenya Municipal Programme (KMP) with the support from World Bank underlined the need of promotion of Non-Motorized Transport (NMT) facilities in selected towns. To realize this, an economic evaluation of the feasibility of non-motorized transport facilities in Mombasa town has been carried out. The proposed NMT facilities are grouped into Structures, Footpaths, Cycle Tracks and Traffic Calming Measures. Benefit Cost technique has been adopted as method of economic evaluation. The costs of the proposed facilities have been derived by engineering cost estimate. Benefit to NMT users accrue when dedicated NMT infrastructure is created. Provision of appropriate infrastructure has both short and long term benefits. The long term benefits are more complex and quantification of these benefits is more complex. The present analysis is confined to the short term benefits, accruing over a 5 year period. The quantum of benefits in term of saving in productivity loss and time saving has been estimated. The construction is expected to be completed in one year. Benefits start accruing from 2nd year onwards. The benefits and costs have been discounted at a rate of 12% to derive the NPV in the first year. A factor of 0.85 has been adopted to convert financial costs into economic costs. The Benefit Cost (B/C) Ratio for provision of Footpaths is estimated to be 17.22, Cycle Tracks to be 0.74, Foot Over Bridges to be 0.51 and traffic calming measure to be 17.56. The overall B/C ratio

is 8.41. Overall the proposed investment programmes are economically viable.

Key words: Benefit-Cost Ratio, NPV, economic viability, non-motorized transport

1.0 Introduction:

Kenya is experiencing high growth of population and urbanization. The population, which was 38 million in 2009 (Census of Kenya, 2009), is estimated to increase to 74 million by 2030 and urbanization from 34% to more than 50%. The Kenya Vision 2030 envisages a sustained economic growth of 10% up to 2030. Such a growth will induce high urbanization and in turn depends on urban areas for services, technologies and infrastructure. Urban areas need to play a prominent role in Kenya's development.

Restructuring and reformation of urban infrastructure and institutions are critical in this development process. Government of Kenya, has initiated the Kenya Municipal Programme (KMP) with support from World Bank, the Agence Francaise de Development (AFD) and the Swedish International Development Cooperation Agency (SIDA) (KMP Project 2012-13). KMP has the overall objectives to strengthen local governance and improve urban service delivery. The KMP, under the third component, has recognized the importance of Non-Motorized Transport (NMT) in enabling mobility of the people of the towns. One of the components includes promotion of Non-Motorized Transport modes to enable mobility of the people. In the KMP, several towns of Kenya including Mombasa have been selected for provision of NMT facilities. Here we have chosen Mombasa as it is the second biggest town of Kenya as well as the one of the major port towns of east Africa.

Appreciation of the traffic and travel characteristics of the study town is important to plan for the transport facilities

in general and NMT facilities in particular. Mombasa is an important and fast growing town in Kenya. Its population, presently 0.94 million (2009), is envisaged to be nearly 2 million by 2031 (Census of Kenya, 2009). Mombasa has a good road network of sound form and reasonable capacity. International trunk road A109 runs through the town. It provides high accessibility to the town. On the other hand the high speed high volume traffic is a major cause of congestion and accidents. The availability of road capacity in Mombasa is reasonable but not sufficient. The carriageway is generally of 2-lanes. Road reserves are good. The availability of footpath is poor. There is no exclusive cycle track. Condition of footpaths is not good. There are obstructions by parked vehicles and vendors. The traffic volumes on roads are high with a maximum of 29,117 vehicles (12 hours) on Jomo Kenyatta Avenue. The share of NMT modes is reasonable, up to 23%. Pedestrian volumes are very high. Nkrumah road had 34,124 pedestrians over a 14 hour period (Traffic Survey Result 2013 of KNMT project, 2012-13). Traffic Management along the road network is poor. 44% of road lengths do not have signage.

NMT users were mostly males (59%); young (35% in age group 26-35 years); large number of students (15%); and had an average income of Kenyan Shilling (Ksh.) 9000/- per month. NMT trip lengths were short (less than 2 km for 33%); average trip time was 37 minutes and that of walk trips 28 minutes. Average monthly expenditure was Ksh. 1250. NMT users considered pedestrian environment as 'bad' (80%). Walk is resorted for want of public transport (38%). Absence of footpaths and cycle tracks were considered as major problems. 'Continuity' of the facility was given top priority in the preference. At-grade crossing was preferred. NMT operators (bicycle boda-bodas) were young in age (40% in 20-25 years); owned their mode (71%); operate 8-10 hours a day; perform 10-20 trips (87%); and carried about 10 to 20 passengers per day (NMT Operators Survey 2013 of KNMT project, 2012-13).

Household Interview Surveys in 2013 (KNMT project, 2012-13) has revealed interesting information about the household, personal and trip characteristics. The mobility of the people is high with a per capita trip rate (PCTR) of 2.4. Mini Bus/ Matatu trips were moderate (20%) followed by 'walk' trips were very high (70%); 'Work' and Business' trips accounted for 63%; Average trip length of all trips was high (2.14 km). Average trip length of walks trips was 1.01 km. The average per capita income was observed to be Ksh. 8052 per month. The expenditure on 'Transport' was high (15.60%).

2.0 Literature Survey:

A brief overview of the best practices in NMT policy, planning, design, finance and development approaches followed in several developed and developing countries. A holistic combination of all the above aspects is necessary for successful implementation of NMT programme. Some of the successful examples in NMT Policy and Planning measures have been described and include NMT network planning in Bogota-Columbia (Cervero et.al. 2009); Dublin Public bicycle sharing schemes (Ghosh et.al. 2011), National Bicycle initiative in South Africa (Gwala, 2007); Legislation of National Bicycle law in Japan (ECMT, 2004); Integration of NMT planning in the overall Urban framework as successfully done in Netherlands (Fietsberaad, 2008), various successful promotional strategies as Car Free Days in Bogota (Cervero et.al. 2009) etc.

Some of the globally accepted design concepts in NMT facilities have also been described and suitably incorporated in the recommended designs. Once the NMT policy and plans are streamlined there is a need for a well-coordinated institutional and financing arrangement for successful implementation. Some of the institutional frameworks that have been successful in the areas of Urban Transport and NMT i.e. formation of Boards, Groups with representations from Ministry &

Provincial Governments for implementing Bicycle Network Plan in Netherlands (Fietsberaad, 2008); legislation of cycling laws as in Germany, Japan, Bogota (GTZ I-CE, 2009); formation of Unified Metropolitan Transport Authority (UMTA) (Gupta, 2013) in all cities with at least a million inhabitants as recommended in the Urban Transport Policy in India. Experiences world over show the major source of finance for NMT investment is indeed the central government which funds directly to NMT programmes or decentralizes budgets to municipal level. However, various other innovative financing mechanisms used in NMT funding (National Funds, PPP, Community funding, Levies & Charges) have also been described.

To carry out a successful NMT programme in Mombasa town of Kenya; require review of a number of policy/statues/acts, that impact the course of Urban/Transport/NMT planning and development in Kenya (Pendakur, 2005). The important documents reviewed in this regards are the New Constitution of Kenya, 2010, Kenya Vision 2030, The National Transport Policy 2010 and The (Draft) Urban Development Policy 2012 and a host of legal statutes (KNBS, 2010 & 2012). Urban Transport and NMT in Kenya still continue to be affected by a number scattered and uncoordinated legislation and need reforms and restructuring to establish a sound policy and legal framework with clearly established roles and responsibilities at all levels of governance. The Integrated National Transport Policy (KNBS, 2012) recognizes the need to eliminate the impediments to development and use of non-motorized and intermediate means of transport to enhance transport safety. It also recommends adoption of an Urban Transport Policy with clear identification of specific NMT strategies and the institutional arrangements for its implementation. The new Constitution and the Urban Areas and Cities Act 2011 provide for governance and management structure for the urban areas and cities by the

County Government and administered on its behalf through constituted Boards/Committees. The various road agencies like Kenya Urban Road Authority (KURA) and Kenya National Highway Authority (KeNHA) constituted as part of Road Act 2007 are also expected to be devolved in this newly established governance structure. The National Transport Safety Authority Act 2012 is a positive development for NMT and shall ensure implementation of policies related to Safety of Vulnerable Road users. The Traffic Act Cap 403, primarily deals with the law related to motor traffic on the roads, however it fails to recognize NMT and clusters them as other users. Mombasa needs a Master Plan to guide its growth. The expansion of the Port, the modernization of the Mombasa – Nairobi rail line, the development of the Northern Corridor would all accelerate the growth of Mombasa. Presently the city is divided into 4 parts separated by the creeks. A new Orbital Corridor inter-connecting the parts and polycentric development pattern has been conceptualized. The city is planned to contain a population of 2 million by 2030. In the framework of the Concept Master Plan the NMT Master Plan (NMTMP) has been prepared. It has the vision to promote mobility through NMTS and a mission to develop NMT facilities on a sustained basis. The NMTMP envisages provision of segregated footpaths and cycle tracks; improvement of intersections; provision of foot over bridges; provision of parking and other facilities for bicycle boda-bodas; application of intense traffic calming measures to improve safety of NMT users and operators; and a number of institutional reforms to promote sustained development of operation of NMTs.

The Engineering Interventions in Mombasa include provision of 3 foot over bridges; Provision of the pedestrian bridge across the drain; footpath and cycle tracks (47.6 km) along important roads; intense traffic calming measures; improvement of junctions; provision of Bicycle stands; etc. Design of the Engineering Interventions identified need to be

cost effective, user friendly and low in maintenance cost apart from other features. The designs conform to international standards. For footpath, parking areas, bus bays etc. precast concrete blocks of 50-100 mm thick laid over 50-100 mm thick compacted granular base course is adopted. For the foot over bridge steel truss is selected. Modular design is adopted. Design of NMT facilities/infrastructure has been carried out. The pavement structure can be either of rigid type or flexible type. For catering the needs of non-motorized vehicles, the use of asphalt pavement (i.e. flexible pavement) has been preferred (KNMT Project 2012 -13 on the basis of Transport Road Research Laboratory (TRRL) Road Note 29, UK).

To ensure safety and comfort to the pedestrians crossing the road, Foot over Bridges (FOB) and NMT bridges have been proposed near Buxton Junction at Abdul Saleh Road, Kangeleni Junction at Malindi Road and Changamwe Round about at Mombasa – Nairobi Road (A109) arm. NMT Bridge has been proposed at Magongo Road near Airport Road Junction – Across the Drain Box Truss type steel Foot over Bridge (FoB) with Ramps on either side, to facilitate physically challenged pedestrians, has been proposed. General Arrangement of the four Barrel RCC pipe culvert beside vehicular bridge on Magongo Road comprises 4 nos. 1000 mm diameter, with an increased discharge capacity (KNMT Project 2012 -13).

The Cost for NMT Project in the study town of Mombasa works out to 550.62 million Ksh. The quantities were derived based on engineer's estimate, which in turn, were derived from the engineering drawings. The unit rates were established based on available resources such as prevalent market rates, data from recently awarded projects, quotations from vendors, etc. (KNMT project, 2012-13).

3.0 Objective:

The objective of economic evaluation is to assess the viability of the proposed project in terms of the benefits likely to accrue to the users. This will help decision makers to justify the cost of implementation of Non-Motorized Transport interventions.

The predominant cost is the cost of construction, together with maintenance and operation costs. All costs and benefits are valued in monetary terms. The costs are expressed in economic prices to reflect the true resource cost to the economy. The economic feasibility of a project is established when the benefits are more than the cost.

Benefits to NMT users accrue when dedicated infrastructure is created for NMT. Provision of appropriate infrastructure for NMT has both short term and long term benefits. The most significant benefits in the short term are the reduction in fatal / serious injury accidents and time savings to pedestrians and cyclists due to improvement in walking and cycle speeds.

The long term benefits are more complex and related to behavioural changes. These include increase in use of NMT, with persons shifting from motorized to non – motorized modes of transport, fuel savings and reduced emissions. The present analysis is confined to the short term benefits, accruing over a period of 5 years.

4.0 Approach

The NMT project aims at reducing the risks to pedestrians and bi-cyclists by improving the quality of infrastructure for them. NMT interventions for Mombasa town comprise:

- Traffic Calming Measures such as improvement of junctions, provision of speed tables / humps, entry/exit gates at the city limits;

- New NMT Facilities viz. footpaths, cycle tracks, bi-cycle (boda boda) stands, foot over bridges, pedestrian bridges;
- Other Facilities like pedestrian railing.

Economic analysis has been carried out for the four major NMT components for which quantification of benefits was possible, viz.

- Traffic Calming Measures,
- Footpaths
- Cycle tracks, and
- Foot Over Bridges

Other components of NMT interventions have not been considered for economic analysis because of the complexity involved with quantification of benefits.
The approach for estimating the benefits of each is discussed below.

4.1.1 Component 1 : Traffic Calming Measures

Traffic Calming measures will reduce the speed of motorized traffic from 50/60 kmph to 20 kmph. While this in itself may not reduce the number of accidents, it will result in lesser force of impact and thereby reduce fatal (killed) as well as serious injury accidents (KSI). Studies worldwide, including Sub-Saharan African Transport Project in Africa (SSATP)[1], show that Traffic Calming Measures generally result in reducing KSI by 15% to 30%.

The monetary value or cost of a fatal accident is defined as the loss in productivity of the person killed. This has been calculated based on the average age of the victim, his per capita earnings, growing at 5% per annum over a total working life of 20 years. In the absence of any other data, the cost of a serious

[1] Traffic calming measures has reduced the speed to 15% in Tanzania according to the report *Assessment of NMT Programme in Kenya and Tanzania*, SSATP, World Bank and Economic Commission for Africa, page no. 28. This is further confirmed by Safety Effects of Traffic Calming, UK

injury has been assumed as 25% of the cost of a fatal accident. Thus, the major benefit of Traffic Calming Measures is the reduction in KSI and the resultant saving in loss of productivity.

It is envisaged that total accidents will not increase with growth in population in the future. The dis-benefits to the motorists, in terms of reduction in motorized speed, have not been taken into consideration.

Normally Traffic Calming measures would reduce KSI of all categories. However, since in this analysis, footpaths (which would reduce KSI of pedestrians) and cycle tracks (which would reduce KSI of cyclists) are being analysed separately, we have taken the impact of TCM to be primarily on KSI of categories other than pedestrians and cyclists.

4.1.2 Component 2 : Footpaths

Footpaths proposed are segregated facilities. This facility will have two major benefits for pedestrians. The first is reduction in KSI of pedestrians because of segregation from general traffic, and the second is improvement in walking speed because of better surface resulting in time savings. Benefits due to saving in KSI would be the same as that discussed in *Component 1*.

Time saving benefits has been estimated using average trip length for walk, walking speed –with and without improvement; per capita walk trip rate, trip purpose distribution and percentage of population being benefitted by improvement of footpaths.

The Value of Time (VOT) has been estimated for the population greater than 5 years of age, based on the average earnings per person in Kenya. The unit VOT for work is taken as the average earning per hour. The unit VOT of commuting trips (i.e. from home to work and back/home to school and back /other social and recreational purposes) has been taken as 30% of VOT of work/ business trips.

4.1.3 Component 3 : Cycle Tracks

Since bi-cycle tracks provided are also segregated facilities, these will have similar benefits viz. reduction in KSI of pedal cyclists and improvement in speed because of better surface resulting in time savings. Benefits due to saving in KSI have been discussed in *Component 1*. Time saving benefits has been discussed in *Component 2*.

4.1.4 Component 4 : Foot Over Bridges

Foot Over Bridges basically ensure safety of the pedestrians. This facility will have two major benefits. The first is safety of pedestrians resulting in reduction in pedestrian's accidents, and the second is time savings to the motorists.

Normally Foot Over Bridges would reduce KSI of Pedestrians. However, since in this analysis, footpaths (which would reduce KSI of pedestrians) are being analysed separately, we have not taken the impact of KSI on pedestrians due to FOBs especially to avoid the double counting.

Time saving benefits to motorists has been estimated using average waiting time of each motorized passenger vehicle viz. 2 Wheeler, 3 Wheeler, Car, Matatu, Mini Bus and Standard Bus –with and without construction of foot over bridges. Time savings of freight vehicles has not been estimated with the basic assumption that the time savings of freight vehicles would only increase the benefits.

The Value of Time (VOT) has been estimated for the population greater than 5 years of age, based on the average earnings per person in Kenya. The unit VOT is taken as the average earning per hour of above-mentioned vehicles users.

5.0 Costs of NMT Interventions

The capital costs of NMT interventions have been ascertained on the basis of the engineering estimates (KNMT Projects 2012-13). The operation and maintenance (O & M) cost is taken from

the second year of operation @ 2% of capital cost. A standard conversion factor of 0.85 has been used to derive the economic cost of capital investment.

The financial and economic costs of different NMT interventions for Mombasa town are presented in **Table 1.**

Table 1: Estimated Cost of Various NMT Interventions

Sl. No.	NMT Interventions	Quantity (No./ Length)	Capital Cost in Million Kenyan Shilling (Ksh.) (Financial)	Preliminary, General Supervision, Contingencies Cost in Million Ksh.	Total Cost in Million Ksh. (Financial)	Total Cost in Million Ksh. (Economic)
A. Traffic Calming Measures (TCM)						
1	Improvement of Junctions	10 Nos.	11.91	2.69	14.6	12.41
2	Speed Tables / Humps	107 Nos.				
3	Entry / Exit Gates	2 Nos.	15	3.38	18.38	15.63
Sub –Total (A)			***26.91***	***6.07***	***32.98***	***28.03***
B. New NMT Facilities						
1	Pedestrian Walkway (Footpath)	36.6 Km.	165.3	37.28	202.59	172.2
2	Cycle Track	11.0 Km.	20.05	4.52	24.57	20.89
3	Cycle Parking	4 No.	7.59	1.71	9.31	7.91
4	NMT Structures (FOBs)	3 No.	195.98	44.2	240.18	204.15
5	NMT Structure (Pedestrian Bridge)	1 No.	12.82	2.89	15.71	13.35
Sub –Total (B)			***401.74***	***90.61***	***492.36***	***418.5***
C. Other Facilities						
1	Pedestrian Railing	1.65 Km.	20.63	4.65	25.28	21.49
Sub –Total (C)			***20.63***	***4.65***	***25.28***	***21.49***
Total Cost = Sub Total (A)+(B)+(C)					***550.62***	***468.02***

Source: Engineering Cost Estimate, KNMT Project, 2012-13

6.0 Cost Benefit Analysis

In this approach, the total cost of NMT interventions is compared with the monetary value of total benefits. Since the benefits are likely to accrue in the short term, the analysis has been done for a five years period. The Benefit - Cost Ratio (BCR) has been calculated by discounting the cost and benefit streams @ 12% rate of interest.

6.1.1 Component 1: Traffic Calming Measures

Costs: The economic cost for provision of different Traffic Calming Measures is presented in **Table 1**. The investment would be incurred in 2014. O&M would be incurred from the second year of operation, i.e. 2016.

Benefits: As mentioned earlier, the benefits of traffic calming measures will accrue primarily due to saving in productivity loss of KSI accidents of categories other than pedestrians and cyclists.

KSI Reduction: The reduction in the number of KSI accidents has been estimated based on the following data/assumptions/parameters:

- No of persons (excl. pedestrians and cyclists) killed in Mombasa = 37[2] per year
- No of persons (excl. pedestrians and cyclists) seriously injured in Mombasa = 210[3] per year
- Reduction in KSI Accidents due to TCM = 30%[4]
    - Reduction in killed = 30% of 37 = 11 per year
    - Reduction in Seriously Injured = 30% of 210 = 63 per year

The cost of a fatal accident or saving in future earnings of a person killed is estimated as below:

- Per capita earning of a person in Kenya = Ksh. 11,169 per month[5]
    - Average work life = 20 years
    - Growth in earnings per year @ 5%

[2] Accident Data of Mombasa City in the year 2012.

[3] Ibid. ii

[4] Studies worldwide including Sub-Saharan African Transport Project in Africa (SSATP) show that provision of traffic calming measures generally result in reducing KSI by 15% to 30%. Here we have assumed that provision of traffic calming measures will reduce KSI by 30%.

[5] Average Salary in Kenya is Ksh. 134,032 per annum according to 2012/2013 Salary Survey (www.averagesalarysurvey.com)

- Based on the above assumptions, future earnings saved due to saving of a fatal accident is estimated as Ksh. 4,787,523 per person[6]
- Cost of a Serious Injury = 25% of cost of fatal accident i.e. Ksh. 1,196,881
- Saving in productivity loss due to reduction in killed accidents =Ksh. 4,787, 523*11 =Ksh. 53,141,503[7]
- Saving in productivity loss due to reduction in serious accidents = 1,196, 881*63 =Ksh.75,403,483[8]

The cost and benefit streams of Traffic Calming Measures for a 5- year period (2014-2019) is presented in **Table 2.**

Table 2: BCR of Component 1- Traffic Calming Measures

Year	Economic Cost (in Ksh.)			Benefits (in Ksh.)		
	Capital Cost	*O & M Cost*	*Total Cost*	*Saving in Productivity Loss – Fatal*	*Saving in Productivity Loss - Seriously Injured*	*Total Benefits*
2014(Y_0)	2,80,33,000		2,80,33,000			
2015(Y1)	-		-	5,31,41,503	7,54,03,483	12,85,44,986
2016(Y_2)		5,60,660	5,60,660	5,31,41,503	7,54,03,483	12,85,44,986
2017(Y_3)		5,60,660	5,60,660	5,31,41,503	7,54,03,483	12,85,44,986
2018(Y_4)		5,60,660	5,60,660	5,31,41,503	7,54,03,483	12,85,44,986
2019(Y_5)		5,60,660	5,60,660	5,31,41,503	7,54,03,483	12,85,44,986
NPV@12% in2014			***2,63,87,022***			***46,33,75,907***
BCR in 2014-2019			***17.56***			
BCR in 2014-2015			***4.59***			

The BCR of Traffic calming measures in the first five years of operation is 17.56, and in the first year of operation are 4.59.

[6] Saving in future earnings due to fatal accidents =11169.333*12*(((1+0.05)^21)-1)/((1+0.05)-1) =4,787,523 (ksh.), (Formula: S = earnings per month (salary)*12*[(1+r)^ (n+1)-1/(1+r)-1], where S= saving in future earnings, r=rate of growth of earnings per annum and n= work life).

[7] Decimal values have been taken into consideration.

[8] Accident Data of Mombasa City in the year 2012.

Thus the provision of traffic calming measures is economically viable right from the first year of operation.

6.1.2 Component 2: Footpaths

Costs: The economic costs of construction and rehabilitation of footpaths is presented in **Table 1**. The investment would be incurred in 2014. O&M would be incurred from the second year of operation, i.e. 2016.

Benefits: Segregated footpaths will provide safety, speed and comfort to pedestrians during walk trips. These are expected to reduce pedestrian KSI, as well as bring about time savings. Benefits like comfort are difficult to quantify and hence not included in the analysis.

Pedestrian KSI Reduction: The reduction in the number of pedestrian KSI has been estimated based on the following data/assumptions/parameters:

- No of pedestrians killed in Mombasa = 38[9] per year
- No of pedestrians seriously injured in accidents in Mombasa = 37[10] per year
- Length of footpaths (36.6 km) provided in Mombasa comprise about 19% of city footpaths
- Reduction in pedestrian KSI Accidents due to footpaths = 25%[11]
- Hence, reduction in pedestrians killed = 25% of 19% i.e. 5% of total pedestrians killed
    - Reduction in killed accidents= 5% of 38 = 2 per year
    - Reduction in seriously injured accidents= 5% of 37 = 2 per year

[9] Ibid. viii

[10] Ibid. viii

[11] Studies worldwide including Sub-Saharan African Transport Project in Africa (SSATP) show that provision of footpaths generally results in reducing KSI by 20% to 35%. Here we have assumed that provision of footpaths will reduce KSI of pedestrians by 25%.

The costs of a fatal and seriously injured accident, described in *Component 1*, are Ksh. 4,787,523 and Ksh. 1,196,881 respectively. Hence, the total benefits due to reduction in pedestrian KSI worked out to Ksh. 10,688,444 per annum.[12]

Pedestrian Time Savings: Pedestrian time savings have been estimated based on the following:

- Average walk trip length of pedestrian in Mombasa town = 1.02 Km[13]
- Average walking speed[14]
    - Without project = 2.25 kmph
    - With segregated footpaths = 3.5 kmph
- Per Capita Trip Rate of pedestrian (PCTR-walk) in Mombasa town = 1.68[15]
- Total no. of pedestrians in 2015 in Mombasa = 1,856,635[16]
- Time saved per walk trip after improvement = 10 minutes
- Time saved per pedestrian in a year, taking 300 days[17] a year = 81 hours
- Percentage of Pedestrians benefitted by provision of footpaths = 19% = 340,672[18]

[12] Benefits due to reduction in pedestrian KSI = (1.796*4,787,523) + (1.748*1,196,881) = 10,688,444 ksh. (Decimal values have been considered).

[13] House Hold Survey 2013 (KNMT project 2012-13).

[14] Available literature for Eldoret town in Kenya shows that with construction and rehabilitation of footpaths, the speed of a pedestrian will increase from 2.25 kmph. to 3.5 kmph. -Assessment of NMT Programme in Kenya and Tanzania, SSATP, World Bank and Economic Commission for Africa, page no. 38.

[15] House Holds Survey Mombasa 2013.

[16] Population growth rate in Mombasa is 3.24 % per annum during the period 1999 to 2009. Per capita Trip rate is 1.68. Thus total no of Pedestrian in 2015 will be: 1,108,282*1.68 = 1,856,635.

[17] Here 300 working days have been considered by excluding 52 Sundays and 13 holidays in a year.

[18] The projected population of Mombasa town for 2015 is 1,108,282. Population growth rate has been taken @ 3.24 % per annum. The total number of Pedestrians is estimated from the PCTR-walk of 1.68. Improvement of 36.6 km footpaths constitutes 19% of total footpath length in the city. Thus, 19% of pedestrians will be using the improved footpaths.

Value of Time (VOT): The unit VOT of a person in Kenya has been estimated based on the following:

- Average monthly earnings per person in Kenya = Ksh. 11,169[19]
- Hourly income, considering 8 work hours a day and 22 work days a month = Ksh.63
- Wage Rate or VOT for business trip is taken as the hourly income = Ksh. 63/hour
- VOT for Non-business trip @ 30% of VOT of business trip = Ksh. 19/hour
- Business trips are 9% and non-business trips are 91% of total trips[20]
- Thus, Average VOT is estimated as Ksh. 23/hour[21]
- Benefits to pedestrians due to time saving have been estimated by taking into account increase in VOT @5% per annum and growth in population @ 3.24% per annum

The cost and benefit streams of Footpaths for a 5- year period (2014-2019) is presented in **Table 3.**

Table 3: BCR of Component 2-Footpaths

Year	Economic Cost (in Ksh.)			Benefits (in Ksh.)			
	Capital Cost	*O & M Cost*	*Total Cost*	*Saving in Productivity Loss – Fatal*	*Saving in Productivity Loss - Seriously Injured*	*Time Saving*	*Total Benefits*
2014(Y_0)	17,22,01,500		17,22,01,500				
2015(Y_1)	-		-	85,95,997	20,92,447	65,74,72,294	66,81,60,738
2016(Y_2)		34,44,030	34,44,030	85,95,997	20,92,447	71,27,38,659	72,34,27,103
2017(Y_3)		34,44,030	34,44,030	85,95,997	20,92,447	77,26,50,651	78,33,39,095
2018(Y_4)		34,44,030	34,44,030	85,95,997	20,92,447	83,75,98,776	84,82,87,220
2019(Y_5)		34,44,030	34,44,030	85,95,997	20,92,447	90,80,06,366	91,86,94,810
NPV@12% in2014			***16,20,90,563***				***2,79,12,43,011***
BCR in 2014-2019			***17.22***				
BCR in 2014-2015			***3.88***				

[19]Average Salary in Kenya is Ksh. 134,032 per annum according to 2012/2013 Salary Survey (www.averagesalarysurvey.com)

[20] Household surveys in 2013 indicate that non business trips are 91% while work and business trips are only 9% of the total trips.

[21] VOT assumed to increase @ 5% per annum.

Results: the Construction and rehabilitation of footpaths is economically viable as the BCR is 17.22 in the first five years (2014 to 2019) of operation. The BCR in the first year of provision of footpaths is 3.88. Thus the provision of footpaths is economically viable right from the first year of operation.

6.1.3 Component 3 : Cycle Tracks

Costs: The economic cost of construction and rehabilitation of cycle tracks is presented in **Table 1**. The investment would be incurred in 2014. O&M would be incurred from the second year of operation, i.e. 2016.

Benefits: Segregated cycle tracks will provide safety, speed and comfort to pedal cyclists. These are expected to reduce cyclist KSI, as well as bring about time savings. Benefits like comfort are difficult to quantify and hence not included in the analysis.

Reduction in Cyclists KSI: The reduction in the number of cyclist KSI has been estimated based on the following data/assumptions/parameters:

- No of cyclists killed in aciidents in Mombasa = 8[22] per year
- No of cyclists seriously injured in Mombasa = 7 [23]per year
- Length of cycle tracks (11.0 km) provided in Mombasa comprise about 6% of city network
- Reduction in cyclist KSI Accidents due to cycle tracks = 40%[24]
- Reduction in cyclist KSI Accidents due to cycle tracks = 6%

[22] Accident Data of Mombasa City in the year 2012.

[23] Ibid. xxii

[24] Studies worldwide, including Sub-Saharan African Transport Project in Africa (SSATP), shows that cycle tracks generally result in reducing KSI by 25% to 50%. Here we have assumed that provision of cycle track will reduce KSI of cyclists by 40%.

- Hence, reduction in cyclists killed = 40% of 6% i.e. 2.4% of total cyclists killed
    - Saving in productivity loss due to reduction in killed in accidents = Ksh. 919,204
    - Saving in productivity loss due to reduction in Seriously Injured = Ksh.201,076

The costs of a fatal and seriously injured accident, described in *Component 1*, are Ksh. 4,787,523 and Ksh 1,196,881 respectively. Hence, the total benefits due to reduction in cyclist KSI worked out to Ksh. 1,120,280 per annum[25].

Cyclist's Time Savings: Cyclist time savings have been estimated based on the following:

- average length of cycle trip in Mombasa town = 2.14 Km[26]
- Average cycling speed[27]
    - Without project = 10 kmph
    - With segregated cycle tracks = 14 kmph
- Per Capita Trip Rate of cyclist (PCTR-cycle) in Mombasa town = 0.09[28]
- Time saved per cycle trip after improvement = 3.67 minutes
- Time saved per cyclist in a year, taking 300 days a year = 18.34 hours
- Percentage of cyclists benefitted by provision of cycle tracks = 6% = 5,966[29]

[25] 919,204 + 201,076 = 1,120,280 Ksh

[26] House Holds Survey of Mombasa City 2013.

[27] Available literature for Eldoret town shows that with construction and rehabilitation of cycle tracks the speed of a cyclist will increase from 10 kmph. to 14 kmph-The significance of Non-Motorized Transport in Developing Countries, (SSATP Report Result World Bank and Economic Commission for Africa , Annex.11.8 and 11.10) page. 75,133 & 135).

[28] House Holds Survey in Mombasa in 2013.

[29] The projected population of Mombasa town for 2014 is 1,073,462. Population growth rate is 3.24 % per annum. The total number of cyclists is estimated from the PCTR-cycle of 0.09. Improvement of 11.0 km cycle tracks

Value of Time (VOT): The VOT estimation has been discussed above. The average VOT of Ksh 23/hour has been adopted.

- Benefits to cyclists due to time saving have been estimated by taking into account increase in VOT @5% per annum and growth in population @ 3.24% per annum.

The cost and benefit streams of Cycle tracks for a 5- year period (2014-2019) is presented in **Table 4.**

Table 4: BCR of Component 3-Cycle Tracks

Year	Economic Cost (in Ksh.)			Benefits (in Ksh.)			
	Capital Cost	*O & M Cost*	*Total Cost*	*Saving in Productivity Loss – Fatal*	*Saving in Productivity Loss - Seriously Injured*	*Time Saving*	*Total Benefits*
2014(Y_0)	2,08,84,500		2,08,84,500				
2015(Y_1)		-	-	9,19,204	2,01,076	25,18,812	36,39,092
2016(Y_2)		4,17,690	4,17,690	9,19,204	2,01,076	27,30,540	38,50,820
2017(Y_3)		4,17,690	4,17,690	9,19,204	2,01,076	29,60,066	40,80,346
2018(Y_4)		4,17,690	4,17,690	9,19,204	2,01,076	32,08,886	43,29,166
2019(Y_5)		4,17,690	4,17,690	9,19,204	2,01,076	34,78,621	45,98,901
NPV@12% in2014			***1,96,58,251***				***1,45,84,153***
BCR in 2014-2019			***0.74***				
BCR in 2014-2015			***0.17***				

Results: The BCR for the construction of cycle tracks is 0.74 in the first five years (2014 to 2019) of operation. The BCR in the first year of provision of footpaths is 0.17. Thus, the provision of cycle tracks is not economically viable on its own.

6.1.4 Component 4: Foot Over Bridges

Costs: The economic costs of construction of 3 foot over bridges and 1 pedestrian bridge are presented in **Table 1**. The investment would be incurred in 2014. O&M would be incurred from the second year of operation, i.e. 2016.

Benefits: Foot over bridges will ensure safety of pedestrians and time savings to motorists. The benefits accruing due to provision of three foot over bridges across the roads have been

constitutes approximately 6% of total road length in the city. Thus, 6% of cyclists will be using the improved cycle tracks.

considered for economic analysis. The pedestrian bridge proposed across the drain is only a widening of the already existing facility. This bridge will ensure convenience, comfort and safety of pedestrians but there will be very little time savings to them due to the improvement. Therefore, the benefit of time savings because of the widening of pedestrian bridge has not been considered in this analysis.

Normally Foot Over Bridges would reduce KSI of Pedestrians. However, since in this analysis, footpaths (which would reduce KSI of pedestrians) are being analysed separately, we have not taken the impact of KSI on pedestrians particularly due to FOBs to avoid double counting. However, there will be significant time savings to motorists because of the provision of FOBs. Thus, the benefits of time savings of motorists have been considered for the analysis.

Time Savings to Motorists: Time savings to motorists have been estimated based on the following assumptions:

- Average waiting time of each motorist in Mombasa town without provision of FOBs = 10 seconds[30]
- Thus, time saved by each motorist with provision of FOBs =10 seconds = 0.0028 hours
- Time savings by 2 wheelers in a year (assuming 300 working days in a year)
    - Number of 2 wheelers benefited = 4,855[31]
    - Each 2 wheeler will save =10 seconds / day= 0.0028 hours /day
    - 4,855 numbers of 2 wheelers will save = 13.49 hours /day
    - Average occupancy of a 2 wheeler = 1.2
    - Total Passenger Hours saved in a day = 13.49*1.2 =16.18 hours / day

[30] Provision of FOBs helps in 20 seconds time saving for each motorized vehicle. The average waiting time of each motorized vehicle is 50% of 20 seconds i.e. 10 seconds

[31] Traffic Volume Count Data (KNMT Project, 2013).

  - Thus, total passenger hours saved in a year = 16.18 * 300 = 4,885 hrs
- Time savings by 3 wheelers in a year (assuming 300 working days in a year)
  - Number of 3 wheelers benefited = 5,241[32]
  - Each 3 wheeler will save =10 seconds / day= 0.0028 hours /day
  - 5,241 numbers of 3 wheelers will save = 14.56 hours / day
  - Average occupancy of a 3 wheeler = 2
  - Total Passenger Hours saved in a day = 14.56*2 =29.12 hours / day
  - Thus, total passenger hours saved in a year = 29.12 * 300 = 8,735 hrs
- Time savings by Cars in a year (assuming 300 working days in a year)
  - Number of cars benefitted = 13, 519[33]
  - Each car will save =10 seconds / day= 0.0028 hours /day
  - 13, 519 numbers of car will save = 37.55 hours / day
  - Average occupancy of a car = 3
  - Total Passenger Hours saved in a day = 37.55*3=112.66 hours / day
  - Thus, total passenger hours saved in a year = 112.66 * 300 = 33,798 hrs.
- Time savings by Matatus in a year (assuming 300 working days in a year)
  - Number of Matatus benefitted= 15, 205[34]
  - Each Matatu save =10 seconds / day= 0.0028 hours /day

[32] Ibid. xxxi
[33] Ibid. xxxi
[34] Ibid. xxxi

  - 15,205 numbers of Matatus will save = 42.24 hours / day
  - Average occupancy of a Matatu = 14
  - Total Passenger Hours saved in a day = 42.24*14 =591.31 hours / day
  - Thus, total passenger hours saved in a year = 591.31 * 300 = 177,392 hrs.
- Time savings by Mini Buses in a year (assuming 300 working days in a year)
  - Number of Minibuses benefitted = 1,311[35]
  - Each Mini bus will save =10 seconds / day= 0.0028 hours /day
  - 1,311 numbers of Mini buses will save = 3.64 hours / day
  - Average occupancy of a Mini bus = 25
  - Total Passenger Hours saved in a day = 3.64*25 =91.04 hours / day
  - Thus, total passenger hours saved in a year = 91.04* 300 = 27,313 hrs.
- Time savings by Standard Buses in a year (assuming 300 working days in a year)
  - Number of Std. Bus benefitted= 677[36]
  - Each Std. bus will save =10 seconds / day= 0.0028 hours /day
  - 677 numbers of Std. buses will save = 1.88 hours / day
  - Average occupancy of a Std. bus = 40
  - Total Passenger Hours saved in a day = 1.88*40 =75.22 hours / day
  - Thus, total passenger hours saved in a year = 75.22* 300 = 22,567 hrs.

Value of Time (VOT): The unit VOT of a person in Kenya has been estimated based on the following:

[35] Ibid. xxxi
[36] Ibid. xxxi

- Average monthly earnings per person in Kenya = Ksh. 11,169[37]
- Hourly income, considering 8 hours of work in a day and 22 work days a month = Ksh. 63
- VOT is taken as the hourly Wage rate = Ksh. 63/hour

The cost and benefit streams of Foot Over Bridges for a 5- year period (2014-2019) is presented in **Table 5.**

Table 5: BCR of Component 4-Foot Over Bridges

Year	Economic Cost (in Ksh.)			Benefits (in Ksh.)			
	Capital Cost	*O & M Cost*	*Total Cost*	*Saving in Productivity Loss – Fatal*	*Saving in Productivity Loss - Seriously Injured*	*Time Saving*	*Total Benefits*
2014(Y_0)	20,41,53,000		20,41,53,000				
2015(Y_1)		-	-	0	0	2,46,17,274	2,46,17,274
2016(Y_2)		40,83,060	40,83,060	0	0	2,69,97,917	2,69,97,917
2017(Y_3)		40,83,060	40,83,060	0	0	2,71,40,545	2,71,40,545
2018(Y_4)		40,83,060	40,83,060	0	0	2,84,97,572	2,84,97,572
2019(Y_5)		40,83,060	40,83,060	0	0	2,99,22,451	2,99,22,451
NPV@12% in2014			***19,21,66,007***				***9,79,09,911***
BCR in 2014-2019			***0.51***				
BCR in 2014-2015			***0.12***				

Results: The BCR of foot over bridge is 0.51 in the first five years (2014 to 2019) of operation. The BCR in the first year of construction of foot over bridges 0.12. Thus, the provision of foot over bridge is not economically viable on its own.

6.1.5 Total NMT Project

The Benefit – Cost Ratio of the total NMT project, comprising of Components 1, 2, 3 and 4 is presented in **Table 6.**

Table 6: Benefit - Cost Ratio of Total NMT Project

[37]Average Salary in Kenya is Ksh. 134,032 per annum according to 2012/2013 Salary Survey (www.averagesalarysurvey.com)

Year	Economic Cost (in Ksh.)			Benefits (in Ksh.)			
	Capital Cost	*O & M Cost*	*Total Cost*	*Saving in Productivity Loss – Fatal*	*Saving in Productivity Loss - Seriously Injured*	*Time Saving*	*Total Benefits*
2014(Y_0)	42,52,72,000		42,52,72,000				
2015(Y_1)	-		-	6,26,56,704	7,76,97,006	68,46,08,380	82,49,62,090
2016(Y_2)	-	85,05,440	85,05,440	6,26,56,704	7,76,97,006	74,24,67,116	88,28,20,826
2017(Y_3)	-	85,05,440	85,05,440	6,26,56,704	7,76,97,006	80,27,51,262	94,31,04,972
2018(Y_4)	-	85,05,440	85,05,440	6,26,56,704	7,76,97,006	86,93,05,234	1,00,96,58,944
2019(Y_5)	-	85,05,440	85,05,440	6,26,56,704	7,76,97,006	94,14,07,438	1,08,17,61,148
NPV@12% in 2014			***40,03,01,844***				***3,36,71,12,982***
BCR in 2014-2019			***8.41***				
BCR in 2014-2015			***1.94***				

7.0 *Conclusion:*

The overall provision comprising NMT facilities viz. traffic calming measures, footpaths and cycle tracks, is economically viable as the BCR is 8.41 in the first five years of operation. The provision is also economically viable in the first year operation. As provision of traffic calming measures generates the highest benefits, with a high BCR, it should be taken up first, followed by footpaths and others.

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